SCOTTISH NATURAL HERITAGE

RSM No 179 (Volume 1 of 3)

Sand dune vegetation survey of Scotland: East Coast
Volume 1: Main report

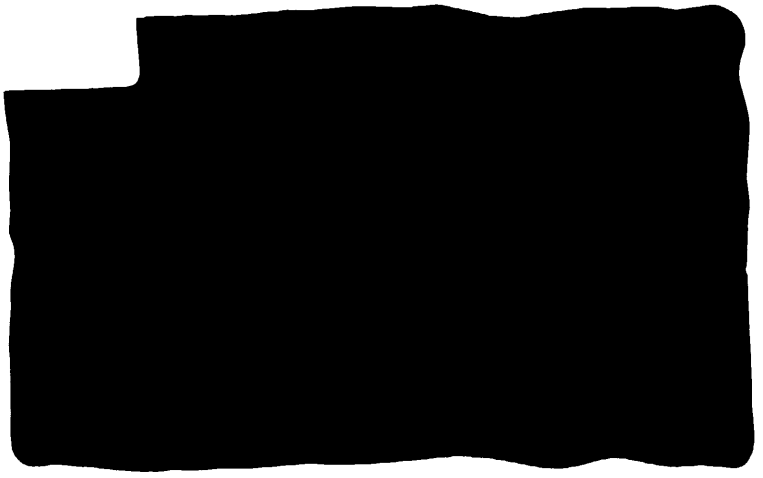
T Dargie

2001

SCOTTISH NATURAL HERITAGE

Research, Survey and Monitoring

REPORT



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Sand dune vegetation survey of Scotland: East Coast
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Dr Tom Dargie, Loch Fleet View, Skelbo Street, Dornoch IV25 3QQ

Nominated Officer:	Stewart Angus, Advisory Services
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Report to:	Scottish Natural Heritage
Contract No:	SNH/032/95/AEB (1998/1999-1999/2000)

The Sand Dune Vegetation Survey of Scotland has been in progress since 1994. The report on the East Coast is part of a series of eight reports covering the whole coast of Scotland. It is split into three Volumes, as follows:

Volume 1: Main report
Volume 2: Site reports
Volume 3: NVC maps (These maps have been reduced to a scale of approximately 1:15,000 for production of this report. Sets of the original maps at 1:10,000 are located within the Maritime Group, Advisory Services, Scottish Natural Heritage, 27 Ardconnel Terrace, Inverness IV2 3AE).

The complete series of reports for the Sand Dune Vegetation Survey of Scotland covers:

- Western Isles
- Orkney
- Shetland
- NW Scotland, mainland
- Moray Firth
- East Coast
- SW Scotland
- Inner Hebrides

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Publications Section
Battleby, Redgorton, Perth PH1 3EW
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A family business has captured the efforts of fieldwork to produce this report. Monica Dargie has deciphered field notebooks to produce the target note list and enter quadrat data into VESPAN2 format, a piece of software requiring much patience, as well as assisting in editing output to produce summary floristic constancy tables. The quadrat datasets in earlier NVC surveys were entered into VESPAN2 and tabulated by Dr Salima Benhouhou to produce the floristic tables in this volume. Field vegetation maps and existing NVC surveys have been digitised with great care by James and Alastair Dargie, including earlier work completed at Loch of Strathbeg, Sands of Forvie, Foveran, Barry Links, Tentsmuir, Aberlady Bay and West Links, Gullane. The very onerous chore of labelling maps using GIS software has been completed with help from Monica Dargie.

Overall support for this complex project has come from Kathy Duncan and Stewart Angus of Scottish Natural Heritage. I am particularly grateful for time spent on careful reading of draft text, including feedback from regional staff.

SUMMARY

1. This three-volume report presents the results of surveys of the dunes of the East Coast of Scotland (Cairnbulg Point to the English Border) undertaken between 1995 and 1998 using the National Vegetation Classification (NVC). The first volume describes the methods used and describes the major vegetation types found. The second volume consists of dune site reports, organised by coastal sectors along the East Coast. The third volume consists of NVC vegetation maps. This work is part of the Sand Dune Vegetation Survey of Scotland (SDVSS) which aims to complete NVC survey of all dunes in Scotland between 1994 and 2000.

2. Survey results were captured, analysed and presented using a geographical information system (GIS). This allowed accurate measurement of the extent of different vegetation types and other types of land cover, export of area data for analysis using spreadsheets, and production of various types of map.

3. The total area of windblown sand which can support vegetation on the East Coast is estimated at 11566 ha. In addition, surveys recorded and mapped beach area, adjacent maritime cliff and saltmarsh, rock outcrop, and running/open water within dunes (470 ha). This is the final region to be completed and allows the total extent of dune and machair vegetation in Scotland (50,002 ha) and Great Britain (*c.* 70,000 ha) to be calculated. The East Coast total therefore represents 23% of extent in Scotland and 17% of extent in Great Britain.

4. Survey recorded 310 types of vegetation and other land cover, distributed in 47 sites. This total included intermediate vegetation types. Quadrat data describing vegetation totalled 740 samples, mainly taken from existing comprehensive NVC surveys for a few sites. Local conditions were also described using 520 target notes.

5. Survey results suggest that vegetation types undescribed by the NVC are present in East Coast dunes. These types cover mobile, semi-fixed dune, fixed calcareous and acidic dune, slack, wet heath, and scrub habitats. Most of these types are described using summary floristic tables allowing comparison with published NVC data, with others referred to summary tables in other regional dune reports produced as part of the SDVSS.

6. The NVC survey results suggest that East Coast dunes have vegetation ranging from more oceanic and calcareous conditions (around Rattray Head) to more continental types developed on acidic soils which are very extensive in this region. Soil conditions appear to be the major factor influencing typical dune vegetation.

7. Overall vegetation condition is sometimes excellent and fine examples of most dune habitats are present. Particularly notable are the large extents of mobile dune, semi-fixed dune, fixed calcareous dune, fixed acidic dune, dry dune heath, wet dune heath and dune slack. The large extent of vegetated blown sand in the East Coast is dominated by four very large sites (>1000 ha): Tentsmuir (3330 ha, the largest site in Britain), Arbroath to Broughty Ferry (1641 ha, dominated by Barry Links), Inverallochy to Peterhead (1258 ha) and Newburgh to Bridge of Don (1083 ha).

8. The SSSI series covering dunes and machair includes several outstanding sites, including two candidate Special Area of Conservation which have dune heath as major interests (Sands of Forvie, Barry Links). All major and typical dune habitats are covered by the SSSI series and SSSI condition is in general good.

9. Several East Coast sites are small and have little high-quality dune vegetation. Larger sites contain the very best ground but many are modified, with improved grassland developed in large quantities (2021 ha). Large areas of dune are used as links golf courses, mostly with strongly modified mown fairway habitat mixed with long-ungrazed rank grassland, scrub and occasionally significant areas of dune heath. Most management for golf can be considered a reduction in nature conservation value. Grazing pressure is rarely high and lack of grazing is more widespread, producing less diverse grasslands and high scrub cover. Very large areas of conifer plantation are present (1616 ha) but tracts of the oldest plantings closely resemble native pinewood vegetation and in time will develop into a significant area of dune woodland. This will require careful planned management and should consider adjacent more typical dune vegetation, as well as attempting reinstatement of former dune habitats.

10. Data on the extent of bare sand suggest that most dunes on the East Coast are stable. Six sites have more than 2.5% bare sand and only one (Newburgh to Bridge of Don) has more than 5% of site area in this condition. Here, a set of very large parabolic blowout dunes are well-developed and are perhaps the most active in Scotland at present. Evidence for slow coastal erosion of the seaward edge is widespread but there is good accretion in several sites.

1 AIMS AND METHODS

1.1 The Sand Dune Vegetation Survey of Scotland (SDVSS)

Scottish Natural Heritage (SNH) commissioned a vegetation survey of dunes in Scotland in August 1994. The project broadly followed the approach adopted by the Sand Dune Vegetation Survey of Great Britain (SDVSGB) which used the National Vegetation Classification (NVC) (Rodwell 1991 *et seq.*) as the basis for mapping areas with vegetated dune sand. The SDVSGB achieved a full survey of dunes in England (Radley 1994) and Wales (Dargie 1995a) between inception in 1987 and completion of survey work in 1992. A partial survey of Scottish dunes was achieved in this period as part of the SDVSGB, covering 30% of estimated vegetated sand area but perhaps only 5% of dune sites (Dargie 1993). The aim of the SDVSS is to complete work for remaining dune areas in Scotland which lack NVC survey, integrating results with earlier studies to provide a full survey of the national dune resource.

The principal objectives of the SDVSS project are:

- to locate areas of vegetated windblown sand around the coast of Scotland;
- to map and describe the vegetation of unsurveyed areas in the field using the NVC system;
- to harmonise SDVSS results with existing NVC surveys of other sites;
- to present results in a series of reports covering different sectors of the Scottish coast;
- to synthesise results from different coastal sectors as a national report covering all of Scotland.

1.2 Previous dune surveys of the East Coast

The dunes, links and other habitats on blown sand of the East Coast are well-studied. Systematic studies of beaches and their adjacent dune/links systems were completed for the Countryside Commission for Scotland (Ritchie, Smith & Rose 1978; Ritchie, 1979; Wright, 1979; Rose, 1980), together with an overview for all of Scotland (Ritchie & Mather 1984). The first systematic vegetation survey covering selected areas took place in the late 1970s and early 1980s (Shaw, Hewett & Pizzey 1983) but this used techniques and a classification system which are difficult to relate to the NVC (Dargie 1992a). Formal survey using NVC methods began in 1988 using a draft NVC classification of dune vegetation. This covered sites at Tentsmuir (Robertson, 1988) and Barry Links (Woolven, 1988). The draft NVC classification was revised in 1989 and surveys using this version were completed as part of the SDVSGB at Foveran Links and Loch of Strathbeg (Doarks, Holder & Radley, 1994a,b), Aberlady Bay (Dargie, 1992b) and Sands of Forvie (Dargie, 1992c). The 1988 NVC survey of Barry Links was provisionally harmonised with the 1989 NVC classification following field visits in 1995 to provide information for the Natura 2000 notification process (Dargie, 1995b). Two additional surveys using the NVC system have also been undertaken recently in East Lothian: at West Links, Gullane on land being considered for development as a golf course within Gullane to Broadsands SSSI (Averis, 1998), and at Gullane Links Golf Course (within Aberlady Bay SSSI) to inform management of areas of nature conservation interest (Tidswell, 1997). Information on NVC maps has also been used to examine vegetation change since the late 1940s at two sites using air photo interpretation: Tentsmuir and Earlshall Muir (Dargie, 1994c) and Barry Links (Dargie, 1998).

1.3 Sites and site assemblages

Sites were considered to be *site assemblages*, areas defined as windblown sand with limits extending inland from the Mean High Water Spring Tide (MHWS) line on OS maps to where windblown sand ceased to be the dominant medium in the plant rooting zone. Such assemblages cover a very wide range of ecological conditions from open beach to swamp and fen, and include arable land, improved pasture and land take for tracks, pits, buildings etc. Large open water areas, notably lochs, were usually excluded from survey since they represent aquatic rather than terrestrial habitats and are subject to different survey methods and a non-NVC classification. Small outlier areas of windblown sand adjacent to large blocks were generally considered as part of the main block. Earlier work on dunes has focused on beaches and these form the basis of published lists of dune sites (e.g. Ritchie & Mather 1984). However, the windblown sand of the hinterland behind several beaches is often continuous and separate beaches can belong to one single large area of windblown sand (e.g. blown sand deposits are continuous from Elie East Links to Earlsferry Links in Fife, and from Aberlady to North Berwick in East Lothian). Furthermore, there are four long stretches of open coast with a dune frontage (from just south of Cairnbulg Point at Inverallochy to Peterhead; from Newburgh on the south side of the Ythan Estuary to Aberdeen; from Arbroath to Broughty Ferry, including Barry Links). In some cases groups of adjacent small bay dune systems are treated as one site assemblage. Given these forms of treatment it is important to recognise that site assemblages in this report do not necessarily correspond with sites and site boundaries used in other work. The

term site is used synonymously here with site assemblage. Site assemblage locations along the East Coast are illustrated in Map 1.1.

1.4 SDVSS field preparation

Preparation for fieldwork aimed to abstract a list of potential sites from the above studies, together with the likely extent of sand in each area. Soil maps produced by the Macaulay Institute for Soil Research proved to be the best in terms of recording the full extent of windblown sand, though this did not become clear until well into the 1996 field season. Access permission was sought from landowners and tenants using a combination of formal letters, telephone contacts and on-site verbal requests. The SNH offices in Aberdeen, Airlie, Cupar, Dalkeith and Galashiels were visited and copies made of 1:10,000 and 1:10,560 OS maps likely to have windblown sand. Air photo collections were also examined to determine the extent and quality of recent coverage but none was of a sufficiently large scale to be used for field survey.

1.5 Fieldwork time requirements

The East Coast survey was completed in the following time sequence: May 1995 (Barry Links SSSI, as part of work for the Natura 2000 programme) and May to October 1999 for the remainder of the region. An initial estimate of sand area for survey based on SNH and JNCC Coastal Database information, excluding all previous NVC work, summed approximately to 4100 ha. This proved to be a major underestimate, with 1999 survey covering approximately 8900 ha of unsurveyed ground. Three days in May 1995 and five days in 1999 were also spent within the areas of earlier survey at Aberlady Bay, Tentsmuir, Barry Links, Foveran and Sands of Forvie, harmonising 1988 and 1990s results with the current NVC system and new vegetation types found elsewhere upon the Scottish coast. Field time totalled approximately 57 days between May 1995 and October 1999.

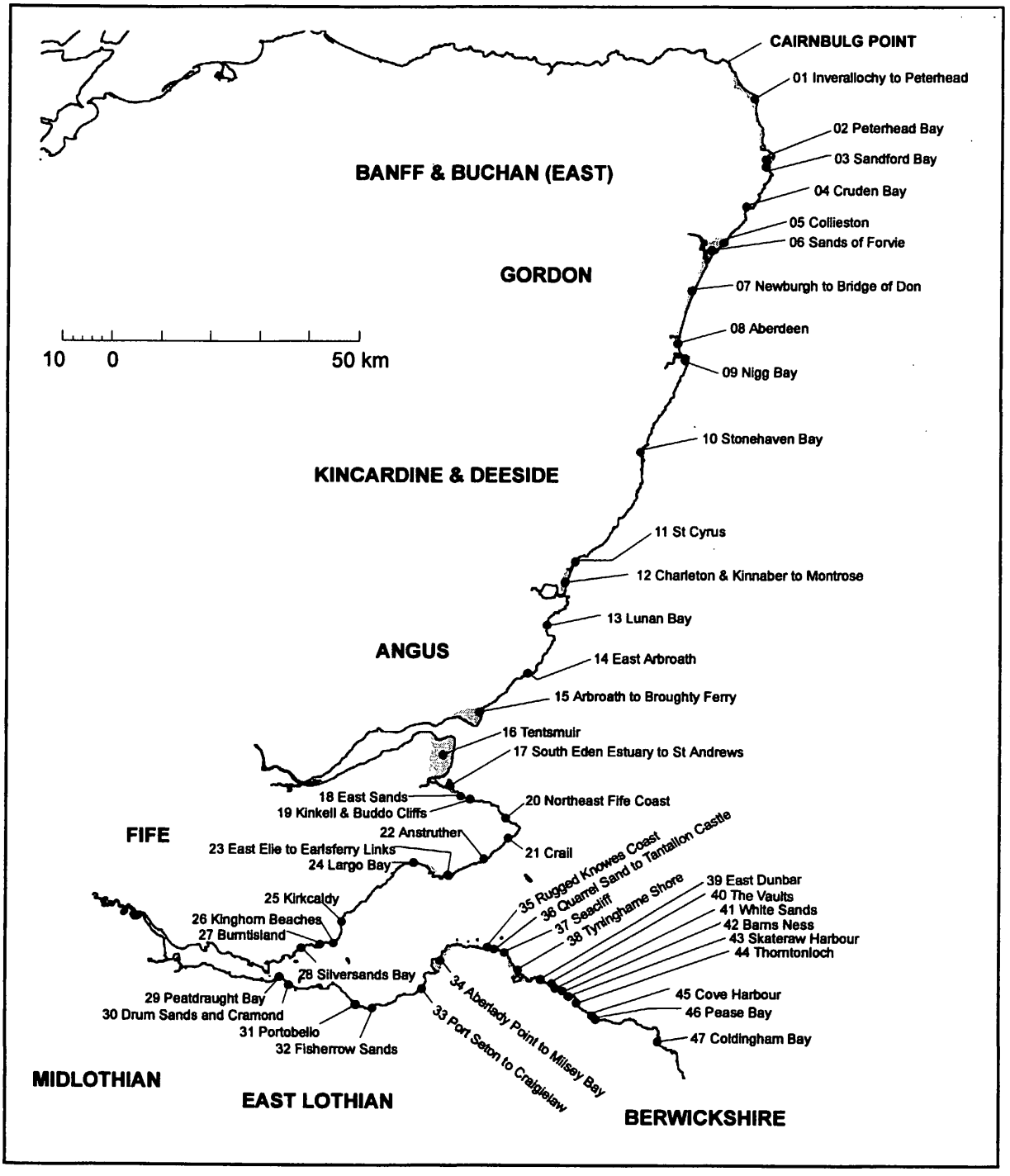
1.6 Unsurveyed sites or parts of sites

Most of the vegetated windblown sand along the East Coast has been surveyed, including virtually all typical dune vegetation. It is likely that very small amounts of dune vegetation occur in isolated bays along this considerable coastline but total extents are likely to be very low. It was not possible in October 1999 to reach a very small beach on Inchcolm Island in the Firth of Forth (NT190826) and this is the only known beach with vegetated sand which has not been surveyed. The vegetated sand area here is probably no more than 0.1 ha.

1.7 Field methods

Field survey followed a combination of techniques used in the SDVSGB and those recommended for NVC survey (Rodwell in prep.):

- ground to be covered in a morning or afternoon of work was walked to establish the range of habitat conditions present;
- areas with visually homogeneous vegetation were demarcated by boundaries in pencil on a drafting film overlay placed upon an A3 copy of the OS 1:10,000 or 1:10,560 map for the field area, adding a mapping code for the vegetation type;
- areas with mosaic conditions (two or more types of homogeneous vegetation and/or other land cover varying over short distances, often due to microtopography in hummocky dune terrain) were also drawn in pencil and codes added for their constituent types which included an estimate of extent for each type (in tenths of demarcated area/polygon);
- quadrats were recorded in a waterproof field notebook. Selected areas of visually homogeneous vegetation were used by marking the corners of a 2m x 2m area. All vascular plants, bryophytes and lichens were identified and their cover/abundance estimated using the Domin scale (Table 1.1). Herb and moss layer height (cm), shrub/herb/moss cover, bare sand and open water were also estimated as percentage scores. Over time an attempt was made to record the commoner dune vegetation types by five separate quadrats recorded from different patches of the same vegetation, often in separate areas of blown sand. Rarer vegetation types and possible new NVC categories were described in the SDVSS using at least five quadrats, sometimes recording more than one quadrat from a single area of homogeneous vegetation;
- quadrat positions were recorded as an eight-figure (10 metre) grid reference using either map information or GPS (Garmin GPS 12). The GPS instrument is probably accurate to 40 metres (root mean square error);
- target notes were recorded in a waterproof field notebook, providing descriptive information on typical and contrasting habitats (e.g. grazing differences in vegetation either side of a fence), beach condition (erosion or accretion evidence) and anthropogenic impacts (e.g. tipping, sand pit excavation, stock carcass burial). The positions of target notes were recorded as an eight-figure (10 metre) grid reference using either map information or a GPS instrument.



Map 1.1 East Coast site assemblage locations

These methods produced datasets totalling 740 quadrats and 520 target notes for all survey (including quadrats from previous NVC surveys along the East Coast).

Table 1.1 Domin scale values for species cover/abundance
Source: Rodwell (In prep.)

Domin scale value	Cover/abundance
1	one or few individuals, cover <4%
2	several individuals, cover <4%
3	many individuals, cover <4%
4	4 - 10% cover
5	11 - 25% cover
6	26 - 33% cover
7	34 - 50% cover
8	51 - 75% cover
9	76 - 90% cover
10	91 - 100% cover

1.8 Quadrat data and target note table preparation

Quadrat data were entered into a computer database using the VESPAN2 suite of microcomputer programs produced by Andrew Malloch of Lancaster University (Malloch 1988). Quadrats of a particular vegetation type were grouped manually using the TABLE program in VESPAN2, comparing the results with tables and written descriptions provided in the various chapters of the NVC (Rodwell 1991 *et seq.*). In the case of vegetation types with five or more quadrats, a constancy value (Table 1.2) was included for component species based on frequency classes scored I - V in ascending 20% frequency class groups (e.g. *Festuca rubra* present in 3 out of 10 quadrats would have a constancy score of II in the class 21-40% frequency).

Table 1.2 Constancy classes for groups of five or more quadrats

Constancy class	Quadrat frequency in group
I	>0 - 20%
II	21 - 40%
III	41 - 60%
IV	61 - 80%
V	81 - 100%

In most cases groupings corresponded well with an NVC type, though in several cases variation new to the NVC seemed likely. These types were examined thoroughly, including a comparison with NVC frequency and Domin scores using the MATCH programme produced by Andrew Malloch of Lancaster University (Malloch, 1990). Such possible new NVC types were allocated a provisional code (e.g. SD7y) for use in mapping and a provisional name (e.g. SD7y *Hylocomium splendens – Rhytidiadelphus triquetrus* provisional sub-community of the SD7 *Ammophila arenaria - Festuca rubra* semi-fixed dune community), inserting all details in a working document of non-NVC vegetation. In some cases vegetation types were found which had been recorded in other recent NVC surveys and the original mapping codes and titles for these were retained. A full list and description of provisional new NVC types will be included a national report summarising dune vegetation in Scotland.

Floristic tables giving quadrat data were prepared using VESPAN2 for all sites surveyed in 1999. Other quadrat information is available and large sets are in reports covering Loch of Strathbeg (Doarks et al., 1992), Sands of Forvie (Dargie, 1992), Foveran Links (Doarks et al., 1992), Barry Links (Woolven, 1987); Tentsmuir

(Robertson, 1988), Aberlady Bay (Dargie, 1992), Gullane Links Golf Course at Aberlady Bay (Tidswell (1997) and West Links - Gullane (Averis, 1998). These report data sets and 1999 survey total to *c.* 740 quadrats. The 1999 quadrats are included in full as annexes in site reports (Volume 2). The only departure from field recording concerns quadrat grid references which are limited to six figures (100 metre accuracy) by VESPAN2 data formats.

Summary tables are included in this volume, covering the major vegetation types encountered in surveys in this region. Each aggregated dataset was produced as a table using the VESPAN2 package. Most tables were then edited, retaining all species with a constancy class of II or higher (i.e. present in >20% of quadrats in the group) together with their range in Domin scores. These summary tables are used as a basis for describing vegetation character, particularly types which might represent new variations to the NVC system.

Quadrat data entry into VESPAN2 format and checking required 50 hours. Production of floristic tables for individual sites required 10 hours of work. Production of summary floristic tables required 5 hours of work to enter all data, produce NVC lists per quadrat set, and edit TABLE output into summary table format.

Target notes were entered into Word for Windows tables, including eight-figure grid references. This work required 40 hours of work for all East Coast records, including checking.

1.9 NVC vegetation map production

Early in the project a decision was taken to use a Geographical Information System (GIS) to hold field vegetation boundaries, supply area data for vegetation types, and produce several types of map for inclusion in reports. The following steps were taken to produce NVC vegetation maps:

Digitising – Method A

This technique was applied to all sites with existing survey except for Tentsmuir. Each hand-drawn NVC map was carefully photocopied on to A3 paper and the photocopies were then digitised using an A3 Numonics tablet. Four corner points were marked for each sheet with grid references accurate to 1 metre, a requirement for GIS work. The centroids of each area (polygon) were marked with a cross and the co-ordinates of centroids and vegetation boundaries were captured using GIMMS DIGIT-II digitising software. A copy of each map sheet was produced at map scale as a green line on A3 tracing paper and this was laid over the inked field sheet as an initial check for digitising errors. Once all sheets for a site assemblage were digitised and checked, line (boundaries) and point (polygon centroids) data layers were generated by GIMMS DIGIT-II software. This included edge checking along field sheet map boundaries. The line and point layers were imported into the Tydac SPANS Explorer GIS package and checked for dangling lines and faulty nodes using line self-intersection procedures. The line layer was corrected and then transformed into an area (polygon) layer by the GIS, generating data on the area and perimeter length of each polygon.

Digitising – Method B

This technique was applied to the existing vegetation map of Tentsmuir (Robertson, 1988) and all sites surveyed in 1999. Vegetation boundaries without vegetation or other land cover codes were drawn on to high-quality thick A3 tracing paper and 1 km grid line intersections were marked. These drawings were then digitised under sub-contract by Boreas Technologies (Aviemore) using proprietary software. Each drawing was scanned and the scanned raster image was vectorised using ground control points entered for the 1 km grid line intersections. Vectors for all drawings were then aggregated into a single data file. Results from Method A digitising were then added to the single data file as line and node coordinates. The single file covering all of the East Coast was then edited along sheet joins and the very narrow zone of overlap between Method A sites and the Method B area (i.e. the internal edges of earlier surveys at Loch of Strathbeg, Sands of Forvie, Foveran, Barry Links and Aberlady Bay). Faulty nodes, dangling lines and illogical polygons (unclosed ring errors) were then checked, edited and corrected in the presence of the field surveyor. The final data set was then exported to CD-ROM as a line layer in ESRI shp/shx/dbf format. This method required less than half the time of tablet digitising and coordinate checks on line data suggest that it is at least as accurate. The line layer was imported into Tydac SPANS Explorer GIS and then transformed into an area (polygon) layer, generating data on the area and perimeter length of each polygon.

GIS Data Preparation

The NVC map codes for each polygon were added as a data column attached to the area layer, reading codes from photocopies of the original field maps. This work was done by the field surveyor to minimise errors which might arise from operators unfamiliar with NVC notation. A total of *c.* 6300 polygons required coding in this manner for the East Coast. In one site (Loch of Strathbeg - Doarks *et al.*, 1992) some polygons were labelled

only with a target note code and the positions of polygons suggested that the label numbers were incorrect. Target note detail for all such polygons was ignored and these cases were attributed as NO LABEL.

Labelled NVC map production

This information was then used to generate a label layer for use in labelling NVC maps. The GIS was used to label maps by displaying the label layer over polygon boundaries. This was not straightforward. Many labels were clustered and fell on top of each other, requiring the operator to tease them apart with mouse operations (grab and drag). This lost the relationship with polygon identity, since labels were often dragged beyond their correct polygon. This required further work, opening the area layer to identify the NVC code for each polygon and then closing the layer to allow a label to be moved to a good position. Small labels could be positioned within many polygons but the majority of labels were too large and required positioning elsewhere, generating a further line layer to hold lines linking labels to polygons.

The longest labels were associated with vegetation mosaics and intermediate vegetation types, in one case involving 57 characters. Many long labels also fell within the interior of large, complex sites and it was impossible to place them close to their polygon of origin. With the approval of the project nominated officer all long labels (i.e. >6 charcters) were handled differently. All labels were exported to a spreadsheet and the long label set isolated by sorting on character length. A small-case habitat code was applied to each label, based on the dominant vegetation type(s) present (e.g. a = beach and strand; i = swamp, fen and mire). Long labels were then grouped by habitat code and a number added to the habitat code to index a particular label string (e.g. a1 - a117 represented all beach and strand long labels). The long label abbreviation codes were then added to all short labels and this set of all-short labels was re-imported into the GIS. This label set was applied to maps and all long labels were excluded from the labelling process. A separate appendix of long-labels was produced (see Volume 3). The small-case habitat code served two purposes: to clearly identify a polygon as a long-label case, and to allow some interpretation of the map without continual reference to the long label appendix. Without abbreviated codes it would have been impossible to position many long labels on map sheets. The long label codes adopted were:

a) Beach and strand;

b) Mobile dunes;

c) Semi-fixed dunes;

d) Fixed calcareous dune grassland;

e) Fixed acidic dune grassland;

f) Dry dune heath;

g) Wet dune heath;

h) Dune slack and wet grassland;

i) Swamp, fen and mire;

j) Arable and fallow;

k) Improved grassland';

l) Scrub;

m) Woodland and plantation;

n) Other vegetation and land cover.

Once labelling was finished, a map was composed in the GIS containing polygon boundaries, NVC labels, label link lines and 1 km OS national grid lines. Areas were then selected as individual map sheets (maximum size generally 3 km x 2 km for A3 printing at 1:10,000 scale). Each area was stored as a Microsoft Windows metafile and then exported to CorelDRAW software. The metafile was re-scaled to 1:10,000 scale, 1 km grid references for OS grid lines were added, and a map title label positioned where it would not obscure NVC detail. A total of 104 A3 map sheets was produced in this manner to cover East Coast dune sites.

Time requirement for NVC map production

Preparing SDVSS field maps, digitising field maps and checking results required 200 hours of work for the East Coast. NVC coding of polygons required 60 hours of work and labelling took 40 hours of work to complete all sites. Map composition and final production using CorelDRAW software required 20 hours of work. Digital

capture of NVC data for the East Coast was therefore time-consuming, requiring 320 hours to obtain a full digital data set and a collection of labelled NVC maps for SDVSS survey.

1.10 Dune habitat map production

NVC maps are difficult to interpret, even for specialists fully familiar with NVC coding. They normally consist only of vegetation boundaries and codes for each polygon, plus OS grid lines and sometimes with quadrat and target note positions added. As line and text maps they lack the colour, shading or hatching necessary to show the locations of different conditions (e.g. beach, mobile dune, dune slack). They cannot be used as a rapid means of understanding habitat zonation and require a considerable investment of time to grasp fully the overall character of a site.

It was therefore decided to use NVC information as the basis for producing a map of major dune habitats as an aid to rapid visual appreciation of site character. The following habitat categories were used (see section 2 for NVC vegetation details), following the groupings used in handling long labels (see 1.9 above):

1. **Beach and strand** Beach (beach sand, shingle) mapped above MHWS plus strand and embryo dune vegetation types in this zone (SD2, SD3, SD4, provisional new SDy NVC strand types, plus transitions between saltmarsh and strandline such as the provisional SDxx strand type).
2. **Mobile dune** Vegetation dominated by sea lyme-grass *Leymus arenarius* (SD5), marram grass *Ammophila arenaria* (SD6); bare sand within the vegetated dune zone, often indicating blowouts which are a characteristic component of mobile dune conditions; dune grassland receiving moderate inputs of blown sand which are sufficient to support the moss *Tortula ruralis* ssp. *ruraliformis* (SD8c) and show significant changes in dune relief as a result of sand accumulation, areas of largely bare sand but with a high density of *Carex arenaria* (SD10).
3. **Semi-fixed dune** Vegetation dominated by a mix of *Ammophila arenaria* and red fescue *Festuca rubra* (SD7), indicating part-stabilisation of former mobile dunes, plus other vegetation containing a high quantity of *Ammophila arenaria* (SD9 and provisional SD12z types).
4. **Fixed dry calcareous dune** Vegetation dominated by *Festuca rubra* and with characteristic dune grassland herbs, including *Galium verum*. Covers NVC SD8a, SD8b and provisional new SD8 types, but excludes SD8c (defined here as a mobile dune type).
5. **Fixed dry acidic dune** Vegetation with a mix of sand sedge *Carex arenaria*, sheep's fescue *Festuca ovina* and common bent *Agrostis capillaris*, covering the NVC SD12 type, provisional new SD12 types (except SD12z) and U2, U4, U5 categories, indicating leached acidic sand.
6. **Dry dune heath** Vegetation with *Carex arenaria*, ling *Calluna vulgaris* and often crowberry *Empetrum nigrum nigrum* (H11), representing heath developed on acidic sand.
7. **Wet dune heath** Shrub-dominated wet acidic sand with four-leaved heath *Erica tetralix*, *Calluna vulgaris* and often *Empetrum nigrum* (M16).
8. **Slacks and wet grassland** Vegetation of damp ground, often inundated in winter but generally drying out in summer. Covers dune slack (SD15, SD16, SD17) and wet mesotrophic grasslands (MG9, MG10, MG11, MG13).
9. **Swamp, fen, mire** Vegetation of very wet ground, often under the influence of a surface watertable for most of year, or close to open water of lochs. Covers all swamp and tall-herb fens (e.g. S10, S19) and mire vegetation (e.g. M23)
10. **Arable and fallow** Cultivated ground with barley, wheat, potatoes, peas, field beans, carrots or turnips, together with any associated fallows.
11. **Improved grassland** Grassland dominated or part-dominated by species typical of improved pastures (MG6, MG7 types): crested dog's-tail grass *Cynosurus cristatus* and perennial rye-grass *Lolium perenne.*
12. **Scrub** Woody vegetation dominated by gorse *Ulex europaeus*, broom *Cytisus scoparius*, young birch *Betula* spp. and tall scrub willow *Salix* spp.
13. **Woodland and plantation** Possible semi-natural woodland (W6, W11, W18) and plantation (conifer, mixed, deciduous).

14. **Other habitats** All other mapped ground not covered by habitats 1 - 13, including buildings, gardens, roads and tracks, cemeteries, tips, sand pits, airfield runways, saltmarsh, small areas of open water, maritime cliff grassland, bare maritime rock cliffs and ruderal (weed-dominated) vegetation.

Each polygon in the NVC area layer was classified into one of the above classes. In the case of mosaic polygons a habitat class was allocated on the basis of the dominant vegetation or other land cover type (see 1.9 above).

It is important to stress that some dune habitats correspond only in part with NVC categories of the same name. Mobile dune habitat is defined here using the NVC categories SD5, SD6 and SD8c, plus bare sand. Area results for this category will therefore differ appreciably from mobile dune defined strictly on the NVC SD5 *Leymus arenarius* and SD6 *Ammophila arenaria* mobile dune communities if a site has large extents of SD8c vegetation and bare sand. Likewise, NVC SD8 fixed dune grassland totals could differ appreciably from dry fixed dune habitat because NVC SD8 sub-communities are allocated to two separate habitats: mobile dune (SD8c) and dry fixed dune (all other SD8 types).

Given these differences imposed by the rules defining dune habitat types, it is recommended that data on dune habitat areas are not correlated with NVC type areas without careful consideration of local NVC conditions which could produce anomalies (e.g. a large area of mobile dune habitat in a site with little or no NVC SD5 and SD6 vegetation due to large extents of bare sand in blowouts and SD8c vegetation developed on sand accumulating around the edge of the blowout area).

The GIS was used to construct a map of dune habitats based on dune habitat codes. Screen colours, shadings and hatching were tested and selected which would show up clearly on output from a black and white laser printer (600 dpi). The GIS was used to compose maps displaying the habitat classification, NVC polygon boundaries and 1 km OS grid lines, plus a legend containing habitat types and shadings/hatching. The map compositions were saved as Microsoft Windows metafiles (one per site or set of adjacent sites) and exported to CorelDRAW software for adding OS grid numbers and a border. Habitat maps were produced at a variety of scales to cope with a great range of site sizes (1:10000 for small sites to 1:80000 for the largest site).

Classification of polygons into dune habitat groups required 5 hours of time. A total of 48 dune habitat maps was produced, requiring 15 hours for composition, metafile storage and annotation.

1.11 Quadrat and target note maps

OS 8-figure grid references were converted 12 figure (1 metre accuracy) GIS co-ordinates using a spreadsheet. Quadrat or target note numbers were added and files were converted to dbf format for import into the GIS as separate point layers for quadrats and target notes. These layers were imported into the GIS to create labelled maps of quadrat and target note locations, displaying results over maps of unlabelled NVC polygon boundaries. Maps for each site were composed and stored as Windows metafiles, exporting these to CorelDRAW software to add grid numbers and a border. Production of final maps required 30 hours of work.

1.12 Generating area data for vegetation, habitat and land cover types

The GIS was used to export the area and NVC label codes for polygons to a spreadsheet. This was then used to calculate the area of each vegetation type in each site. Mosaic polygons complicated this process. The proportion of each vegetation or other land cover type (e.g. BS bare sand, BR bare rock) in a mosaic was transferred to the appropriate cell of an n polygons x m vegetation/land cover types matrix (n = 6300; m = 306). As an example, the mosaic SD8c (6) + BS (3) + BR (1) had values of 0.6, 0.3 and 0.1 placed in the appropriate SD8c, BS and BR cells. Polygons with a single vegetation or other land cover type had a value of 1.0 placed in the appropriate cell. When completed the matrix was multiplied by a column vector of polygon areas (in hectares). The totals for each vegetation/land cover type were then calculated, allocating values to individual site assemblages, coastal sectors and all of the East Coast. Results were maintained as a master spreadsheet. A list of vegetation/land cover types, together with total area (ha), is given in Annex 1.

Spreadsheets were also used to calculate the areas of each dune habitat type per site (see 1.10 for list of types). A further calculation involved tallying broad land cover values for the following categories:

1. Beach above MHWS (beach sand and shingle)
2. Bare sand (within the vegetated zone)
3. Total area of vegetated dune (but excluding fallows)
4. Total arable and fallow area (to provide data on extent of tillage)
5. Other land take (buildings, gardens, roads, airfield runways, cemeteries)
6. Total area of windblown sand excluding the beach zone (sum of 2 - 5 inclusive)
7. Total area of all windblown sand (sum of 1 - 5 inclusive)
8. Surveyed ground but not on windblown sand (bare rock, unvegetated maritime cliff, non-sand inliers, open/running water).

The above broad categories allow rapid assessment of overall site characteristics to be made (e.g. amount of erosion as indicated by bare sand extent; arable tillage and fallows; amount of non-arable land take). **The total area of windblown sand excluding the beach zone (no. 6 above) is important because this represents the maximum potential area of windblown sand which could be vegetated. Summed over all sites this represents the most accurate area for dune habitat along the East Coast. This totals 11566.4 ha for all sites except Inchcolm Island, and this figure is used as the regional total for the East Coast.**

A further spreadsheet was developed by aggregating NVC and land cover data into groups for discussion in Section 2 of this report. The basis of aggregation is given in Table 2.1 and results are presented in Table 2.2.

Spreadsheet development, analysis and maintenance required 60 hours of work for handling East Coast GIS output on sites.

1.13 Assessing vegetation and habitat data for SSSIs

The East Coast contains a large number of SSSIs with a dune component, two of which are amongst the best in Britain and are being proposed as cSACs (Sands of Forvie, Barry Links). The extents of each vegetation type and dune habitats for each SSSI were not calculated using NVC data or the dune habitat classification. Instead, the boundaries of SSSIs in relation to habitats and NVC types were assessed visually by comparing maps of SSSI boundaries with NVC and dune habitat maps. Any important areas of good habitat lying outside SSSI boundaries were noted and incorporated into discussion on nature conservation interest. Maps showing SSSI boundaries superimposed on NVC boundaries were produced by the GIS using an SSSI data layer supplied by SNH.

1.14 Report production

The format of this report attempts to use a structure which holds a considerable amount of table and map information in a style which is readable and quick to access. Three volumes are required, allowing reference to material on the East Coast as a whole, sites and detailed vegetation maps at the same time.

The first volume covers aims and methods, presents brief accounts of the main vegetation and land cover types found in survey, and presents dune habitat and NVC vegetation results for all of the East Coast (i.e. an aggregation of all site data).

The second volume presents site reports. These are organised by the following coastal sectors rather than a strict site by site presentation: Banff & Buchan (East Coast), Gordon (including Aberdeen), Kincardine & Deeside; Angus (including Dundee and Monifieth), Fife, Midlothian, East Lothian, and Berwickshire. Each sector follows a similar format: information on location and conservation status, previous surveys and SDVSS survey details. Location maps are provided with a site label, site boundaries marked on a reduced copy of the OS 1:50,000 sheet. This is followed by information on broad land cover categories (see section 1.11). Site descriptions cover several topics: dune types, exposure and coastal erosion/accretion; important dune habitat and NVC vegetation characteristics; plus details of any significant management problems (e.g. blowouts, overgrazing or undergrazing by stock, rabbit damage, tipping, sand extraction, recreation). Dune habitat information is described using a table with areas of each habitat per site, plus maps for each site. Vegetation types are described based on areas given in a table listing NVC and other land cover types per site. The main features of nature conservation interest are briefly described. Annexes with target notes and quadrat data then follow, including location maps.

All GIS maps in the second volume are produced with OS 1 km grid lines to enable scale calculation - site size is so variable that it was not possible to use a single scale. All maps have grid north at the top of the map.

The third volume contains a set of labelled A4 NVC maps at a photo-reduced scale of approximately 1:15,000, using A3 originals produced at 1:10,000. The A3 originals are held in SNH Area Offices and SNH Inverness (Ardconnel Terrace). Preface material contains an explanation of label coding (principally use of long label codes and the meaning of mosaic information containing the proportions of each mosaic element). A list of map label codes is provided which includes the vegetation/other land cover types which they represent. A separate appendix is given containing the long-label list, in alphanumeric order by habitat grouping.

Writing and amending report text, constructing tables from spreadsheet information, and importing annex material and maps for printing required 150 hours of work. It proved inefficient to hold maps as graphic images in word processor files. All maps were therefore stored as CorelDRAW files and printed on to report pages with header and paginated footer information.

2 VEGETATION AND LAND COVER TYPES

2.1 Introduction

This section provides descriptions of the major vegetation and land cover types found on windblown sand on the East Coast. The vegetation information is based on several sources: existing NVC descriptions (Rodwell 1991 *et seq.*), selected summary floristic tables derived from East Coast quadrat data (gathered from various surveys between 1988 and 1998), equivalent floristic tables produced for other coastal dune regions in Scotland, and area information derived from GIS analysis of NVC vegetation maps. Material is organised to reflect the natural zonation inland from the beach of a sand dune system. In general, for a large site with a near-complete range of habitats, the sequence is strand > mobile dune > semi-fixed dune > fixed dune > dune slack and/or wet mesotrophic grassland > mire > swamp > open water. This order is complicated on the East Coast by the presence in many sites of acidic sands supporting acidic grassland, dry heath, wet heath, scrub and woodland/plantation. Modification of the sequence is common, with improvement of grasslands and land taken for other land uses (especially forestry plantation). The natural order can be further simplified, most notably into dune (strand to semi-fixed dune steps) and links (fixed dune grassland, usually with a short sward). The NVC classification system is used to provide the framework for discussing vegetation types.

A total of 306 categories of vegetation and land cover was mapped on the East Coast, probably one of the largest totals of any dune region in Scotland. Total mapped area for these 306 types is 11566 ha (see Annex 1), of which 11566 ha is potential vegetated windblown sand (see section 1.12). The 307 categories are aggregated here into 22 vegetation and other land cover types (Table 2.1) for description purposes. The total extents for the 22 types are also in Table 2.1. Aggregate figures are given in Table 2.2 for all sites and coastal sector groupings. **(N.B. values in Tables 2.1 and 2.2 are based on spreadsheet cells accurate to at least 4 decimal places but rounded to two decimal places - rounding errors can create small differences between row/column totals and the sum of individual cell values in a row or column.)** A listing of individual NVC and land cover types for all of the East Coast is given in Annex 1. Site and sector values for NVC and other land cover types are given in Volume 2.

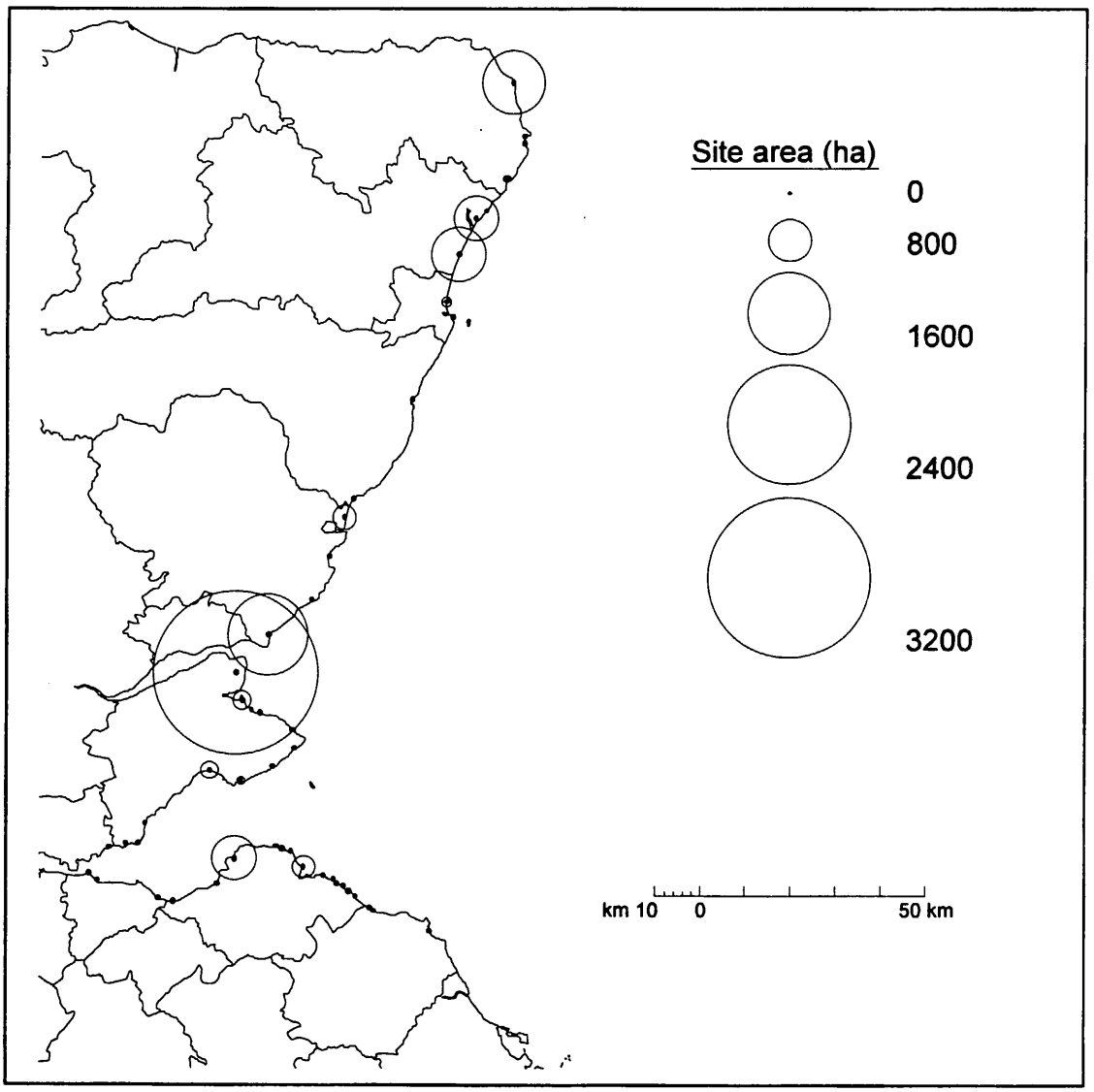
The total site assemblage set (47) on the East Coast includes several small and very small bay dune systems. Area data based on potential vegetated sand extent is shown in Map 2.1 and the size range is so great that variation amongst the smaller sites is poorly differentiated. The regional dune resource is dominated by Tentsmuir (3330 ha, 28.8 % of regional area and the largest dune system in Britain). Three site assemblages have areas >1000 ha: Arbroath to Broughty Ferry (1641 ha, dominated by Barry Links), Inverallochy to Peterhead (1258 ha, including dunes at Loch of Strathbeg), and Newburgh to Bridge of Don (1083 ha). Nine sites are larger than 100 ha: Aberlady Point to Milsey Bay (882 ha), Sands of Forvie (875 ha), Charleton & Kinnaber Links to Montrose (479 ha), Tyninghame Shore (407 ha), South Eden Estuary to St Andrews Links (377 ha), Largo Bay (318 ha), Aberdeen (171 ha), Cruden Bay (128 ha) and Elie East Links to Earlsferry Links (122 ha). Three sites have extents in the range 50 - 100 ha: Port Seton to Craigielaw (78 ha), St Cyrus (71 ha) and Lunan Bay (63 ha). Moderate sand areas (10 - 50 ha) are present at Barns Ness, Portobello, Fisherrow Sands, Kirkcaldy, Northeast Fife Coast, East Arbroath, Thorntonloch, Pease Sands and White Sands. Small areas (1 - 10 ha) are present in sixteen further sites and trivial sand quantities (<1 ha) are found at six sites. Listings of site area (potential vegetated sand extent) are given in Volume 2 on a site and sector basis.

Maps of extent are provided for dune habitat aggregates but the distortion imposed by the large size of some sites (particularly Tentsmuir) and comparative poverty of sand area in many other sites often makes it difficult to see the full distribution of an aggregate type in very small assemblages. For a full appreciation of the distribution of habitat aggregates it is important to consult the information in Table 2.2.

Information on the geographical setting and particularly the geomorphology of most sites is covered comprehensively in reports produced for the Countryside Commission for Scotland (CCS): Ritchie, Smith & Rose (1978) covering Banff & Buchan, Gordon, Kincardine & Deeside; Wright (1979) covering Tayside; Ritchie (1979) covering Fife; and Rose (1980) covering Southeast Scotland. Brief descriptions on some aspects of geomorphology are also provided here in site reports (Volume 2) but most emphasis is upon vegetation, its management and condition at the site scale. Survey did not involve a comparison of SDVSS conditions (with its emphasis on vegetation) with those described in CCS reports (which emphasise geomorphology and recreational management). Little comment is therefore included here on possible change since the early 1970s.

Table 2.1 Habitat aggregates for East Coast NVC and land cover types

	Aggregated habitats	NVC and land cover types (see Annex 1 for definitions)	Total area (ha) in East Coast
1	Strand and embryo dunes	SD2, SD3, SD4, SDxx, SDy	34.26
2	Mobile dunes	SD5, SD6, SD10	357.68
3	Semi-fixed dunes	SD7, SD9	921.58
4	Fixed calcareous dune	SD8	235.20
5	Fixed acidic dune	SD12	1461.75
6	Other fixed dune grasslands	MG1, U2, U4, U5, U6	598.43
7	Dry dune heath	H11, SD11	450.64
8	Maritime cliff grassland	MC8, MC9	15.26
9	Wet neutral grasslands	MG9, MG10, MG11, MG12, MG13	89.07
10	Wet dune heath	M16	144.52
11	Dune slack	SD13, SD15, SD16, SD17	202.79
12	Mire (excluding Mx types)	M23, M25, M27, M28	151.35
13	Mx rich fen	Mxbd	1.21
14	Swamp	S4, S5, S6, S8, S9, S10, S11, S12, S14, S18, S19, S20, S21, S26, S28	45.24
15	Saltmarsh	SM6, SM8, SM9, SM10, SM13, SM16, SM18, SM28	95.02
16	Other semi-natural habitat	BIS, BMC, BR, BSCRUB, BURNT, OSCRUB, OW, RUD, RUDPh, RUNWAT, SD18, U20, W1, W6, W11, W18, W21, W22, W23, W24, W25	581.53
17	Beach above MHWS	BBS, BSH	306.57
18	Bare sand (in vegetated zone)	BS	201.78
19	Arable	ACAR, AP, AR, ARAP, ARB, ARBEAN, ARO, ARPEA, ATUR, AWHEAT	1138.63
20	Fallow	MG1F, SD8F, SD12F	8.34
21	Improved grassland	MG6, MG7	2021.15
22	Other anthropogenic habitat	AIRFIELD, BBG, CMTY, CP, DP, MP, PIT, QUARRY, RAILWAY, ROAD, TIP, WALL	2973.98
	Total (ha)		12035.99



Map 2.1 Dune site assemblage size (ha) on East Coast

Table 2.2 Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 01 - 04

Habitat aggregates	01 Inverallochy to Peterhead	02 Peterhead Bay	03 Sandford Bay	04 Cruden Bay	All Banff & Buchan (East) site assemblages (01-04)
Strand and embryo dunes	2.43	0.03	0.01	0.01	2.47
Mobile dunes	78.09	1.35	0.21	7.22	86.87
Semi-fixed dunes	328.46	0.12	0.36	14.94	343.87
Fixed calcareous dune	134.21			1.15	135.36
Fixed acidic dune	20.99			6.98	27.96
Other fixed dune grasslands	31.71		3.11	9.28	44.10
Dry dune heath					
Maritime cliff grassland	1.65				1.65
Wet neutral grasslands	44.54				44.54
Wet dune heath					
Dune slack	29.91				29.91
Mire (excluding Mx types)	5.54	0.21	0.16	0.49	6.39
Mx rich fen	1.21				1.21
Swamp	8.64			0.09	8.74
Saltmarsh	17.82				17.82
Other semi-natural habitat	65.81	0.31	0.34	9.15	75.61
Beach above MHWS	37.62	1.81	0.60	5.20	45.23
Bare sand (in vegetated zone)	58.29	0.16		1.63	60.08
Arable	45.98			6.23	52.21
Fallow					
Improved grassland	378.41	4.50	1.35	51.11	435.37
Other anthropogenic habitat	43.41	2.02		19.76	65.19
Total	1334.71	10.50	6.12	133.25	1484.58

Site Assemblages 05 - 07

Habitat aggregates	05 Collieston	06 Sands of Forvie	07 Newburgh to Bridge of Don	All Gordon site assemblages (05-09)
Strand and embryo dunes		0.25	1.34	1.85
Mobile dunes		33.10	102.06	135.99
Semi-fixed dunes		17.30	41.58	62.82
Fixed calcareous dune		3.46	2.47	7.23
Fixed acidic dune		154.24	267.42	426.46
Other fixed dune grasslands	0.18	3.43	24.73	35.08
Dry dune heath		287.95	33.99	321.94
Maritime cliff grassland		10.20		10.20
Wet neutral grasslands			12.11	13.91
Wet dune heath		101.64	5.38	107.02
Dune slack		13.00	13.66	26.66
Mire (excluding Mx types)		38.53	7.58	46.11
Mx rich fen				
Swamp		2.09	9.55	11.63
Saltmarsh		5.11	0.54	5.96
Other semi-natural habitat		15.63	95.33	114.74
Beach above MHWS	0.11	14.68	47.29	70.60
Bare sand (in vegetated zone)		26.33	79.46	105.80
Arable		73.18	91.31	164.49
Fallow				
Improved grassland		95.49	229.04	413.30
Other anthropogenic habitat	0.38	14.03	75.57	152.81
Total	0.66	909.66	1140.40	2234.62

Table 2.2 (continued) Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 08 - 09

Habitat aggregates	08 Aberdeen	09 Nigg Bay	All Gordon site assemblages (05-09)
Strand and embryo dunes		0.26	1.85
Mobile dunes	0.84		135.99
Semi-fixed dunes	3.94		62.82
Fixed calcareous dune	1.31		7.23
Fixed acidic dune	4.81		426.46
Other fixed dune grasslands	6.22	0.51	35.08
Dry dune heath			321.94
Maritime cliff grassland			10.20
Wet neutral grasslands	1.80		13.91
Wet dune heath			107.02
Dune slack			26.66
Mire (excluding Mx types)			46.11
Mx rich fen			
Swamp			11.63
Saltmarsh	0.31		5.96
Other semi-natural habitat	3.78		114.74
Beach above MHWS	7.40	1.12	70.60
Bare sand (in vegetated zone)			105.80
Arable			164.49
Fallow			
Improved grassland	87.08	1.69	413.30
Other anthropogenic habitat	62.06	0.77	152.81
Total	179.54	4.35	2234.62

Site Assemblages 10 - 11

Habitat aggregates	10 Stonehaven Bay	11 St Cyrus	All Kincardine & Deeside site assemblages (10-11)
Strand and embryo dunes	0.02	1.62	1.64
Mobile dunes	0.29	9.46	9.75
Semi-fixed dunes		17.00	17.00
Fixed calcareous dune		0.52	0.52
Fixed acidic dune		8.75	8.75
Other fixed dune grasslands		8.35	8.35
Dry dune heath			
Maritime cliff grassland			
Wet neutral grasslands		2.19	2.19
Wet dune heath			
Dune slack			
Mire (excluding Mx types)			
Mx rich fen			
Swamp		0.12	0.12
Saltmarsh		7.06	7.06
Other semi-natural habitat	0.22	8.65	8.87
Beach above MHWS	2.25	4.95	7.20
Bare sand (in vegetated zone)		2.15	2.15
Arable		8.38	8.38
Fallow			
Improved grassland	0.07	0.26	0.33
Other anthropogenic habitat	5.06	3.51	8.57
Total	7.91	82.97	90.88

Table 2.2 (continued) Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 12 - 15

Habitat aggregates	12 Charleton & Kinnaber Links to Montrose	13 Lunan Bay	14 East Arbroath	15 Arbroath to Broughty Ferry	All Angus site assemblages (12-15)
Strand and embryo dunes		0.23	0.11	1.72	2.05
Mobile dunes	4.58	3.21		22.46	30.25
Semi-fixed dunes	44.84	16.40		102.77	164.00
Fixed calcareous dune	5.99	1.38		26.67	34.04
Fixed acidic dune	152.27			466.90	619.16
Other fixed dune grasslands	12.79	3.93		81.72	98.44
Dry dune heath	16.61			36.23	52.84
Maritime cliff grassland					
Wet neutral grasslands	4.02			3.40	7.42
Wet dune heath	0.28			27.85	28.13
Dune slack	0.68			107.56	108.24
Mire (excluding Mx types)				18.40	18.40
Mx rich fen					
Swamp	0.15	0.11		8.79	9.05
Saltmarsh	9.81			2.15	11.96
Other semi-natural habitat	24.07	0.81		114.47	139.35
Beach above MHWS	13.86	6.76	1.48	41.26	63.36
Bare sand (in vegetated zone)	4.60	1.04		3.65	9.30
Arable		24.86		62.58	87.44
Fallow				4.21	4.21
Improved grassland	57.80	6.87	8.70	270.15	343.51
Other anthropogenic habitat	151.26	4.24	4.19	289.28	448.96
Total	503.59	69.85	14.47	1692.23	2280.14

Site Assemblages 16 - 19

Habitat aggregates	16 Tentsmuir	17 South Eden Estuary to St Andrews Links	18 East Sands	19 Kinkell & Buddo Cliffs	All Fife site assemblages (16-28)
Strand and embryo dunes	6.06	0.47		0.08	9.36
Mobile dunes	34.50	9.30	0.09		56.93
Semi-fixed dunes	6.48	18.13			73.57
Fixed calcareous dune	7.85	1.86			11.14
Fixed acidic dune	345.48	17.13			373.52
Other fixed dune grasslands	122.70	15.42		0.08	194.77
Dry dune heath	70.54	0.35			70.89
Maritime cliff grassland				0.10	0.46
Wet neutral grasslands	15.77			0.05	15.82
Wet dune heath	9.38				9.38
Dune slack	31.38				31.38
Mire (excluding Mx types)	59.38				60.38
Mx rich fen					
Swamp	10.32	0.09			10.75
Saltmarsh	15.00	3.02		0.07	27.42
Other semi-natural habitat	113.51	23.22		0.32	144.40
Beach above MHWS	37.69	8.70	1.04	0.81	68.77
Bare sand (in vegetated zone)	1.47	6.42			8.41
Arable	643.70	70.23			720.11
Fallow					
Improved grassland	162.78	183.97	2.15		572.73
Other anthropogenic habitat	1692.81	30.56	1.33		1860.45
Total	3386.80	388.88	4.61	1.51	4320.64

Table 2.2 (continued) Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 20 - 22

Habitat aggregates	20 Northeast Fife Coast	21 Crail	22 Anstruther	All Fife site assemblages (16-28)
Strand and embryo dunes	1.23	0.03		9.36
Mobile dunes	2.66			56.93
Semi-fixed dunes	0.16			73.57
Fixed calcareous dune				11.14
Fixed acidic dune				373.52
Other fixed dune grasslands	5.06	0.35		194.77
Dry dune heath				70.89
Maritime cliff grassland				0.46
Wet neutral grasslands				15.82
Wet dune heath				9.38
Dune slack				31.38
Mire (excluding Mx types)				60.38
Mx rich fen				
Swamp				10.75
Saltmarsh				27.42
Other semi-natural habitat	0.30			144.40
Beach above MHWS	4.85	0.20	0.24	68.77
Bare sand (in vegetated zone)				8.41
Arable	1.08			720.11
Fallow				
Improved grassland	12.29		0.17	572.73
Other anthropogenic habitat	0.40	0.14	0.13	1860.45
Total	28.03	0.71	0.54	4320.64

Site Assemblages 23 - 25

Habitat aggregates	23 Elie East Links to Earlsferry Links	24 Largo Bay	25 Kirkcaldy	All Fife site assemblages (16-28)
Strand and embryo dunes	0.64	0.83		9.36
Mobile dunes	2.21	5.99	0.53	56.93
Semi-fixed dunes	11.30	36.89		73.57
Fixed calcareous dune	0.04	1.38		11.14
Fixed acidic dune		10.91		373.52
Other fixed dune grasslands	9.30	41.85		194.77
Dry dune heath				70.89
Maritime cliff grassland		0.36		0.46
Wet neutral grasslands				15.82
Wet dune heath				9.38
Dune slack				31.38
Mire (excluding Mx types)		1.01		60.38
Mx rich fen				
Swamp		0.35		10.75
Saltmarsh		9.33		27.42
Other semi-natural habitat	0.80	4.84	0.01	144.40
Beach above MHWS	4.11	7.68	1.41	68.77
Bare sand (in vegetated zone)	0.08	0.44		8.41
Arable	4.65	0.45		720.11
Fallow				
Improved grassland	50.44	149.35	1.44	572.73
Other anthropogenic habitat	42.21	63.63	26.24	1860.45
Total	125.78	335.30	29.64	4320.64

Table 2.2 (continued) Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 26 - 28

Habitat aggregates	26 Kinghorn Beaches	27 Burntisland	28 Silversands Bay	All Fife site assemblages (16-28)
Strand and embryo dunes	0.02			9.36
Mobile dunes	1.65			56.93
Semi-fixed dunes	0.61			73.57
Fixed calcareous dune				11.14
Fixed acidic dune				373.52
Other fixed dune grasslands				194.77
Dry dune heath				70.89
Maritime cliff grassland				0.46
Wet neutral grasslands				15.82
Wet dune heath				9.38
Dune slack				31.38
Mire (excluding Mx types)				60.38
Mx rich fen				
Swamp				10.75
Saltmarsh				27.42
Other semi-natural habitat	1.27		0.13	144.40
Beach above MHWS	1.12	0.38	0.53	68.77
Bare sand (in vegetated zone)				8.41
Arable				720.11
Fallow				
Improved grassland		6.23	3.92	572.73
Other anthropogenic habitat	1.29	1.36	0.34	1860.45
Total	5.97	7.96	4.92	4320.64

Site Assemblages 29 - 31

Habitat aggregates	29 Peatdraught Bay	30 Drum Sands and Cramond	31 Portobello	All Midlothian site assemblages (29-31)
Strand and embryo dunes		0.82		0.82
Mobile dunes	0.10	0.55		0.65
Semi-fixed dunes	0.26	0.89		1.15
Fixed calcareous dune				
Fixed acidic dune		0.06		0.06
Other fixed dune grasslands		0.35		0.35
Dry dune heath				
Maritime cliff grassland				
Wet neutral grasslands				
Wet dune heath				
Dune slack				
Mire (excluding Mx types)				
Mx rich fen				
Swamp				
Saltmarsh		0.21		0.21
Other semi-natural habitat		0.19		0.19
Beach above MHWS	0.29	2.47	1.04	3.80
Bare sand (in vegetated zone)	0.04	0.09		0.13
Arable				
Fallow				
Improved grassland		1.22		1.22
Other anthropogenic habitat	0.84	5.13	33.02	39.00
Total	1.54	11.98	34.06	47.58

Table 2.2 (continued) Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 32 - 34

Habitat aggregates	32 Fisherrow Sands	33 Port Seton to Craigielaw	34 Aberlady Point to Milsey Bay	All East Lothian site assemblages (32-44)
Strand and embryo dunes		0.22	0.89	16.06
Mobile dunes	3.61	6.24	12.06	36.60
Semi-fixed dunes		4.79	172.66	258.20
Fixed calcareous dune		2.84	26.58	46.92
Fixed acidic dune			5.74	5.83
Other fixed dune grasslands		3.00	187.87	219.35
Dry dune heath			3.35	4.96
Maritime cliff grassland		0.78	1.67	2.79
Wet neutral grasslands		0.18	4.88	5.19
Wet dune heath				
Dune slack			6.28	6.59
Mire (excluding Mx types)		0.14	19.92	20.06
Mx rich fen				
Swamp		0.09	3.63	4.96
Saltmarsh		0.24	22.57	24.60
Other semi-natural habitat		7.91	55.55	96.34
Beach above MHWS	0.74	6.63	17.44	46.37
Bare sand (in vegetated zone)			2.30	15.89
Arable			15.67	106.00
Fallow				
Improved grassland	10.01	36.98	160.88	248.02
Other anthropogenic habitat	16.41	15.66	207.01	397.29
Total	30.77	85.70	926.93	1562.02

Site Assemblages 35 - 37

Habitat aggregates	35 Rugged Knowes Coast	36 Quarrel Sand to Tantallon Castle	37 Seacliff	All East Lothian site assemblages (32-44)
Strand and embryo dunes	0.08	0.01	0.06	16.06
Mobile dunes	0.23	0.36	0.26	36.60
Semi-fixed dunes	1.63	0.89	0.39	258.20
Fixed calcareous dune				46.92
Fixed acidic dune				5.83
Other fixed dune grasslands		5.19	1.83	215.22
Dry dune heath				4.96
Maritime cliff grassland	0.34			2.79
Wet neutral grasslands				5.19
Wet dune heath				
Dune slack				6.59
Mire (excluding Mx types)				20.06
Mx rich fen				
Swamp				4.96
Saltmarsh				24.60
Other semi-natural habitat	1.26	0.30	1.43	96.34
Beach above MHWS	0.81	0.79	0.83	46.37
Bare sand (in vegetated zone)		0.11		15.89
Arable				106.00
Fallow				
Improved grassland		0.36	1.48	248.02
Other anthropogenic habitat		0.97	1.29	397.29
Total	4.35	8.98	7.57	1562.02

Table 2.2 (continued) Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 38 - 40

Habitat aggregates	38 Tyninghame Shore	39 East Dunbar	40 The Vaults	All East Lothian site assemblages (32-44)
Strand and embryo dunes	13.85		0.03	16.06
Mobile dunes	12.07		0.16	36.60
Semi-fixed dunes	51.42		0.19	258.20
Fixed calcareous dune	8.38			46.92
Fixed acidic dune	0.09			5.83
Other fixed dune grasslands	17.09		0.12	215.22
Dry dune heath	1.61			4.96
Maritime cliff grassland				2.79
Wet neutral grasslands	0.13			5.19
Wet dune heath				
Dune slack	0.31			6.59
Mire (excluding Mx types)				20.06
Mx rich fen				
Swamp	1.04			4.96
Saltmarsh	1.79			24.60
Other semi-natural habitat	27.39			96.34
Beach above MHWS	14.07	0.19	0.31	46.37
Bare sand (in vegetated zone)	13.39			15.89
Arable	85.65			106.00
Fallow				
Improved grassland	30.49		0.42	248.02
Other anthropogenic habitat	144.97	2.37		397.29
Total	423.74	2.56	1.22	1562.02

Site Assemblages 41 - 44

Habitat aggregates	41 White Sands	42 Barns Ness	43 Skateraw Harbour	44 Thorntonloch	All East Lothian site assemblages (32-44)
Strand and embryo dunes	0.07	0.67		0.18	16.06
Mobile dunes	0.25	0.65	0.07	0.65	36.60
Semi-fixed dunes	1.61	21.78	0.23	2.60	258.20
Fixed calcareous dune	0.42	8.69			46.92
Fixed acidic dune					5.83
Other fixed dune grasslands	3.28	0.97			215.22
Dry dune heath					4.96
Maritime cliff grassland					2.79
Wet neutral grasslands					5.19
Wet dune heath					
Dune slack					6.59
Mire (excluding Mx types)					20.06
Mx rich fen					
Swamp		0.20			4.96
Saltmarsh					24.60
Other semi-natural habitat		2.51			96.34
Beach above MHWS	0.59	2.47	0.38	1.12	46.37
Bare sand (in vegetated zone)				0.09	15.89
Arable	0.72			3.96	106.00
Fallow					
Improved grassland	1.06	0.88	2.42	3.06	248.02
Other anthropogenic habitat	2.77	3.31	1.33	1.20	397.29
Total	10.78	42.13	4.43	12.87	1562.02

Table 2.2 (continued) Areas (ha) of aggregated NVC and land cover types within East Coast sites

Site Assemblages 45 - 47

Habitat aggregates	45 Cove Harbour	46 Pease Bay	47 Coldingham Bay	All Berwickshire site assemblages (45-47)
Strand and embryo dunes			0.01	0.01
Mobile dunes	0.24	0.38	0.02	0.64
Semi-fixed dunes		0.86	0.10	0.96
Fixed calcareous dune				
Fixed acidic dune				
Other fixed dune grasslands	0.08	1.07	0.97	2.12
Dry dune heath				
Maritime cliff grassland			0.16	0.16
Wet neutral grasslands				
Wet dune heath				
Dune slack				
Mire (excluding Mx types)				
Mx rich fen				
Swamp				
Saltmarsh				
Other semi-natural habitat		0.56	1.46	2.02
Beach above MHWS	0.11	0.72	0.39	1.22
Bare sand (in vegetated zone)		0.02		0.02
Arable				
Fallow				
Improved grassland		6.67		6.67
Other anthropogenic habitat		1.70	0.01	1.71
Total	0.42	11.99	3.13	15.54

2.2 Strandline and embryo dune vegetation (SD2, SD3, SD4, SDxx, SDy)

These vegetation types are restricted on the East Coast (Map 2.2), with a total area of only 34.3 ha (0.3% of windblown sand extent). This total is probably an exaggeration, since most strands form a very narrow (1-4 m) linear zone along and just above the strandline which is difficult to map accurately at a scale of 1:10,000. The low overall extent (as a percentage of all vegetated blown sand) is in fact larger than most other sectors of the Scottish coast and suggests that favourable conditions for strandline and foredune development are amongst the best developed at the national scale. A particularly large area is present at Tyninghame Shore where embryo dune vegetation is abundant, forming the largest site extent of this habitat aggregate in Scotland (13.9 ha). Strand and embryo dune development on accreting sand along the edge of the Tentsmuir foreland is also significant (6.1 ha). However, for much of the East Coast strong erosional conditions are dominant in many sites, with few opportunities for good strandline vegetation development.

This is a species-poor habitat, usually with only 3-4 species per quadrat for each vegetation type. Conditions are often extreme, with mobile and part-saline sand as a growth medium and great exposure to storms. Many occurrences are ephemeral due to loss in winter gales, with the community regenerating each year from seed. No single NVC or provisional NVC type is dominant and intermediates with SD2 and SD4 are common in small quantities (Annex 1) suggesting that gradational conditions are often present.

SD2 *Cakile maritima - Honkenya peploides* strandline (Table 2.3)

This is present in 21 sites scattered throughout the region, covering a wide range of large and small assemblages. It is not extensive (6.7 ha, plus 2.8 ha of intermediates) and the largest quantities (>1 ha) are present at Tentsmuir (2.5 ha), Tyninghame Shore (2.2 ha), Inverallochy to Peterhead (1.5 ha) and Arbroath to Broughty Ferry (1.1 ha). *Cakile maritima* is often present, but high and very showy cover is restricted to strandlines with good summer accretion. *Honkenya peploides* is often more frequent in areas of poorer sand supply and this is probably due to large extents of thin sand over shingle in the strandline zone. It prefers shingle

near the surface and can be the only species present in some circumstances. *Elymus farctus* is also moderately common and shows a clear overlap with SD4 embryo dune conditions.

Floristic composition is generally close to the NVC description except for intermediate vegetation types. Quadrat data for clear SD2 conditions are infrequent but an SD2/SD6 intermediate is recorded from Barry Links (Table 2.3) showing the character of SD2 types developed on thick banks of summer sand accretion, with clear links to SD6 vegetation types.

Table 2.3 SD2/SD6 intermediate between SD2 *Cakile maritima - Honkenya peploides* strandline and SD6 *Ammophila arenaria* mobile dune

	Constancy	Domin range
Cakile maritima	V	1-5
Ammophila arenaria	V	3-7
Atriplex prostrata	II	1
Salsola kali	II	1
Species per quadrat 2.67 (based on 6 quadrats)		

SD3 *Matricaria maritima - Galium aparine* strandline community

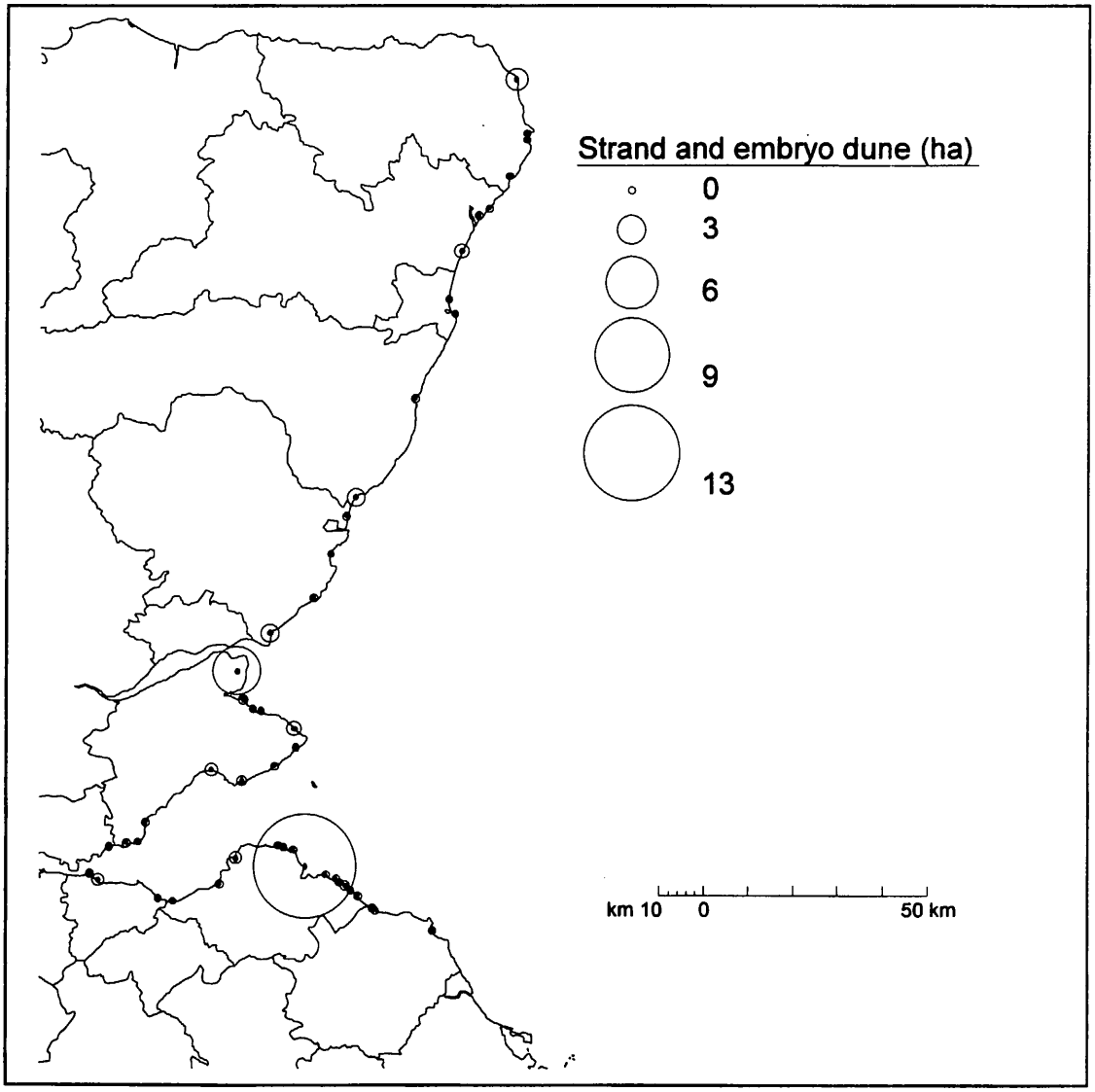
This is rare and confined three sites: Tentsmuir, Northeast Fife Coast and Aberlady Point to Milsey Bay. Total extent, including an SD3/SDy intermediate, is only 0.6 ha. It probably often survives most winter storms and is perhaps the most 'perennial' strand vegetation type in Scotland. It tends to occur on shingle or on thin sand over shingle. There are insufficient quadrat data to construct a floristic table.

SD4 *Elymus farctus* embryo dune

This is present in 17 sites, mostly in very small quantities. Total area, including small amounts of SD4/SD8c, SD4/SDy and SD4/SM16 intermediates, is 19.1 ha. The largest extent, by far, is at Tyninghame Shore (10.2 ha) where conditions on the seaward side of a barrier island in Belhaven Bay seem excellent for a type which is usually confined to a narrow band between the strand and a foredune face. In just this one locality the embryo dune zone replaces the foredune to form a terrace-like feature which extends inland for some distance. Only three other sites have large (>1 ha) extents: Tentsmuir (2.6 ha), St Cyrus (1.6 ha) and Newburgh to Bridge of Don (1.1 ha). Only *Elymus farctus* is constant in the SD4 type, which is typically very species-poor and typical of the NVC description. Notable intermediates involving this type occur in two contrasting sets of environments. First, in transitions to saltmarsh (e.g. where sand is blown on to the upper saltmarsh) *Elymus farctus* forms low embryo dunes and is often accompanied by saltmarsh species (*Festuca rubra, Glaux maritima, Juncus gerardi*). The SD4/SM16 intermediate is only mapped at Tyninghame Shore but was also noted during harmonisation work at Tentsmuir in 1999 on the outer part of a large and very significant area of saltmarsh changing rapidly into a progradational slack. The intermediate here is probably important in forming a low dune barrier which then builds into a low foredune to cut off the saltmarsh from the sea and thus allow slack development. Some low hummocks of this intermediate at Tentsmuir held good numbers of *Parnassia palustris* in 1999, a very unusual species in strand conditions.

SDxx *Leymus arenarius - Elymus repens* provisional new dune/saltmarsh strandline

Sheltered strandlines receiving regular inputs of organic material (particularly seaweed) develop an often narrow but prominent tall grassland dominated by *Leymus arenarius* and with much *Elymus repens*. The latter species provides a clear link to the SM28 *Elymus repens* saltmarsh strandline type, with the notable addition of particularly robust *Leymus arenarius* growth. Good nutrient supply from rotting debris is responsible for strong plant growth and there is usually very poor sand supply, excluding a link with embryo or mobile dune conditions. Equivalent conditions are found in the Moray Firth, Orkney and in Southwest Scotland, though total extent is highest in the Moray Firth where *Leymus arenarius* is particularly abundant. Shelter of this kind is rare adjacent to dunes on the East Coast and this type (total area 1.0 ha) is mapped only at Tentsmuir (0.4 ha), Tyninghame Shore (0.3 ha), South Eden Estuary to St Andrews Links (0.2 ha) and Lunan Bay (0.1 ha). Floristic tables are given in regional reports covering the Moray Firth and Orkney.



Map 2.2 Strand and embryo dune vegetation (ha) within East Coast sites

SDy ***Atriplex glabriuscula - A. prostrata*** **provisional new strandline community**

This vegetation type is widespread, occurring in 20 sites. It is, however, usually restricted to a narrow zone on summer strandlines and its total area is only 4.0 ha. The largest occurrences (>0.5 ha) are at Tyninghame Shore (1.1 ha), Largo Bay (0.7 ha) and Northeast Fife Coast (0.6 ha). The SDy type resembles some northern shingle vegetation described in Sneddon & Randall (1993) but occurs commonly on a sand substrate too. A constancy table is presented in the Orkney report, where it is particularly common.

2.3 Mobile dunes (SD5, SD6, SD10)

Despite the large total area of blown sand on the East Coast, these vegetation types are somewhat restricted in extent (Map 2.3), with 357.7 ha (3.1% of windblown sand extent). Good sand supply is characteristic of this habitat and stimulates *Leymus arenarius* and *Ammophila arenaria* growth (Ranwell 1972). The East Coast and the Moray Firth are distinct from most other sectors of the Scottish coast in having a large area of SD5 *Leymus arenarius* dune (44.2 ha excluding intermediates). The SD6 *Ammophila arenaria* mobile dune community is much more extensive on the East Coast (309.6 ha) and SD6 types which include *Leymus arenarius* (SD6b, SD6c) total 40.9 ha. In the Moray Firth *Leymus arenarius* vegetation is co-dominant with *Ammophila arenaria* but this is not the case on the East Coast, although it does form a significant component of this habitat. *L. arenarius* has its largest extent in Boreal latitudes in Western Europe and its striking importance in the Moray Firth and on the East Coast may well partly reflect climatic conditions in which oceanicity is markedly reduced (Birse 1971). In addition to climate, sand supply conditions are also probably important in determining the balance of SD5 and SD6 conditions. *Ammophila arenaria* is much more tolerant of sand burial than *Leymus arenarius* and these conditions are locally extensive on the East Coast, particularly in its northern sectors. However, *Leymus arenarius* becomes prominent in comparative shelter with strong and regular onshore summer winds in the summer which supply modest amounts of sand. This level of sand supply probably benefits *Leymus arenarius* and not *Ammophila arenaria.* A nutrient factor might also influence the extent of *Leymus arenarius*, since its largest extents on the East Coast tend to be close to large settlements where past sewage and other waste disposal might have been washed ashore, or supported increased seaweed growth which in turn formed a large part of tidal matter.

SD5 ***Leymus arenarius*** **mobile dune**

Total SD5 extent (45.8 ha including intermediates) is divided between three sub-communities, all of which can be locally extensive.

SD5a ***Leymus arenarius*** **mobile dune, species-poor sub-community**

This type, dominated by strongly growing *L. arenarius*, is generally very rare in Scotland and only 2.5 ha is present on the East Coast. No site has the bulk of this total and only two locations have areas >0.25 ha: Arbroath to Broughty Ferry (0.3 ha) and Inverallochy to Peterhead (0.3 ha). It tends to occur on more exposed SD5 areas and is often present in areas with local but heavy seaweed deposition. This vegetation on the East Coast is similar to accounts in the NVC (Rodwell 1991 *et seq.*)

SD5b ***Leymus arenarius*** **mobile dune,** ***Elymus farctus*** **sub-community**

In more sheltered conditions compared to SD5a, there is often the chance for SD4 embryo dune development. The adjacent SD5 vegetation is usually of the SD5b type with *Elymus farctus*. A total of 26.9 ha is present on the East Coast, with a large total (>2 ha) only present at Arbroath to Broughty Ferry (6.6 ha), Tentsmuir (3.9 ha), South Eden Estuary to St Andrews Links (3.4 ha), Inverallochy to Peterhead (2.3 ha) and Port Seton to Craigielaw (2.2 ha). It is common along foredune edges with similar SD6a, SD6b and SD6c types. This vegetation on the East Coast is similar to accounts in the NVC (Rodwell 1991 *et seq.*)

SD5c ***Leymus arenarius*** **mobile dune,** ***Festuca rubra*** **sub-community (Table 2.4)**

The SD5c type marks the most stable conditions under which SD5 mobile dune is found, with low sand supply allowing *Festuca rubra* to invade. It generally occupies the innermost zones of SD5 vegetation, with SD5a or SD5b types to seaward trapping most sand blown up the beach. Vegetation mapped in 1999 on the East Coast is similar to accounts in the NVC (Rodwell 1991 *et seq.*) but quadrat data in published reports (Robertson, 1988; Averis, 1998) show a more weedy, nutriphile assemblage in this vegetation in which *Festuca rubra* is only infrequent (Table 2.4).

Table 2.4 SD5c *Leymus arenarius* foredune, *Festuca rubra* sub-community

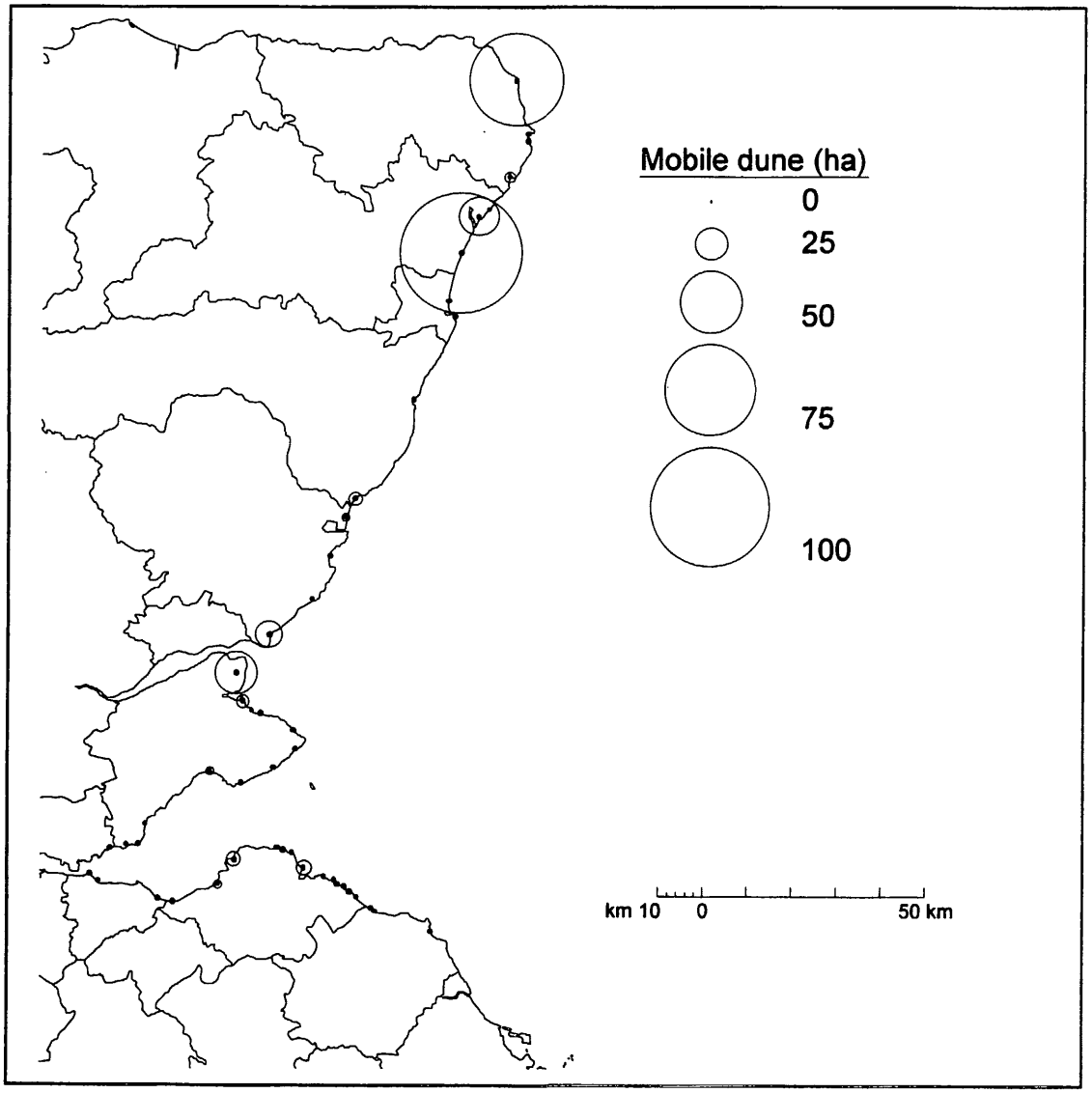
	Constancy	Domin range
Leymus arenarius	V	5-8
Festuca rubra	II	4-6
Cirsium arvense	IV	1-3
Matricaria maritima	IV	1-2
Sonchus arvensis	III	3-6
Ammophila arenaria	III	3-4
Arrhenatherum elatius	III	1-3
Dactylis glomerata	III	2-3
Campanula rotundifolia	II	3
Epilobium angustifolium	II	2-4
Galium aparine	II	4
Hypochoeris radicata	II	3-4
Poa pratensis	II	2
Rumex crispus	II	1-3
Senecio vulgaris	II	1
Trifolium arvense	II	2-3
Brachythecium albicans	II	5-7
Achillea millefolium	I	4
Angelica sylvestris	I	2
Astragalus danicus	I	7
Cerastium fontanum triviale	I	2
Daucus carota	I	1
Lotus corniculatus	I	1
Senecio jacobaea	I	3
Silene dioica	I	2
Trifolium campestre	I	2
Tortula ruralis ssp *ruraliformis*	I	3
Taraxacum seedling/sp.	I	1
Species per quadrat 8.71 (based on 7 quadrats)		

SD6 *Ammophila arenaria* mobile dune

Total SD6 extent (309.6 ha) is divided between all seven published NVC sub-communities, one provisional new sub-community (SD6x) and intermediates (SD6ab, SD6ae, SD6be). Only the SD6g *Carex arenaria* sub-community is uncommon and restricted in total extent. SD6 types tend to dominate the foredune zone over much of the East Coast foredune zone where conditions are exposed and levels of sand supply are suited to *Ammophila arenaria*. Particularly large extents (>50 ha) are present in this coastal sector, confined to the north where there are large blowout systems extending well inland with SD6 extensive on their margins: Newburgh to Bridge of Don has 100.5 ha and Inverallochy to Peterhead has 73.7 ha.

SD6a *Ammophila arenaria* mobile dune, *Elymus farctus* sub-community (Table 2.5)

This type has a total area of 64.2 ha, with large extents (>5 ha) at Inverallochy to Peterhead (17.6 ha), Newburgh to Bridge of Don (14.8 ha), Tyninghame Shore (8.1 ha) and St Cyrus (5.4 ha). It is usually present on the outer edge of the foredune zone, often occurring on turf slumping down the face of dunes cliffed by winter storms. *Ammophila arenaria* and *Elymus farctus* are constant, with occasional *Cakile maritima* present in addition. Given its location on the foredune edge and its species composition, it is suggested that the strand and embryo dune zones of some of the East Coast beaches are often compressed into this sub-community since exposure prevents much strand and embryo dune development. This feature is widespread elsewhere in western and northern Scotland and is always associated with exposed conditions. Species composition (Table 2.5) is similar to the NVC type (Rodwell 1991 *et seq.*).



Map 2.3 Mobile dune (SD5, SD6, SD10) vegetation (ha) in East Coast sites

Table 2.5 SD6a *Ammophila arenaria* mobile dune, *Elymus farctus* sub-community

	Constancy	Domin range
Ammophila arenaria	V	5-8
Elymus farctus boreali-atlanticus	V	1-8
Cirsium arvense	II	1-2
Senecio jacobaea	I	1
Elymus repens	I	4
Sonchus asper	I	3
Species per quadrat 2.70 (based on 10 quadrats)		

SD6ae *Ammophila arenaria* mobile dune, intermediate between SD6a and SD6e *Festuca rubra* sub-communities

This occupies similar conditions to the SD6a type and has a total area of 10.9 ha distributed in six sites. Most of its area (8.0 ha) is found in northern sites (Inverallochy to Peterhead, Newburgh to Bridge of Don and Cruden Bay. It is often found a very short distance inland from SD6a on the very edge of the foredune zone where it marks a rapid transition to SD6e or SD6f vegetation. *Ammophila arenaria, Elymus farctus* and *Festuca rubra* are all constant, together with a set of additional moderately common species which indicate the early stages of stabilisation (e.g. *Trifolium repens*). A constancy table is given in the Western Isles report. It is often replaced by SD7c, SD7x or SD9a vegetation immediately inland.

SD6b *Ammophila arenaria* mobile dune, *Leymus arenarius - Elymus farctus* sub-community (Table 2.6)

This is widespread in small quantities, with a total area of 32.6 ha. Large extents (>5 ha) are present only at Inverallochy to Peterhead (5.6 ha) and Tentsmuir (5.1 ha). It is often close to the SD5b *Elymus farctus* sub-community in composition and ecological conditions, usually being found on the outer edge of foredunes with moderate to good sand supply. The type (Table 2.6) is close to NVC published descriptions (Rodwell 1991 *et seq.*).

Table 2.6: SD6b *Ammophila arenaria* mobile dune, *Leymus arenarius - Elymus farctus* sub-community

	Constancy	Domin range
Ammophila arenaria	V	2-8
Leymus arenarius	V	1-8
Elymus farctus boreali-atlanticus	V	2-7
Cirsium arvense	I	2
Cakile maritima	I	1
Salsola kali	I	1
Senecio jacobaea	I	1
Senecio vulgaris	I	1
Species per quadrat 3.55 (based on 11 quadrats)		

SD6c ***Ammophila arenaria*** **mobile dune,** ***Leymus arenarius*** **sub-community (Table 2.7)**

This is restricted in extent, with a total area of 8.9 ha in only six sites (Inverallochy to Peterhead, Tentsmuir, St Cyrus, Newburgh to Bridge of Don, Arbroath to Broughty Ferry, and Aberlady Point to Milsey Bay. It is generally found close to strandlines and floristically contains elements of SD2 and SDy strand vegetation (Table 2.7).

Table 2.7 SD6c *Ammophila arenaria* mobile dune, *Leymus arenarius* sub-community

	Constancy	Domin range
Ammophila arenaria	V	3-9
Leymus arenarius	V	1-7
Cakile maritima	II	1-3
Cirsium arvense	II	1
Atriplex prostrata	I	2
Festuca rubra	I	4
Sonchus asper	I	3
Species per quadrat 3.17 (based on 6 quadrats)		

SD6d ***Ammophila arenaria*** **mobile dune, Typical sub-community (Table 2.8)**

This sub-community is the classical form of mobile dune, dominated by *Ammophila arenaria* and with few other species present in environments of plentiful sand supply and much change to surface relief as blowouts develop and change. It is the sub-community most associated with the best sand supply conditions or reworking of sand by wind around blowouts. It is the most extensive SD6 type on the East Coast (94.9 ha) but is present in only eight sites with most extent confined to three locations: Newburgh to Bridge of Don (33.9 ha), Sands of Forvie (31.4 ha) and Inverallochy to Peterhead (26.6 ha). The largest extents in these sites are associated with blowouts and most of the East Coast resource depends on internal dune mobility rather than sand inputs from the beach zone. This restriction in both range and local extent reinforces the view that good sand supply is very uncommon. *Ammophila arenaria* is monodominant and is only accompanied by a few species of low cover (e.g. *Senecio jacobaea*). The type (Table 2.8) is close to NVC published descriptions (Rodwell 1991 *et seq.*).

Table 2.8 SD6d *Ammophila arenaria* mobile dune, Typical sub-community

	Constancy	Domin range
Ammophila arenaria	V	5-10
Cirsium arvense	II	1-2
Senecio jacobaea	I	5-6
Cakile maritima	I	1
Epilobium angustifolim	I	6
Cirsium vulgare	I	5
Poa pratensis	I	3
Salsola kali	I	1
Sonchus asper	I	3
Species per quadrat 1.85 (based on 13 quadrats)		

SD6e *Ammophila arenaria* mobile dune, *Festuca rubra* sub-community (Table 2.9)

This sub-community is scattered in 14 sites, with a total area of 53.8 ha and large amounts (>10 ha) present at Inverallochy to Peterhead (16.9 ha) and Newburgh to Bridge of Don (10.7 ha). It is usually a temporary colonisation phase, often rapidly changing to SD7 semi-fixed dune in local zonations around blowouts.

Table 2.9 SD6e *Ammophila arenaria* mobile dune, *Festuca rubra* sub-community

	Constancy	Domin range
Ammophila arenaria	V	5-9
Festuca rubra	IV	2-4
Cirsium arvense	III	1-2
Holcus lanatus	III	1-4
Senecio jacobaea	III	1-2
Carex arenaria	III	2-4
Hypochoeris radicata	III	1-3
Hieracium pilosella group	II	1-3
Thymus praecox arcticus	II	2-3
Epilobium angustifolium	II	1-5
Luzula campestris	II	1-3
Vicia cracca	II	1
Hypnum cupressiforme var. *lacunosum*	II	2-3
Bellis perennis	I	3
Geranium molle	I	1
Rosa canina agg.	I	1
Sonchus asper	I	1
Teucrium scorodonia	I	1-2
Vicia lathyroides	I	1-3
Taraxacum seedling/sp.	I	1-2
Festuca juncifolia	I	3-4
Agrostis capillaris	I	2
Arrhenatherum elatius	I	2
Astragalus danicus	I	1
Cerastium diffusum diffusum	I	2
Cerastium fontanum triviale	I	1
Corylus avellana	I	1
Galium verum	I	2
Glechoma hederacea	I	2
Lotus corniculatus	I	1
Ononis repens	I	1
Plantago lanceolata	I	1
Sonchus arvensis	I	1
Valerianella locusta	I	1
Bryum caespiticium	I	1
Eurhynchium swartzii	I	1
Pseudoscleropodium purum	I	3
Tortula ruralis ssp. *ruraliformis*	I	1
Species per quadrat 9.90 (based on 10 quadrats)		

SD6f ***Ammophila arenaria*** **mobile dune,** ***Poa pratensis*** **sub-community**

This sub-community is restricted in extent (6.8 ha) and is found in only three sites on the East Coast: Newburgh to Bridge of Don (4.9 ha), Inverallochy to Peterhead (1.8 ha) and Tentsmuir (0.1 ha). It is similar in composition and ecology to the SD6e types but is notable for the frequent occurrence but often low cover of the rhizomatous grass *Poa pratensis* (or rather *Poa subcaerulea* in most cases). The NVC description (Rodwell 1991 *et seq.*) should be consulted for constancy details.

SD6g ***Ammophila arenaria*** **mobile dune,** ***Carex arenaria*** **sub-community**

This sub-community is very restricted in extent (1.7 ha) and distribution on the East Coast, with a presence in three sites: Newburgh to Bridge of Don (1.7 ha) and trivial amounts mapped at Inverallochy to Peterhead and Tentsmuir. It tends to occur in small quantities on the edges of blowouts. The NVC description (Rodwell 1991 *et seq.*) should be consulted for constancy details.

SD6x ***Ammophila arenaria*** **mobile dune, provisional new** ***Brachythecium albicans*** **sub-community (Table 2.10)**

This type is largely restricted to the East Coast, with small areas of similar vegetation possibly also occurring at Culbin and Lossiemouth in the Moray Firth. It is distinctive in structure, with much bare sand, scattered tufts of *Ammophila arenaria* and *Holcus lanatus*, plus patches of *Brachythecium albicans*. It seems confined to sands which have a low initial acidity, forming close to the shore and with little or no SD7 vegetation inland. *Festuca rubra* is absent from the type and it changes inland to SD12z (a mix of *Ammophila arenaria* and *Festuca ovina*). The nationally scarce *Festuca juncifolia* was recorded in this habitat at Balmedie (Newburgh to Bridge of Don). Total extent is 33.8 ha and it is mapped only at Newburgh to Bridge of Don (25.9 ha) and Tentsmuir (7.9 ha). This sub-community is significant, demonstrating that it is possible for an acidic mobile dune type to form and pass into a semi-fixed state without involving the normal foredune succession of SD6e and SD6f vegetation, followed by some form of SD7. Its rarity in Britain suggests that sands with a low initial carbonate level are very rare, though these seem to particularly extensive south of the River Ythan which is their main source on the East Coast. The conditions for this type at Tentsmuir are uncertain - no quadrat data are given but target notes in Robertson (1988) emphasise the joint presence of *Ammophila arenaria, Brachythecium albicans* and *Holcus lanatus*.

Table 2.10 SD6x ***Ammophila arenaria*** **mobile dune, provisional new** ***Brachythecium albicans*** **sub-community**

	Constancy	Domin range
Ammophila arenaria	V	5-6
Brachythecium albicans	V	4-6
Holcus lanatus	V	3-4
Senecio jacobaea	V	2-4
Cerastium diffusum	IV	2
Epilobium angustifolium	IV	3-4
Carex arenaria	III	2-3
Dicranum scoparium	III	2
Festuca ovina	III	2
Aira praecox	II	2
Agrostis capillaris	I	2
Cerastium glomeratum	I	1
Elymus farctus	I	2
Festuca juncifolia	I	3
Hypochoeris radicata	I	1
Luzula campestris	I	2
Rhytidiadelphus triquetrus	I	1
Species per quadrat 9.80 (based on 5 quadrats)		

SD10 *Carex arenaria* dune community

This is rare, occurring in only four sites with a low total area (2.3 ha). It occurs on the edges of blowouts and, very rarely, at the foot of slowly eroding dunes where bare sand is present. The largest extent is mapped at Inverallochy to Peterhead (1.5 ha), with small additional quantities at Newburgh to Bridge of Don (0.5 ha), Aberlady Point to Milsey Bay (0.2 ha) and Arbroath to Broughty Ferry (0.1 ha).

2.4 Semi-fixed dune (SD7, SD9)

In comparison with mobile dune habitat, semi-fixed dunes are much more extensive (921.6 ha, Map 2.4) and represent 8.0 % of potential vegetated sand area (11566 ha). Four sites have large total extents (>50 ha): Inverallochy to Peterhead (328.5 ha), Aberlady Point to Milsey Bay (172.7 ha), Arbroath to Broughty Ferry (102.8 ha) and Tyninghame Shore (51.4 ha). Small amounts are present in many sites but the habitat is absent from fifteen assemblages, most of which have settlements adjacent to or upon the dune area where development has eradicated most of the dune interest. Regular sand deposition is required to maintain a high cover of *Ammophila arenaria* (e.g. a Domin scale score of 4 or above) but sand inundation is low enough for *Festuca rubra* to become dominant, and for many other species to enter the sward in comparison with SD6 types. The SD7 *Ammophila arenaria - Festuca rubra* type is the most characteristic and results for Scotland are notable for the clear separation within the region of southern and northern British types. In areas ungrazed for some time the SD9 type is developed with *Arrhenatherum elatius* entering the sward. The latter type is particularly abundant on the East Coast and is strongly associated with the coastal edges and interiors of golf courses which manage this habitat as thick uncut rough.

SD7a *Ammophila arenaria - Festuca rubra* semi-fixed dune, Typical sub-community (Tables 2.11, 2.12)

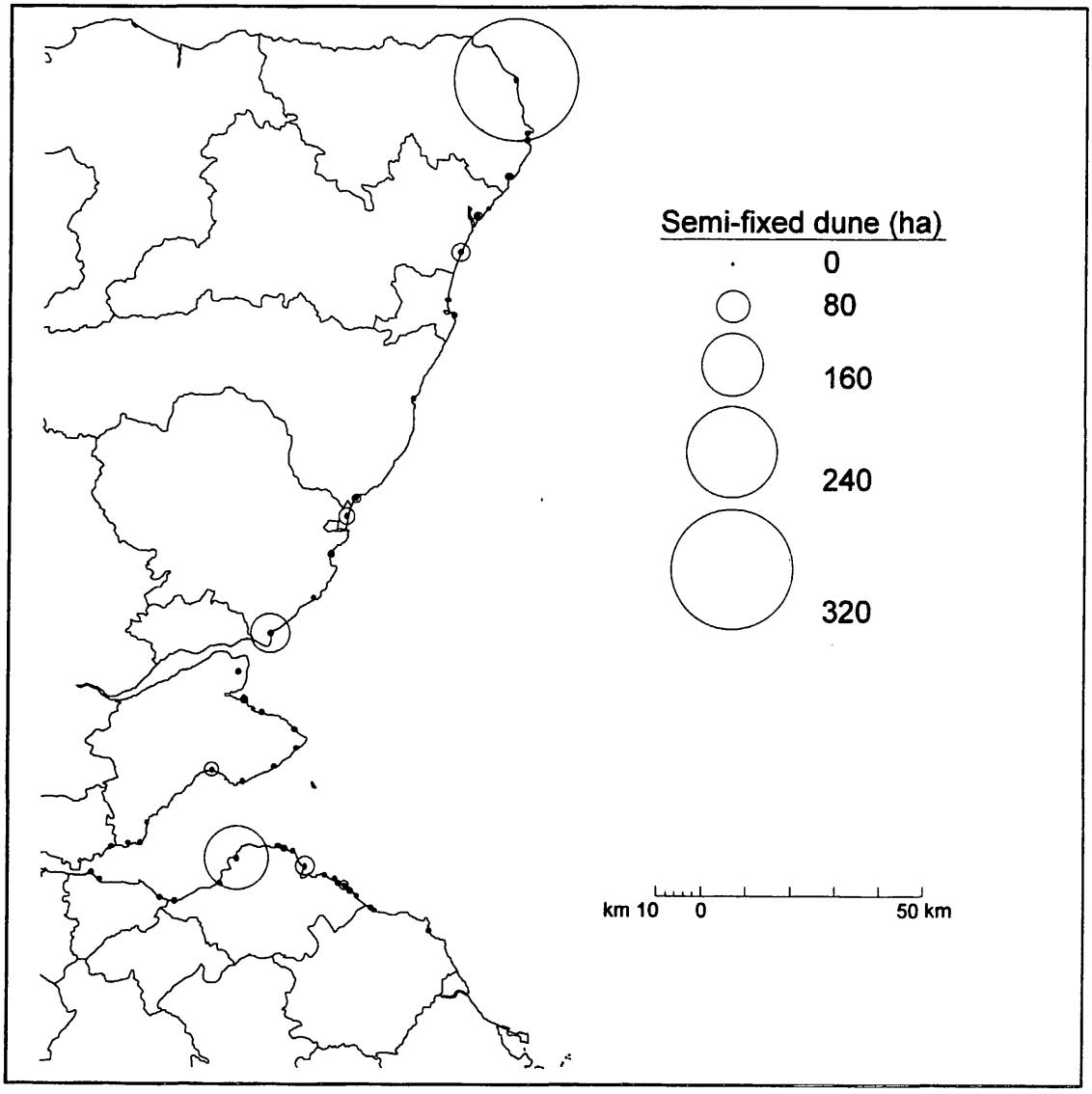
This is uncommon, with 47.7 ha total extent. It is extensive (>10 ha) only at Aberlady Point to Milsey Bay (24,2 ha) and Tyninghame Shore (11.3 ha), with smaller amounts in a further four sites. Mapped areas are close to the existing NVC description, with high covers for both *Ammophila arenaria* and *Festuca rubra*, but with relatively few additional species. It seems to represent areas on the seaward edges of sites without grazing, where spray might check invasion of *Arrhenatherum elatius*. Quadrat data for SD7a vegetation (Table 2.11) is available from part of the Aberlady Point to Milsey Bay site (Averis, 1998), plus data for an extensive (12.1 ha) SD7a/SD9a intermediate (Table 2.12).

SD7b *Ammophila arenaria - Festuca rubra* semi-fixed dune, *Hypnum cupressiforme* sub-community (Table 2.13)

This type reaches its northern limit in Scotland on the East Coast, with a low total area (including intermediates) of 17.5 ha. It is locally common in the Newburgh to Bridge of Don site (12.1 ha) but is rare elsewhere and only occurs in a further six sites. It marks the early stages of SD7 development and often has a high bare sand component within a herb and moss layer with a variable cover of *Hypnum cupressiforme*. In Britain this is predominantly a southern type and at West Links, Gullane (Aberlady Point to Milsey Bay) it seems to prefer south-facing slopes which are disturbed by rabbit activity. It occurs here as an SD7b/SD7d intermediate, with much *Tortula ruralis ruraliformis* in the turf.

SD7c *Ammophila arenaria - Festuca rubra* semi-fixed dune, *Ononis repens* sub-community (Table 2.14)

This type reaches its northern limit in Scotland with very small occurrences in the Moray Firth but the main boundary in its geographical distribution is on the East Coast where it is relatively common as far north as St Cyrus but then disappears. Total extent is 38.8 ha, with large extents (>5 ha) at Arbroath to Broughty Ferry (13.0 ha), Aberlady Point to Milsey Bay (7.3 ha) and Charleton & Kinnaber Links to Montrose (6.0 ha). The presence of *Ononis repens* makes this vegetation distinctive, especially in warm summer weather when this ground becomes highly scented. Its distribution is probably strongly correlated with thermal climate and further north it is replaced mainly by the SD7x type which has a similar species composition but lacks *Ononis repens*. The *Ononis repens* has its highest cover in ground adjacent to paths through SD7c dunes and it seems to thrive on light trampling.



Map 2.4 Semi-fixed dune (SD7, SD9) vegetation (ha) in East Coast sites

Table 2.11 SD7a *Ammophila arenaria - Festuca rubra* dune, Typical sub-community

	Constancy	Domin range
Ammophila arenaria	V	6-7
Festuca rubra	V	5-6
Hypnum cupressiforme var. *lacunosum*	I	3
Lophocolea bidentata	V	3-4
Fragaria vesca	IV	1-4
Holcus lanatus	IV	2-3
Teucrium scorodonia	IV	1-4
Heracleum sphondylium	III	1-2
Polypodium vulgare	III	2-6
Senecio jacobaea	III	1-2
Valerianella locusta	III	1
Vicia lathyroides	III	1-3
Dicranum scoparium	III	1-6
Pseudoscleropodium purum	III	4-6
Rhytidiadelphus triquetrus	III	6
Taraxacum seedling/sp.	III	1
Arrhenatherum elatius	II	3-4
Carex arenaria	II	2-3
Cerastium fontanum triviale	II	1
Cirsium arvense	II	1
Galium verum	II	1
Hypochoeris radicata	II	2-3
Hieracium pilosella group	II	1
Rosa canina agg.	II	1
Thymus praecox arcticus	II	1-3
Eurhynchium praelongum	II	3-4
Hypnum cupressiforme	II	3
Anthriscus sylvestris	I	2
Bellis perennis	I	1
Epilobium angustifolium	I	1
Crataegus monogyna	I	1
Galium saxatile	I	1
Luzula campestris	I	3
Rumex crispus	I	1
Vicia cracca	I	1
Viola riviniana	I	1
Brachythecium rutabulum	I	1
Pleurozium schreberi	I	4
Cladonia ciliata var. *tenuis*	I	5
Species per quadrat 17.80 (based on 5 quadrats)		

Table 2.12 Intermediate between SD7a *Ammophila arenaria - Festuca rubra* dune, Typical community and SD9a *Ammophila arenaria - Arrhenatherum elatius* grassland, *A. elatius* sub-community

	Constancy	Domin range
Ammophila arenaria	V	5-6
Festuca rubra	V	6-7
Arrhenatherum elatius	IV	1-4
Holcus lanatus	V	3-5
Pseudoscleropodium purum	V	3-5
Agrostis capillaris	IV	2-3
Cirsium arvense	IV	1
Teucrium scorodonia	IV	2-3
Anthriscus sylvestris	III	1-2
Carex arenaria	III	3
Anthoxanthum odoratum	II	1
Glechoma hederacea	II	2-3
Senecio jacobaea	II	1
Taraxacum seedling/sp.	II	1
Astragalus danicus	I	2
Calluna vulgaris	I	1
Crataegus monogyna	I	1
Galium verum	I	1
Lotus corniculatus	I	1
Luzula campestris	I	1
Thymus praecox arcticus	I	1
Rhytidiadelphus squarrosus	I	2
Species per quadrat 11.60 (based on 5 quadrats)		

Table 2.13 SD7b/d *Ammophila arenaria - Festuca rubra* dune, intermediate between *Hypnum cupressiforme* and *Tortula ruralis* ssp *ruraliformis* sub-communities

	Constancy	Domin range
Ammophila arenaria	V	1-3
Festuca rubra	I	3
Hypnum cupressiforme var. lacunosum	V	2-6
Tortula ruralis ssp ruraliformis	V	5-6
Carex arenaria	V	3-4
Cerastium semidecandrum	V	3
Hypochoeris radicata	V	3
Myosotis ramosissima	V	2-3
Hieracium pilosella group	V	2-4
Valerianella locusta	V	2-3
Luzula campestris	IV	2-3
Senecio jacobaea	IV	1
Taraxacum seedling/sp.	IV	2-3
Agrostis capillaris	III	2-3
Astragalus danicus	III	1-2
Teucrium scorodonia	III	1-3
Galium verum	II	1
Holcus lanatus	II	3
Vicia lathyroides	II	1
Viola riviniana	II	1-2
Cerastium diffusum diffusum	I	1
Epilobium angustifolium	I	1
Erodium cicutarium	I	3
Festuca ovina	I	3
Fragaria vesca	I	2
Geranium molle	I	1
Senecio vulgaris	I	1
Cladonia rangiformis	I	1
Species per quadrat 16.60 (based on 5 quadrats)		

Table 2.14 SD7c *Ammophila arenaria - Festuca rubra* dune, *Ononis repens* sub-community

	Constancy	Domin range
Ammophila arenaria	V	4-8
Festuca rubra	V	1-7
Ononis repens	V	2-8
Cirsium arvense	V	1-8
Carex arenaria	IV	2-4
Galium verum	IV	1-5
Holcus lanatus	III	1-4
Cerastium fontanum triviale	III	1
Poa pratensis	III	1-3
Veronica chamaedrys	III	1-3
Achillea millefolium	III	1-2
Arrhenatherum elatius	III	2-4
Heracleum sphondylium	III	1-4
Centaurea nigra	II	1-4
Trifolium repens	II	1-3
Valeriana officinalis	II	1-7
Rhytidiadelphus squarrosus	II	2-4
Taraxacum seedling/sp.	II	1
Astragalus danicus	I	1-3
Leymus arenarius	I	1
Koeleria macrantha	I	1-2
Plantago lanceolata	I	1-4
Senecio jacobaea	I	1-3
Tussilago farfara	I	1-3
Brachythecium albicans	I	1-4
Pseudoscleropodium purum	I	1-6
Anthoxanthum odoratum	I	3
Campanula rotundifolia	I	1
Dactylis glomerata	I	1
Equisetum arvense	I	2
Hypochoeris radicata	I	2
Ranunculus repens	I	1
Rumex acetosa	I	1
Torilis japonica	I	1
Viola riviniana	I	1
Species per quadrat 11.92 (based on 12 quadrats)		

Table 2.15 SD7d/x *Ammophila arenaria* - *Festuca rubra* dune, intermediate between *Tortula ruralis* ssp. *ruraliformis* and provisional new *Galium verum* sub-communities

	Constancy	Domin range
Ammophila arenaria	V	4-8
Festuca rubra	V	2-9
Tortula ruralis ssp. *ruraliformis*	IV	2-6
Galium verum	IV	3-5
Poa pratensis	V	2-4
Cerastium fontanum triviale	V	1-3
Senecio jacobaea	V	1-4
Lotus corniculatus	IV	3-5
Taraxacum seedling/sp.	IV	1-4
Holcus lanatus	III	1-5
Myosotis ramosissima	III	1-3
Cerastium diffusum diffusum	II	1-3
Cirsium arvense	II	2-4
Veronica arvensis	II	1-2
Viola tricolor	II	1-3
Brachythecium rutabulum	II	1-4
Rhytidiadelphus triquetrus	II	3-8
Vicia sativa	II	1-2
Campanula rotundifolia	II	3
Carex arenaria	II	3-4
Hypochoeris radicata	II	2-3
Luzula campestris	II	2-3
Brachythecium albicans	II	4-5
Rhytidiadelphus squarrosus	II	4
Peltigera canina	II	1-2
Agrostis stolonifera	I	2
Aira praecox	I	2
Anthriscus sylvestris	I	1
Arctium minus	I	1
Bellis perennis	I	2
Cerastium semidecandrum	I	1
Dactylis glomerata	I	4
Equisetum arvense	I	1
Geranium molle	I	1
Heracleum sphondylium	I	1
Linum catharticum	I	1
Plantago lanceolata	I	2
Thalictrum minus	I	1
Valerianella locusta	I	1
Viola riviniana	I	2
Campylium stellatum var. *protentosa*	I	3
Hylocomium splendens	I	1
Hypnum cupressiforme	I	3
Pseudoscleropodium purum	I	3
Viola tricolor curtisii	I	2
Species per quadrat 15.50 (based on 8 quadrats)		

SD7d ***Ammophila arenaria - Festuca rubra*** **semi-fixed dune,** ***Tortula ruralis ssp. ruraliformis*** **sub-community (Tables 2.13 and 2.15)**

This is locally extensive (62.8 ha) with large areas (>5 ha) mapped at Inverallochy to Peterhead (45.4 ha) and Tyninghame Shore (7.4 ha). The moss *Tortula ruralis* ssp. *ruraliformis* is present in large patches and indicates vegetation that is either just recovering from a phase of dune instability or one on the edge of becoming unstable. The sub-community is therefore often an indicator of local site instability and sand blow. It is found on steep dune slopes on the sides of stabilised parabolic blowouts around Rattray Head (NK095575). Its presence elsewhere is often partly maintained by rabbit burrowing. Some of its East Coast extent is found a short distance inland from the foredune edge where there is still active sand deposition by windblow. Here it forms a transition from SD6 mobile dune to SD7x semi-fixed and SD8 fixed dune types. Locally, visitor trampling also provides sufficient bare sand for this sward to develop close to paths. Quadrat data are not available for clear SD7d vegetation but intermediates with SD7b (Table 2.13) and SD7x (Table 2.15) show the floristic composition well.

SD7x ***Ammophila arenaria - Festuca rubra*** **semi-fixed dune, provisional new** ***Galium verum*** **sub-community (Table 2.15)**

This is restricted to the north of the East Coast, with a total area of 260.7 ha confined to three sites: Inverallochy to Peterhead (243.3 ha), Sands of Forvie (17.3 ha) and Peterhead Bay (0.1 ha). This strongly localised distribution seems to reflect more calcareous sands, higher levels of sand deposition by windblow, and perhaps a climatic influence around Cairnbulg Point where more oceanic conditions might exist. Similar vegetation extends west into the Moray Firth, but only as far as Fraserburgh Bay. At Sands of Forvie it occurs in a confined area around Rockend (NK020263) and this is its southern limit on the east coast of Scotland. On more calcareous sands further south it is replaced by SD7c vegetation.

Sand supply is sufficient to retain a high cover of *Ammophila arenaria* (Domin score 4 or more) but sand burial is sufficiently low to allow a high cover of *Festuca rubra* and many dune grassland species into the sward (e.g. *Trifolium repens, Ranunculus acris, Plantago lanceolata*). Separation of SD7x from some types of SD8 vegetation was often not easy in cases of low *A. arenaria* cover and in such conditions a Domin score of 4 or more was accepted as the threshold for mapping as SD7x vegetation. In borderline cases intermediates were mapped and these are also moderately extensive (SD7x/SD8b, 20.7 ha) or rare (SD7d/SD7x, 2.6 ha). Ungrazed swards change rapidly to SD9 vegetation.

The successional character of this vegetation is discussed in Dargie (1993), including constancy tables drawn largely from Inner Hebrides quadrats which show the consistent presence of *Galium verum*, a species missing from most quadrats defining other SD7 sub-communities. This type is the characteristic SD7 sub-community of the Inner Hebrides, Western Isles, northwestern Scotland, Orkney and Shetland and shows a very clear association with oceanic conditions. Its general restriction to the northern East Coast and outer Moray Firth is probably strongly related to more oceanic conditions. Constancy tables are given in Dargie (1993) and the Western Isles report.

SD7y ***Ammophila arenaria - Festuca rubra*** **semi-fixed dune, provisional new** ***Hylocomium splendens - Rhytidiadelphus triquetrus*** **sub-community (Table 2.6)**

This is rare and confined to Barry Links (Arbroath to Broughty Ferry) where 11.3 ha is mapped in a fairly confined area. Elsewhere, this type is largely confined to the inner Moray Firth where it is locally extensive. Like SD7x vegetation it often contains *Galium verum* but its most striking characteristic is a high cover of feather mosses, particularly *Hylocomium splendens*. In the Moray Firth it is not uncommon to find a bryophyte layer with >90% cover and a depth of 10 - 30 cm in the best examples of this distinctive vegetation. In older, more leached swards *Rhytidiadelphus triquetrus* is replaced by *Pleurozium schreberi* and there is a transition to acidic semi-fixed dune types in which *Ammophila arenaria* cover remains high (SD12z with *Festuca ovina*, SD12xy with *Deschampsia flexuosa*). The SD7y type is part of a suite of vegetation types containing a large biomass of *Hylocomium splendens* which seem to represent a distinctive boreal biogeographic zone both within Scotland and Great Britain.

SD9 *Ammophila arenaria - Arrhenatherum elatius* grassland

This is the main dune analogue to MG1 grassland, with *Arrhenatherum elatius* invading semi-fixed dune grassland (the SD7x, SD7y and SD12z types), always in areas which are not grazed, or which have been ungrazed until recently. It is abundant on the East Coast, with 362.7 ha of coverage between SD9a, SD9b, SD9x and their intermediates. This extent reflects the large areas of dune which are managed as links golf courses, within which thick uncut rough is a traditional element of play and a major element of the links landscape.

SD9a *Ammophila arenaria - Arrhenatherum elatius* grassland, *Arrhenatherum elatius* sub-community (Table 2.16)

This is the main SD9 type and it is extensive throughout the East Coast, occurring in 27 sites with a total area of 318.1 ha (including intermediates). It is particularly abundant at Aberlady Point to Milsey Bay (106.9 ha) and two other sites have areas >20 ha: Newburgh to Bridge of Don (26.6 ha) and Largo Bay (22.1 ha). For most of its large extent it is present on golf courses which have probably not been grazed for a considerable period, allowing *Arrhenatherum elatius* into the sward. Constancy data for this vegetation type are also given in the report covering Orkney. Regional examples are similar to the NVC description (Rodwell 1991 *et seq.*). *Ammophila arenaria, Arrhenatherum elatius* and *Festuca rubra* are all constants in a rank, species-poor turf which can show interesting local variation if there are local moisture gradients present (Tidswell, 1997). There is a transition to wet heath at Tentsmuir and elsewhere there is invasion of swards by *Hippophae rhamnoides* (SD9a/SD18a, 0.4 ha) and bracken (SD9a/W25, 7.6 ha).

SD9b *Ammophila arenaria - Arrhenatherum elatius* grassland, *Geranium sanguineum* sub-community

Strictly, this type is absent from the East Coast because the key preferential species, *Geranium sanguineum*, is absent. However, a known SD9b preferential associate, *Rosa pimpinellifolia*, is present in four scattered locations and SD9 here was mapped as SD9b. Total extent is 3.8 ha, with occurrences at Port Seton to Craigielaw (2.6 ha), Largo Bay (0.7 ha), Tyninghame Shore (0.3 ha) and Peatdraught Bay (0.2 ha). All locations are southern and this is consistent with the main geographical locus of this type, where it is locally abundant on the Northumberland coast (Radley 1995). The SD9b type indicates areas undergoing invasion by bracken and scrub. Such transitional conditions with partial shading and a very rank sward are characteristic of habitats favoured by *Geranium sanguineum* and *Rosa pimpinellifolia.* No quadrat data are available.

SD9x *Ammophila arenaria - Arrhenatherum elatius* grassland, provisional new *Hylocomium splendens* sub-community

This is restricted to Barry Links (Arbroath to Broughty Ferry) where 40.7 ha of ground has vegetation closely resembling a provisional new SD9x type which is largely confined to the inner Moray Firth. There, it forms part of a Boreal suite of vegetation types with a high biomass of feather mosses. The sward has a high moss biomass which is normally dominated by *Hylocomium splendens*. More acidic cases have the moss *Pleurozium schreberi* and in a few examples *Deschampsia flexuosa* can be present. A floristic table is given in the Moray Firth report. Mapping at Barry Links was based on quadrat data in Woolven (1989) and a limited amount of field survey in 1995.

2.5 Fixed calcareous dune (SD8)

Fixed calcareous dune grassland (Map 2.5) is only locally extensive on the East Coast, with 235.2 ha (2.0 % of potential area of vegetated sand, 11566 ha) largely concentrated in the north of this region. This category covers most of the drier grassland types with short swards which are characteristic of strongly grazed dune grassland plains with calcareous soils derived from shell sand content. The SD8 grasslands show complex variation, with grazing, soil moisture, surface stability, and successions from semi-fixed dune comprising the main controlling factors. Salt spray and sward improvement are also locally important. Several intermediate NVC vegetation types were mapped involving SD8 swards and are listed in Annex 1, reflecting the essentially continuous variation which characterises calcareous dune grasslands. These swards are highly colourful and scented in early summer, often with abundant quantities of *Thymus praecox*.

More acidic SD8 types are dominant on the East Coast and it is important to note that acidic dune grassland (SD12, U2, U4, U5, U6) types are much more extensive (1461.8 ha). This pattern of balance suggests that acidic parent material is much more extensive than sands with a high shell content, except in the north. The acidic sands are probably derived from fluvioglacial materials in adjacent river basins and offshore, brought on land as part of near-shore processes operating in the Holocene transgression. Some shell content is usually present in beach materials but this is probably low in comparison with western Scotland dune materials, allowing leaching to quickly form near-neutral and acidic soils following stabilisation of dunes by vegetation.

Table 2.16 SD9a *Ammophila arenaria-Arrhenatherum elatius* grassland, *A. elatius* sub-community

	Constancy	Domin range
Ammophila arenaria	V	1-7
Arrhenatherum elatius	V	4-9
Festuca rubra	V	1-9
Carex arenaria	III	2-8
Cirsium arvense	III	1-3
Poa pratensis	III	1-4
Pseudoscleropodium purum	III	1-7
Achillea millefolium	III	1-3
Galium verum	III	1-4
Agrostis capillaris	II	1-7
Stellaria graminea	II	1-3
Dactylis glomerata	II	1-3
Holcus lanatus	II	1-6
Anthoxanthum odoratum	II	2-5
Plantago lanceolata	II	1-4
Rhytidiadelphus squarrosus	II	1-5
Rhytidiadelphus triquetrus	II	3-9
52 species with constancy class I excluded from table		
Species per quadrat 11.41 (based on 29 quadrats)		

SD8a *Festuca rubra - Galium verum* fixed dune, Typical sub-community (Table 2.17)

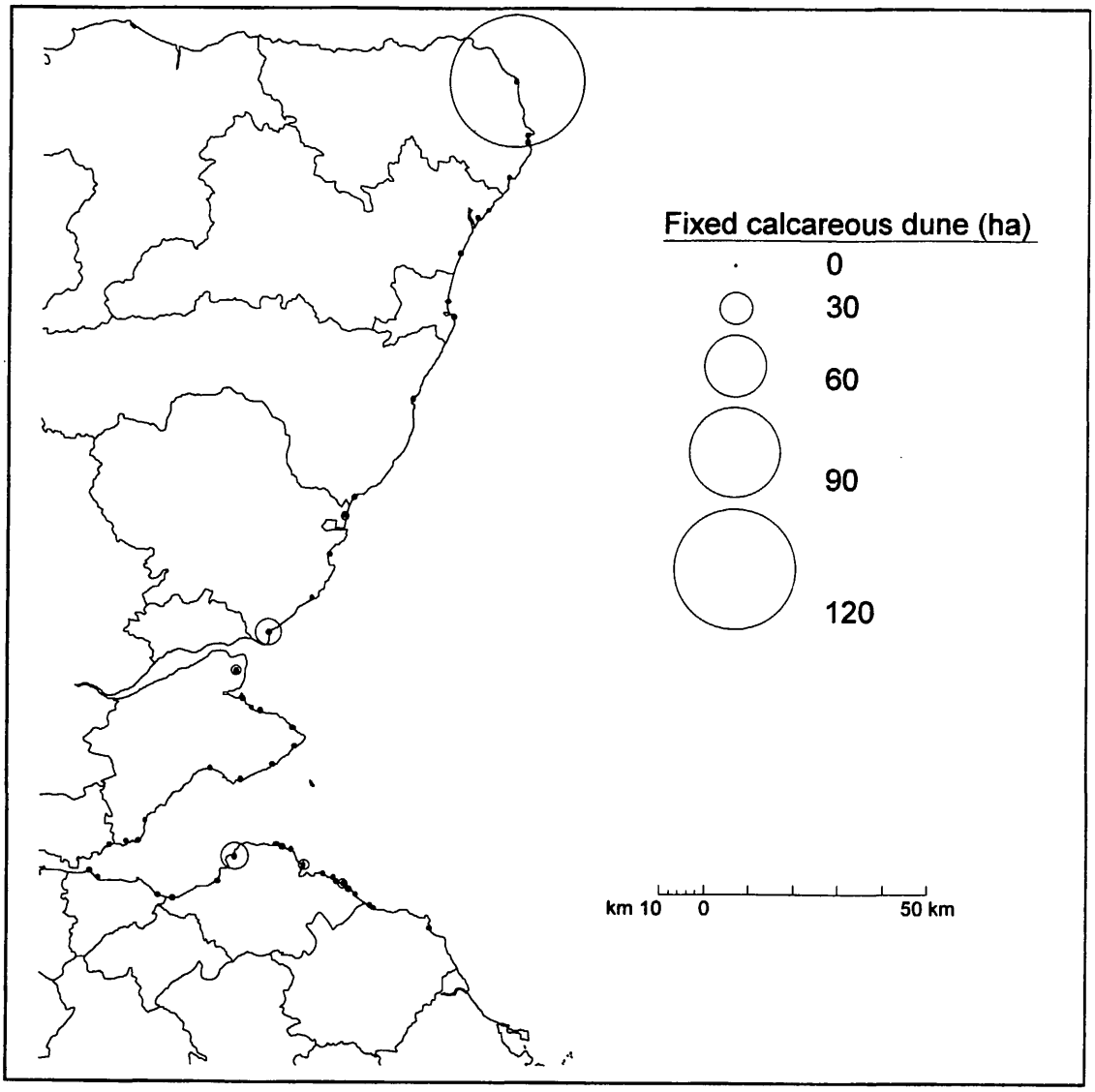
Total extent is 48.2 ha, with two sites having >5 ha: Aberlady Point to Milsey Bay (19.6 ha) and Inverallochy to Peterhead (14.1 ha). *Festuca rubra* is constant and is dominant. Some herbs are common (e.g. *Plantago lanceolata, Lotus corniculatus, Trifolium repens, Lotus corniculatus, Achillea millefolium*) but the sward is tall and has a thick 'thatch' of dead grass at ground level. This is a characteristic feature of grasslands which are either young in character (in successional terms) or which have become tall and rank due to lack of grazing. The latter condition applies to most East Coast occurrences and lack of grazing over longer periods probably produces a succession to MG1/SD8 and then MG1 types. Constancy data for SD8a vegetation are available in reports for the Western Isles and Orkney. Regional types are close to the existing NVC description.

SD8b *Festuca rubra - Galium verum* fixed dune, *Luzula campestris* sub-community (Table 2.18)

This sub-community is moderately extensive, with a total area of 99.6 ha (excluding intermediates). Only one site has >10 ha: Inverallochy to Peterhead (70.7 ha). It is recognised as the most leached SD8 type. It forms part of an acidity sequence, usually changing inland in large sites into SD12 dune grassland. East Coast types (Table 2.17) show evidence of slightly acidic conditions in the presence of *Campanula rotundifolia, Festuca ovina, Dicranum scoparium* and *Cladonia rangiformis*. Transitional types to acidic dune grassland are also mapped (SD8b/SD12, 18.9 ha, mainly at Inverallochy to Peterhead where there are fine intermediates within Loch of Strathbeg SSSI.

SD8c *Festuca rubra - Galium verum* fixed dune, *Tortula ruralis* ssp. *ruraliformis* sub-community

This sub-community is scattered in small quantities, with a total area of 9.0 ha. It is only present in large quantities (>1 ha) at Inverallochy to Peterhead (3.6 ha), Tyninghame Shore (3.5 ha) and Aberdeen (1.0 ha). The last site is anomalous, with grass mowing providing much of the surface instability which this type requires. *Tortula ruralis* ssp. *ruraliformis* is constant in this type, sometimes with other mosses which can also develop in bare sand environments: *Homalothecium lutescens* and *Brachythecium albicans*. It is characteristic of zones receiving blown sand from the beach or nearby blowouts.



Map 2.5 Fixed calcareous dune (SD8) grassland vegetation (ha) in East Coast sites

Table 2.17 SD8a *Festuca rubra-Galium verum* grassland, Typical sub-community

	Constancy	Domin range
Festuca rubra	V	5-9
Galium verum	IV	2-5
Plantago lanceolata	IV	1-5
Agrostis capillaris	IV	2-7
Cerastium fontanum triviale	IV	1-2
Anthoxanthum odoratum	III	1-5
Trifolium repens	III	1-4
Ammophila arenaria	III	1-4
Carex arenaria	III	1-4
Lotus corniculatus	III	1-5
Achillea millefolium	III	1-4
Veronica chamaedrys	III	1-3
Holcus lanatus	III	1-6
Koeleria macrantha	III	1-2
Ononis repens	III	1-5
Rhytidiadelphus squarrosus	III	1-5
Cirsium arvense	II	1-2
Euphrasia officinalis agg.	II	3-4
Poa pratensis	II	2-6
Campanula rotundifolia	II	1-2
Hieracium pilosella group	II	1-2
Rhinanthus minor	II	1-4
Pseudoscleropodium purum	II	2-4
Arrhenatherum elatius	II	1-3
Astragalus danicus	II	1-6
Hypochoeris radicata	II	1-4
Linum catharticum	II	1-3
Thymus praecox arcticus	II	1-4
Viola riviniana	II	1-2

45 species with constancy class I excluded from table

Species per quadrat 16.58 (based on 24 quadrats)

Table 2.18 SD8b *Festuca rubra - Galium verum* grassland, *Luzula campestris* sub-community

	Constancy	Domin range
Festuca rubra	V	4-10
Galium verum	V	1-5
Luzula campestris	IV	1-5
Poa pratensis	IV	2-6
Trifolium repens	III	2-5
Cerastium fontanum triviale	III	1-2
Holcus lanatus	III	1-5
Lotus corniculatus	III	1-7
Plantago lanceolata	III	1-5
Thymus praecox arcticus	III	1-5
Rhytidiadelphus squarrosus	III	1-8
Agrostis capillaris	III	3-8
Carex arenaria	III	2-4
Pseudoscleropodium purum	III	2-5
Ammophila arenaria	II	2-4
Anthoxanthum odoratum	II	4-7
Bellis perennis	II	1-5
Koeleria macrantha	II	1-4
Senecio jacobaea	II	1-5
Veronica arvensis	II	1
Achillea millefolium	II	1-4
Carex flacca	II	2-3
Cirsium arvense	II	1-3
Hieracium pilosella group	II	1-3
Trifolium dubium	II	1-2
Viola canina	II	1-2
Brachythecium albicans	II	2-4
Dicranum scoparium	II	3-5
Hypnum cupressiforme	II	1-5
Cladonia rangiformis	II	1-4
41 species with constancy class I excluded from table		
Species per quadrat 17.42 (based on 12 quadrats)		

SD8x *Festuca rubra-Galium verum* grassland, provisional new *Centaurea nigra - Daucus carota* sub-community

This is uncommon, with 15.2 ha largely restricted to Arbroath to Broughty Ferry (14.4 ha) and further small quantities at Inverallochy to Peterhead, largo Bay and Elie East Links to Earlsferry Links. It is distinct from other NVC SD8 sub-communities in being relatively tall, with distinctive tall herbs and grasses which are lacking or much less frequent in swards subject to grazing for most of the year: e.g. *Centaurea nigra* and *Daucus carota.* Many usual dry grassland (SD8a, SD8b) species are also less frequent. In some respects this type is a dune analogue to MG5 *Cynosurus cristatus - Centaurea nigra* meadow and pasture, especially the MG5b *Galium verum* sub-community, but its floristics are distinct. It is widespread in the Inner Hebrides and scattered in the Western Isles and Northwest Scotland where it is an indicator of ungrazed or undergrazed machair. Constancy data are given in the Western Isles and Inner Hebrides reports. All occurrences on the East Coast are in ungrazed fields which have not been grazed for some time.

2.6 Fixed acidic dune grassland (SD12, U2, U4, U5, U6)

This type of dune grassland (Map 2.6) is present in many sites and is often very extensive, with a total area of 1461.8 ha. This represents 12.6% of potential vegetated sand area (11566 ha). It is developed on sands which are either acidic due to very low initial shell carbonate content, or which have had a small initial amount of shell carbonate leached from the soil over time to create acidic conditions. Much parent material was probably derived from fluvioglacial materials deposited following ice retreat. Most of this aggregate is made up of SD12 *Carex arenaria - Festuca ovina - Agrostis capillaris* types (1276.0 ha), with a further 185.7 ha of other acidic grassland (U2, U4, U5, U6). Almost 10% of this habitat aggregate is affected by mowing, mainly as part of golf course management but with a much smaller cut component on military firing ranges at Barry Links (Arbroath to Broughty Ferry) and Blackdog (Newburgh to Bridge of Don).

SD12 *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland

All community constants (*Carex arenaria, Festuca ovina, Agrostis capillaris*) are normally present but many stands are impossible to allocate to a sub-community because both SD12 sub-community type constants (SD12a *Anthoxanthum odoratum*, SD12b *Holcus lanatus*) are generally present. In the largest extents, particularly at Tentsmuir and Charleton & Kinnaber Links, slight moisture variations do produce quite distinct differentiation between the SD12a and SD12b types. Areas similar to the NVC descriptions but with all constants were mapped only as SD12 (124.9 ha, including intermediates). However, such cases are only locally extensive and the bulk of SD12 grassland is made up of a notable complex which is probably developed best in Britain on the East Coast. Intermediates with SD16 *Salix repens - Holcus lanatus* dune slack are also locally extensive in a few sites. Several provisional new sub-communities are required to cover the range of variation present, with six (SD12x, SD12y, SD12z, SD12xx, SD12xy, and SD12yy types) are present in the region, some with a very large extent. These are described below. Additional information is available in reports for Inner Hebrides, Southwest and Northwest Scotland, and the Moray Firth where some or all of these types are also present.

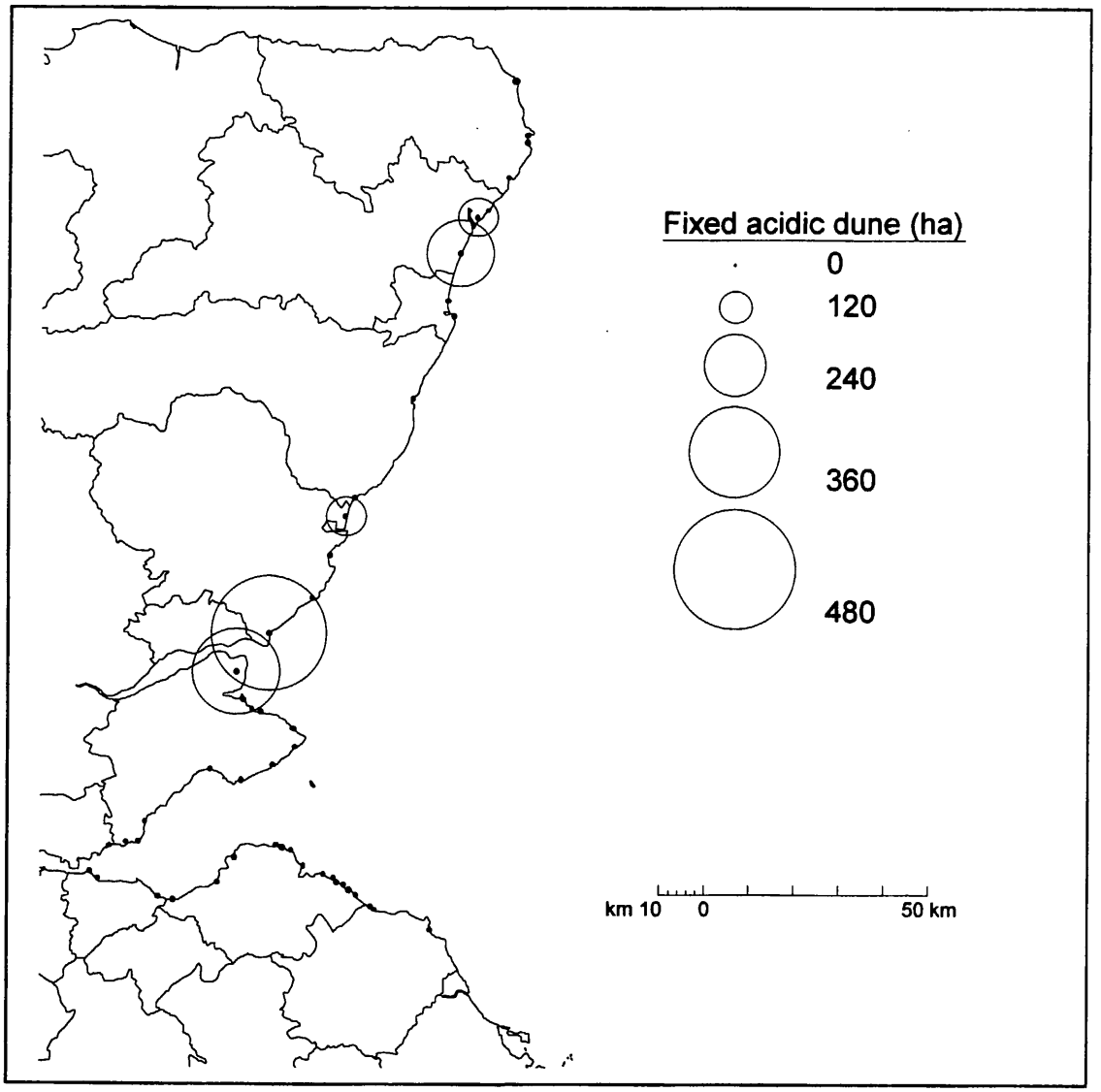
SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, No clear sub-community (Tables 2.19, 2.20)

This is locally extensive in the region, with a total area of 98.8 ha plus 26.0 ha of intermediates which include 23.9 ha of an important transition to slack, SD12/SD16 (see Table 2.20). Large extents (>10 ha) are mapped only at Newburgh to Bridge of Don (42.2 ha) and Tentsmuir (33.5 ha). The SD12/SD16 intermediate is mainly confined to Barry Links in the Arbroath to Broughty Ferry assemblage. Quadrat data (Table 2.19) grouped from Loch of Strathbeg, Aberlady Bay and Gullane Links (Aberlady) show a sward with near-equal frequencies and cover ranges for *Holcus lanatus* and *Anthoxanthum odoratum*, plus a surprisingly high constancy for *Galium verum* which in this region persists into quite acidic soil conditions. Only *Festuca ovina* falls into constancy class V but there is a suite of other good acidic grassland indicators present in classes IV and III: *Agrostis capillaris, Danthonia decumbens* and *Dicranum scoparium*. Samples are taken largely from ungrazed sites or parts of sites and it is possible that the absence of grazing obscures the differentiation into SD12a and SD12b vegetation where moisture variation is present in soils.

The SD12/SD16 intermediate with dune slack is extensive at Barry Links around the margins of quite large slacks formed behind parabolic dune blowout complexes. The transition zone forms about 20% of the combined slack and slack transition area for the Arbroath to Broughty Ferry assemblage and in some slacks only the presence of *Salix repens* separates this sward from clear SD12 vegetation. Even the wetter centres of many slacks hold tall, rank grassy vegetation which is species-poor, the result of a long period without grazing (though grazing has recently been re-introduced to Barry Links). This large proportion of transitional conditions suggests that slacks might be drying out in parts of this important site, possibly due to attempts at land drainage in areas of military training.

SD12a *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Anthoxanthum odoratum* sub-community (Table 2.21)

This is locally extensive, occurring in thirteen sites with a total extent of 163.3 ha, plus 9.3 ha of an Sd12a/b intermediate. Large areas (>10 ha) are restricted to three sites: Charleton & Kinnaber Links (79.7 ha), Arbroath to Broughty Ferry (22.9 ha, mostly at Barry Links) and Newburgh to Bridge of Don (19.2 ha). It is present on dry, well-drained ground in the centre of many sites. Samples from 23 quadrats (Sands of Forvie, Foveran, Tentsmuir, Aberlady Bay and Gullane Links (Aberlady) show vegetation which is close to the NVC description of this type, but with a very high constancy for *Galium verum* (Table 2.21).



Map 2.6 Fixed acidic (SD12) dune grassland (ha) in East Coast sites

Table 2.19 SD12 *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, No clear sub-community

	Constancy	Domin range
Carex arenaria	IV	2-5
Festuca ovina	V	3-8
Agrostis capillaris	IV	3-8
Hieracium pilosella group	IV	1-6
Anthoxanthum odoratum	IV	3-5
Galium verum	IV	2-4
Holcus lanatus	IV	2-6
Plantago lanceolata	IV	2-3
Danthonia decumbens	IV	2-6
Lotus corniculatus	III	3-4
Senecio jacobaea	III	2
Thymus praecox arcticus	III	1-5
Dicranum scoparium	III	1-4
Rhytidiadelphus squarrosus	III	2-8
Astragalus danicus	II	1-4
Campanula rotundifolia	II	2-3
Cirsium arvense	II	1
Luzula campestris	II	1-2
Plantago maritima	II	1-6
Poa pratensis	II	3-6
Veronica chamaedrys	II	1
Pseudoscleropodium purum	II	1-4
Ammophila arenaria	II	2
Arrhenatherum elatius	II	3-4
Briza media	II	4-6
Carex flacca	II	3-4
Centaurium erythraea	II	1
Cerastium fontanum triviale	II	1
Coeloglossum viride	II	1
Dactylis glomerata	II	1-3
Equisetum arvense	II	2-3
Festuca rubra	II	3
Koeleria macrantha	II	2
Linum catharticum	II	1-3
Trifolium repens	II	1-3

32 species with constancy class I excluded from table

Species per quadrat 19.00 (based on 8 quadrats)

Table 2.20 SD12/SD16 intermediate between *Carex arenaria* - *Festuca ovina* - *Agrostis capillaris* acidic dune grassland and *Salix repens* - *Holcus lanatus* dune slack

	Constancy	Domin range
Carex arenaria	IV	1-3
Festuca ovina	I	2-5
Agrostis capillaris	V	2-5
Salix repens agg.	V	4-8
Holcus lanatus	III	2-4
Lotus corniculatus	V	1-4
Anthoxanthum odoratum	V	2-6
Festuca rubra	V	3-8
Trifolium repens	IV	1-6
Cerastium fontanum triviale	III	1-2
Plantago lanceolata	III	1-3
Poa pratensis	III	1-3
Galium saxatile	III	1-3
Viola canina	III	1-3
Koeleria macrantha	II	1-2
Rhinanthus minor	II	1-2
Achillea millefolium	II	3
Galium verum	II	1-2
Senecio jacobaea	II	1-4
Veronica chamaedrys	II	1
Ammophila arenaria	I	1
Luzula campestris	I	2-3
Hieracium pilosella group	I	1-3
Potentilla erecta	I	1
Ranunculus repens	I	1
Succisa pratensis	I	1
Dicranum scoparium	I	1-4
Hylocomium splendens	I	1-4
Pleurozium schreberi	I	2-3
Pseudoscleropodium purum	I	2-3
Rhytidiadelphus squarrosus	I	2-3
Rhytidiadelphus triquetrus	I	1-8
Achillea ptarmica	I	2
Agrostis canina	I	3
Anthyllis vulneraria	I	1
Bellis perennis	I	1
Botrychium lunaria	I	1
Campanula rotundifolia	I	1
Cirsium arvense	I	1
Hypochoeris radicata	I	1
Lathyrus pratensis	I	1
Linum catharticum	I	1
Ophioglossum vulgatum	I	1
Salix aurita	I	1
Senecio vulgaris	I	1
Viola palustris	I	3
Brachythecium rutabulum	I	1
Cladonia furcata	I	4
Cladonia ciliata var. *tenuis*	I	1
Taraxacum seedling/sp.	I	1

Species per quadrat 14.64 (based on 11 quadrats)

Table 2.21 SD12a *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, *Anthoxanthum odoratum* sub-community

	Constancy	Domin range
Carex arenaria	IV	2-4
Festuca ovina	V	2-8
Agrostis capillaris	III	3-7
Anthoxanthum odoratum	V	1-7
Galium verum	V	1-4
Lotus corniculatus	IV	1-5
Holcus lanatus	IV	1-5
Luzula campestris	IV	1-4
Plantago lanceolata	IV	1-6
Hieracium pilosella group	III	2-6
Thymus praecox arcticus	III	2-5
Danthonia decumbens	III	2-7
Pseudoscleropodium purum	III	1-6
Achillea millefolium	II	2-4
Koeleria macrantha	II	1-5
Rhytidiadelphus squarrosus	II	1-8
Hypochoeris radicata	II	1-4
Senecio jacobaea	II	1-2
Dicranum scoparium	II	1-5
Equisetum arvense	II	1-4
Festuca rubra	II	3-5
Poa pratensis	II	2-3
Hypnum cupressiforme	II	2-5
Carex flacca	II	2-4
Ononis repens	II	1-4
Viola canina	II	1-3
Arrhenatherum elatius	II	2-6
Campanula rotundifolia	II	2
Carex hirta	II	1-5
Cirsium arvense	II	1-3
Rumex acetosella	II	2-3

64 species with constancy class I excluded from table

Species per quadrat 18.61 (based on 23 quadrats)

SD12b *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Holcus lanatus* sub-community (Table 2.22)

This is locally extensive, with 139.7 ha distributed in six sites. Large occurrences (>20 ha are confined to Newburgh to Bridge of Don (57.8 ha), Sands of Forvie (46.6 ha) and Charleton & Kinnaber Links to Montrose (30.2 ha). It occurs on slightly damp ground with acidic soils, often within depressions but also in slightly flushed ground on hillslopes with a sand blanket. Quadrat data (Table 2.22) from Sands of Forvie, Foveran, Aberlady and Gullane Links (Aberlady) show vegetation which is close to the NVC description of this type. There are few indicators of very wet ground but the nationally scarce *Equisetum variegatum* is present in some samples and, unlike the drier SD12a type, the frequency of *Galium verum* is reduced and *Galium saxatile* is present, often with a high cover. Swards of this vegetation at Aberlady Bay are notable for the occasional presence of *Briza media* in flushed areas of climbing dune.

SD12x *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, provisional *Hylocomium splendens* sub-community (Table 2.23)

This is locally extensive on the East Coast, with 139.7 ha distributed in four sites: Arbroath to Broughty Ferry (97.5 ha), Tentsmuir (37.0 ha), Newburgh to Bridge of Don (2.9 ha) and South Eden Estuary to St Andrews Links (2.3 ha). It is one of several provisional new NVC types with Boreal characteristics, particularly a high cover and biomass of feather mosses such as *Hylocomium splendens*. It occurs on well-drained grazed and ungrazed ground. Mowing and trampling on golf courses has probably reduced its extent on the East Coast and it has probably been replaced in many areas by a mown type, SD12M (135.9 ha) in which the moss cover is much reduced. The exact extent of this type is uncertain because it is not identified as a distinct category in earlier NVC surveys and harmonisation methods did not include a re-mapping of sites. It is possible that some other SD12 vegetation could fall into this category. In terms of dune succession, further acidification of this type probably produces the SD12xy sub-community with *Deschampsia flexuosa*. Phases of instability or stabilisation of acidic mobile dune produce an allied SD12z type with abundant *Ammophila arenaria*, a form of acidic semi-fixed dune. Available quadrats (Table 2.23) possibly covering this type from Barry Links and Tentsmuir show its character rather weakly. The feather moss component (*Hylocomium splendens, Pleurozium schreberi*) has only a low constancy and the presence too of *Ammophila arenaria* and *Deschampsia flexuosa* suggests overlap in the sample set with the SD12z and SD12xy sub-communities. In other respects the samples show conditions which are more acidic and perhaps more open than the SD12a and SD12b types. *Galium saxatile* is far commoner than *G. verum*, strong calcifugous indicators are present: *Dicranum scoparium, Deschampsia flexuosa, Polytrichum piliferum, Danthonia decumbens, Calluna vulgaris, Nardus stricta* plus a raft of lichens - *Cornicularia aculeata, Cladonia ciliata, C. coccifera, C. foliacea, C. furcata, C. gracilis, C. pyxidata.* The latter suggest strong links with SD11 vegetation.

SD12xx *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, provisional *Racomitrium canescens* sub-community

This provisional new sub-community is very rare on the East Coast, with 1.3 ha mapped at Arbroath to Broughty Ferry (1.0 ha) and Tentsmuir (0.3 ha). It is a direct analogue of the calcareous SD8c *Festuca rubra - Galium verum* fixed dune community *Tortula ruralis* ssp. *ruraliformis* sub-community, occurring on acidic sands receiving inblown sand in small quantities close to blowouts or ground disturbance. The moss *Racomitrium canescens* often has high cover in a varied sward. The SD8c and SD12xx types are rarely both present. At most of its East Coast locations this sward appears to be an initial stabilisation phase in successions from bare sand in blowouts to acidic grassland or dune heath. This type is also present in the Inner Hebrides and on the west coast mainland of Scotland. Constancy tables are presented in the reports covering Southwest and Northwest Scotland.

Table 2.22 SD12b *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, *Holcus lanatus* sub-community

	Constancy	Domin range
Carex arenaria	V	2-5
Festuca ovina	V	2-8
Agrostis capillaris	V	1-7
Holcus lanatus	V	1-5
Rhytidiadelphus squarrosus	III	2-8
Anthoxanthum odoratum	III	2-4
Galium saxatile	III	4-6
Galium verum	III	1-5
Pseudoscleropodium purum	III	4-7
Campanula rotundifolia	III	1-3
Festuca rubra	III	3-6
Lotus corniculatus	III	1-5
Hieracium pilosella group	III	2-6
Poa pratensis	III	2-5
Pleurozium schreberi	III	3-9
Ammophila arenaria	II	2-7
Plantago lanceolata	II	3-6
Rumex acetosa	II	1-4
Hylocomium splendens	II	4-7
Achillea millefolium	II	1-4
Arrhenatherum elatius	II	2-4
Briza media	II	2-4
Carex hirta	II	1-2
Cirsium arvense	II	1-2
Euphrasia officinalis agg.	II	1-5
Koeleria macrantha	II	2-4
Ononis repens	II	1-3
Thymus praecox arcticus	II	1-5
Dicranum scoparium	II	2-5
Rhytidiadelphus triquetrus	II	2-5
Carex flacca	II	2-4
Centaurium erythraea	II	1-2
Cerastium fontanum triviale	II	1-3
Equisetum variegatum	II	3-4
Luzula campestris	II	1-3
Danthonia decumbens	II	3-4
Viola riviniana	II	2

44 species with constancy class I excluded from table

Species per quadrat 18.71 (based on 14 quadrats)

Table 2.23 SD12x *Carex arenaria - Festuca ovina - Agrostis capillaris* dune grassland community, provisional new *Hylocomium splendens* sub-community

	Constancy	Domin range
Carex arenaria	V	1-8
Festuca ovina	V	1-9
Agrostis capillaris	V	1-9
Hylocomium splendens	I	4
Pleurozium schreberi	II	2-8
Galium saxatile	IV	1-8
Rumex acetosella	III	1-5
Ammophila arenaria	III	1-5
Hieracium pilosella group	III	1-4
Anthoxanthum odoratum	II	1-7
Poa pratensis	II	1-4
Dicranum scoparium	II	1-6
Achillea millefolium	II	1-5
Cladonia ciliata var. *tenuis*	II	1-8
42 species with constancy class I excluded from table		
Species per quadrat 9.90 (based on 30 quadrats)		

SD12xy *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, provisional *Deschampsia flexuosa* sub-community (Table 2.24)

This is moderately extensive, with a total area of 66.9 ha. It is confined to seven sites, with large extents at three locations: Charleton & Kinnaber Links to Montrose (27.6 ha), Arbroath to Broughty Ferry (14.9 ha) and Newburgh to Bridge of Don (10.5 ha). It is closely related to U2 calcifugous grassland and is probably more extensive in the region, falling within SD12, SD12a and SD12b vegetation mapped in some earlier surveys. It represents the most acidic grasslands developed on dry sand and tends to occur at the rear of sites on what is probably the oldest soil. It is often found in mosaic with H11 dune heath. The balance between grassland and heath in such areas is probably explained by past grazing history (with a high extent of grassland reflecting heavier grazing). It is very similar to more acidic semi-fixed dunes with a high cover of *Ammophila arenaria* (SD12z type). Five quadrats from Sands of Forvie and Tentsmuir show high frequencies for *Ammophila arenaria, Hylocomium splendens* and *Pleurozium schreberi* and suggest strong overlap with SD12x and SD12z vegetation.

SD12y *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, provisional *Carex arenaria* sub-community (Table 2.25)

This is locally extensive and present in nine sites, with a total area of 295.4 ha. Large extents (>15 ha) are found at Tentsmuir (179.6 ha), Arbroath to Broughty Ferry (48.3 ha), Sands of Forvie (47.5 ha) and Newburgh to Bridge of Don (16.0 ha). This is by far the largest SD12 type on the East Coast and is the largest concentration of its type in Scotland. It is characterised by a very high cover of *Carex arenaria*, often close to former rabbit burrows. It contains small quantities of both *Festuca ovina* and *Agrostis capillaris* but compared to other SD12 types it is species-poor. *Carex arenaria* probably invades bare sand created by rabbit activity, perhaps following a population collapse, and is able to dominate the subsequent sward. Such vegetation is not a mobile dune type (i.e. SD10) since the ground is fully stabilised and it is best placed here. In its three major sites it occurs in areas which are grazed or only lightly grazed. With increased stocking and a rise in rabbit numbers it probably develops into SD12yy grassland which might have been predominant in the region up to onset of myxomatosis.

SD12yy *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, provisional *Cladonia rangiformis* - *C. portentosa* sub-community

This is uncommon, with 27.4 ha mapped in two sites: Arbroath to Broughty Ferry (22.5 ha) and Newburgh to Bridge of Don (5.0 ha). It is characterised by a high cover of *Cladonia portentosa* in an SD12 sward, sometimes accompanied by *C. arbuscula*. This vegetation does not contain the lichen *Cornicularia aculeata*, a diagnostic species of SD11 vegetation, and appears to be an different and distinct form of lichen-rich dune grassland sward. Similar vegetation is reported from dunes in Tayside (Barry Links) and Fife (Earlshall Muir, Tentsmuir). In both these areas such vegetation was probably very widespread in the late 1940s, judged by distinct light tones covering areas which in the late 1980s and early 1990s had mainly SD12a/b or SD12y acidic dune grassland (Dargie 1994b, 1998). A lichen-rich sward of this type could therefore be a product of rabbit grazing and the general decline in rabbit population since the onset of myxomatosis in the 1950s might have been paralleled by a great reduction in area of this vegetation type. There are no good quadrat records covering this important vegetation type, although it was noted as part of harmonisation in sites at Foveran and Barry Links. Rabbit numbers and general grazing pressure have increased in both sites, possibly allowing this vegetation type to increase in the period since initial survey in the late 1980s and 1990. Further quadrat recording is probably needed for this type, particularly to relate it to other lichen-rich grassland which is present in the region (see SD11 under dry dune heath).

SD12z *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, provisional *Ammophila arenaria* sub-community (Table 2.26)

Semi-fixed dune vegetation containing *Carex arenaria, Ammophila arenaria, Agrostis capillaris,* and *Festuca ovina* is widespread, with a total extent of 166.3 ha. It is present in nine sites and large areas (>10 ha) are present at Newburgh to Bridge of Don (59.4 ha), Arbroath to Broughty Ferry (47.8 ha) and Sands of Forvie (40.0 ha). This sub-community occurs on large to small dunes, including isolated groups of hummocks, and probably marks ground stabilised following a period of erosion and dune re-working by wind. This type appears to be a direct acidic analogue to SD7 *Ammophila arenaria - Festuca rubra* semi-fixed dune and occurs in sites which usually have other SD12 types, some H11 dune heath and/or M16 wet dune heath. On the Newburgh to Bridge of Don sector it often develops directly from SD6x mobile dune. Existing NVC descriptions make no mention of *Ammophila arenaria* persisting in quantity into acidic grasslands (though it is recorded for H11 dune heath), but the 1988 draft sand dune account included an SD11 type (*Ammophila arenaria - Festuca ovina - Agrostis capillaris* dune, with SD11a *Brachythecium albicans* and SD11b *Pleurozium schreberi - Hylocomium splendens* sub-communities). The floristic data published with the draft account shows a strong resemblance to the proposed SD6x, SD12x and SD12z types sub-communities proposed as a result of this national survey. It is unfortunate that the former SD11 category was eliminated from the 1989 revision of sand dune types, given that strong floristic evidence was available to include it. Floristic data for SD12z vegetation (Table 2.26, drawn from Sands of Forvie, Tentsmuir and Gullane Links surveys) shows a sward with abundant *Ammophila arenaria* mixed with *Carex arenaria* and *Festuca ovina. F. rubra* remains present in many samples and *Galium verum is* an occasional, but most frequent species are calcifuges related to SD12x and SD12z vegetation (e.g. *Dicranum scoparium, Hylocomium splendens, Pleurozium schreberi*).

Other calcifugous grasslands (U2, U4, U5, U6)

These grasslands usually lack Carex arenaria and were mapped as non-SD types. They have a large total extent (185.7 ha), most of it at Arbroath to Broughty Ferry (148.4 ha, mostly at Barry Links) and Tentsmuir (23.5 ha, mostly at Earlshall and Ward's Muir).

U2 *Deschampsia flexuosa* calcifugous grassland (Table 2.27)

This is rare, with 0.8 ha mapped only at Aberlady Point to Milsey Bay, where it occurs as rough adjacent to fairways on Gullane Golf Course. Occasional mowing produces a turf dominated by *Deschampsia flexuosa* (Domin values 9-10) and a species-poor turf with many calcifugous species. One sample in Table 2.27 contains *Carex arenaria* and in the absence of mowing it is likely that this type might develop as SD12xy vegetation.

U4 *Festuca ovina - Agrostis capillaris - Galium saxatile* calcifugous grassland

This type is rare, with 6.0 mapped as the U4 community (2.8 ha, at Newburgh to Bridge of Don) and the U4b *Holcus lanatus - Trifolium repens* sub-community (3.2 ha, Inverallochy to Peterhead). In most cases it is very similar to SD12 acidic dune grassland and lacks only *Carex arenaria*. Constancy data are likely to be similar to the existing NVC description (Rodwell 1991 *et seq.*).

Table 2.24 SD12xy *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, provisional new *Deschampsia flexuosa* sub-community

	Constancy	Domin range
Carex arenaria	V	4-7
Festuca ovina	II	2-4
Agrostis capillaris	II	2-3
Deschampsia flexuosa	III	6-8
Ammophila arenaria	V	1-5
Galium saxatile	V	2-5
Pleurozium schreberi	V	7-9
Holcus lanatus	III	2-4
Hylocomium splendens	III	4-7
Cladonia arbuscula	III	3-5
Anthoxanthum odoratum	II	2
Cirsium arvense	II	3
Poa pratensis	II	2-4
Dicranum scoparium	II	2
Rhytidiadelphus triquetrus	II	2-3
Festuca rubra	I	2
Hypochoeris radicata	I	3
Luzula campestris	I	2
Danthonia decumbens	I	2
Rhytidiadelphus squarrosus	I	3
Ptilidium ciliare	I	3
Peltigera canina	I	2
Species per quadrat 10.60 (based on 5 quadrats)		

Table 2.25 SD12y *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, provisional new *Carex arenaria* sub-community

	Constancy	Domin range
Carex arenaria	V	5-8
Festuca ovina	IV	3-6
Agrostis capillaris	V	2-6
Cerastium fontanum triviale	III	1-3
Galium saxatile	III	4-5
Holcus lanatus	III	2-4
Luzula campestris	III	2-3
Poa pratensis	III	1-5
Rhytidiadelphus squarrosus	III	4-7
Galium verum	II	2-5
Lotus corniculatus	II	1-2
Senecio jacobaea	II	2-6
Trifolium repens	II	3-6
Hylocomium splendens	II	4-6
Pseudoscleropodium purum	II	6-8
Agrostis stolonifera	II	4-5
Cirsium arvense	II	2-4
Pleurozium schreberi	II	4-6
Ammophila arenaria	I	3
Anthoxanthum odoratum	I	3
Festuca rubra	I	7
Lathyrus pratensis	I	2
Myosotis discolor	I	1
Nardus stricta	I	5
Plantago lanceolata	I	2
Ranunculus repens	I	2
Rumex acetosa	I	3
Salix repens agg.	I	2
Danthonia decumbens	I	3
Viola canina	I	1
Viola riviniana	I	4
Rhytidiadelphus triquetrus	I	5

Species per quadrat 10.38 (based on 8 quadrats)

Table 2.26 SD12z *Carex arenaria - Festuca ovina - Agrostis capillaris* acidic dune grassland, provisional new *Ammophila arenaria* sub-community

	Constancy	Domin range
Carex arenaria	V	2-7
Festuca ovina	V	3-7
Agrostis capillaris	II	3-6
Ammophila arenaria	V	4-7
Holcus lanatus	IV	4-5
Festuca rubra	IV	1-5
Dicranum scoparium	IV	3-8
Poa pratensis	III	2-4
Pseudoscleropodium purum	III	1-7
Rhytidiadelphus squarrosus	III	3-6
Anthoxanthum odoratum	III	2-5
Galium saxatile	III	3-5
Luzula campestris	III	2-4
Hylocomium splendens	III	1-6
Pleurozium schreberi	III	3-5
Galium verum	II	2
Epilobium angustifolium	II	1-5
Koeleria macrantha	II	2-3
Thymus praecox arcticus	II	1-3
Veronica officinalis	II	2-3
Hypnum cupressiforme	II	1-8
Rhytidiadelphus triquetrus	II	2-6
Cladonia arbuscula	II	2-3

43 species with constancy class I excluded from table

Species per quadrat 17.09 (based on 11 quadrats)

Table 2.27 U2 *Deschampsia flexuosa* grassland

	Constancy	Domin range
Deschampsia flexuosa	V	9-10
Danthonia decumbens	V	2-4
Dicranum scoparium	V	2-4
Galium saxatile	IV	2-4
Hypnum cupressiforme	IV	4-5
Luzula campestris	III	2
Hieracium pilosella group	III	1-2
Anthoxanthum odoratum	II	1-4
Rumex acetosella	II	1-2
Pseudoscleropodium purum	II	2-3
Carex arenaria	I	2
Carex pilulifera	I	1
Crataegus monogyna	I	1
Festuca ovina	I	5
Galium verum	I	1
Holcus lanatus	I	1
Koeleria macrantha	I	3
Veronica officinalis	I	2
Viola riviniana	I	1
Ptilidium ciliare	I	2
Cladonia arbuscula	I	3
Cladonia portentosa	I	2
Species per quadrat 9.40 (based on 5 quadrats)		

U5 *Nardus stricta - Galium saxatile* calcifugous grassland (Table 2.28)

This is by far the most extensive non-SD calcifugous grassland type, with 178.8 ha mapped as the U5 community (170.5 ha, with 140.9 ha at Barry Links and 23.5 ha at Tentsmuir) and as small quantities of the U5c *Carex panicea - Viola riviniana* and U5d *Calluna vulgaris - Danthonia decumbens* sub-communities (both at Newburgh to Bridge of Don). Some of its extent at Arbroath to Broughty Ferry is mown (U5M, 7.5 ha), mainly on military firing ranges at Barry Links. Quadrat data from Barry Links (Table 2.28) do not show a strong link with a particular sub-community and the absence of grazing for some time might have obscured variation within this vegetation type.

U6 *Juncus squarrosus - Festuca ovina* calcifugous grassland

Small quantities are recorded at Newburgh to Bridge of Don (0.1 ha) and Charleton & Kinnaber Links to Montrose (0.04 ha). No quadrat data is available to describe this insignificant type which probably relates to locally impeded drainage within other calcifugous grassland.

Table 2.28 U5 *Nardus stricta - Galium saxatile* grassland

	Constancy	Domin range
Nardus stricta	V	5-9
Galium saxatile	III	2-4
Anthoxanthum odoratum	V	2-5
Festuca ovina	V	2-4
Potentilla erecta	V	1-5
Carex arenaria	V	2-7
Agrostis canina	III	1-4
Pleurozium schreberi	III	3-6
Carex nigra	II	1-2
Juncus squarrosus	II	1-3
Poa pratensis	II	1
Agrostis capillaris	I	3
Aira praecox	I	2
Equisetum arvense	I	1
Holcus lanatus	I	2
Lotus corniculatus	I	4
Ononis repens	I	2
Hieracium pilosella group	I	2
Plantago lanceolata	I	2
Rumex acetosella	I	5
Danthonia decumbens	I	3
Dicranum scoparium	I	4
Hypnum cupressiforme	I	4
Pseudoscleropodium purum	I	3
Tortula ruralis ssp. *ruraliformis*	I	2
Species per quadrat 9.43 (based on 7 quadrats)		

2.7 Other fixed dune grasslands (MG1)

These grasslands are more typical of non-dune conditions. Total extent is large and widespread, with 604.6 ha (5.0% of potential vegetated sand area, 11566 ha) present in 31 sites. Only one grassland type (MG1) features in this aggregate.

MG1 *Arrhenatherum elatius* coarse mesotrophic grassland (Table 2.29, Table 2.30)

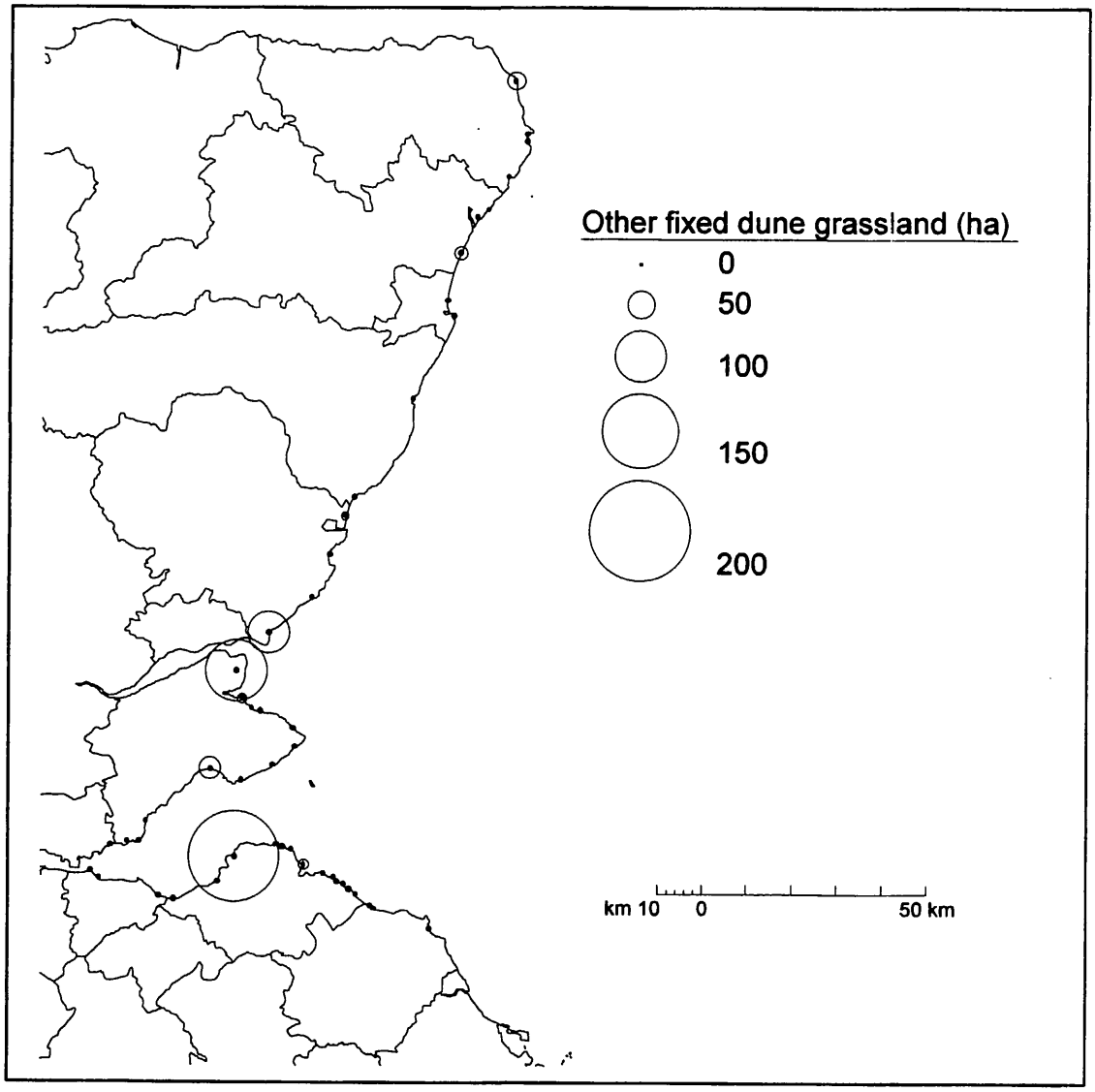
This grassland is mapped as a wide variety of types (22 categories), with many intermediates. Large combined extents (>50 ha) are found at Aberlady Point to Milsey Bay (186.5 ha), Tentsmuir (122.7 ha) and Arbroath to Broughty Ferry (85.1 ha). The range of conditions covered suggest it is highly successional, replacing much SD8 and SD12 grassland in the absence of grazing, the presence of benign management (e.g. golf course uncut rough, sides of old railway lines, wide forestry rides), and partial invasion by bracken. In addition to succession it covers some damp ground, with the MG1c *Filipendula ulmaria* sub-community occurring in very small quantity (0.2 ha). The major types mapped are the MG1a *Festuca rubra* sub-community (336.7 ha), the MG1e *Centaurea nigra* sub-community (46.5 ha, common on old railway lines and track sides), mown sides to golf fairways (MG1/SD12M, 77.2 ha at Tentsmuir and MG1M, 45.4 ha at Arbroath to Broughty Ferry). This sward develops in areas which have not been grazed for several years, allowing *Arrhenatherum elatius* to develop as a tall, rank grassland which shades and suppresses many typical herbs and finer-leaved grasses of the former grazed vegetation. The many intermediates recorded represent either younger stages in the transition from short and grazed to coarse and ungrazed conditions (e.g. MG1/SD5c, MG1/SD8, MG1/SD12) or later stages of transition to bracken (MG1/W25). The high extent of this type, including the mown and unmown components on golf course, suggests that such areas of fixed dune grassland have been under-grazed or without grazing for a considerable time. This allows *Arrhenatherum elatius* to come into the sward in quantity. Most stands are close to existing NVC descriptions (Table 2.29, 2.30). Some coarse grassland is dominated by the nutriphile *Dactylis glomerata* and with only small amounts of *Arrhenatherum elatius* was also placed in this category. It is common in parts of the East Coast in dune sectors close to settlements, particularly close to paths used for dog walking.

2.8 Dry dune heath (H11, SD11)

Dry dune heath, with a total area of 450.6 ha, represents 3.9% of potential vegetated sand area, 11566 ha. It is restricted to eight sites on the East Coast (Map 2.8). Only two sites have a large extent (>50 ha): Sands of Forvie (288.0 ha) and Tentsmuir (70.5 ha) but moderate areas (25 - 50 ha) are present at Arbroath to Broughty Ferry (36.2 ha, mainly at Barry Links) and Newburgh to Bridge of Don (34.0 ha, mainly at Foveran Links). As with SD12 grassland (section 2.6) its presence marks sand with either little or no initial shell carbonate, allowing development of an acidic soil. The parent material of much heath is probably fluvioglacial sand deposited on the East Coast following ice retreat, and then brought onshore as sea level rose in the Flandrian. Two communities (H11, SD11) are covered under this category. Dry dune heath *sensu stricto* is represented by H11 *Calluna vulgaris - Carex arenaria* dune heath and this is the dominant type (351.4 ha on the East Coast). It is occasionally accompanied by a high lichen biomass. Open vegetation rich in lichens, low dwarf shrub cover, and bare sand is represented by the SD11 *Carex arenaria – Cornicularia aculeata* community but this is more restricted (99.3 ha in six sites). The H11a and H11b types are priority habitats under the EC Habitats Directive and the regional resource shows excellent examples, especially of the H11b *Empetrum nigrum* sub-community. The SD11 types are often in succession to H11 heath and probably warrant inclusion with the H11 type as priority habitat.

H11a *Calluna vulgaris - Carex arenaria* dune heath, *Erica cinerea* sub-community

This vegetation is much less extensive than the dominant H11b sub-community, with 24.7 ha plus 17.8 ha of intermediates (mainly 13.4 ha of an H11a/b intermediate which is restricted to Tentsmuir). It is found in four sites, with large extents (>5 ha, excluding intermediates) at Charleton & Kinnaber Links to Montrose (9.4 ha), Tentsmuir (7.8 ha) and Newburgh to Bridge of Don (7.4 ha). The H11a sub-community is regarded as a western dune type which is a direct analogue of H10 heath, characteristic of western Britain. However, it is important to stress that on the East Coast it often occurs with the dominant eastern H11b sub-community and there is no clear separation of the two at a regional scale. Regional H11a heaths are similar to existing NVC descriptions in terms of dwarf shrub composition.



Map 2.7 Other fixed dune grassland vegetation (ha) in East Coast sites

Table 2.29 MG1a *Arrhenatherum elatius* coarse grassland, *Festuca rubra* sub-community

	Constancy	Domin range
Arrhenatherum elatius	V	4-9
Festuca rubra	V	4-9
Galium verum	IV	1-4
Cirsium arvense	IV	1-5
Anthoxanthum odoratum	IV	1-5
Achillea millefolium	IV	1-4
Poa pratensis	IV	1-6
Holcus lanatus	III	1-4
Equisetum arvense	III	1-9
Pseudoscleropodium purum	III	2-5
Carex arenaria	III	1-4
Plantago lanceolata	III	1-3
Ammophila arenaria	II	1-4
Dactylis glomerata	II	1-6
Agrostis capillaris	II	2-5
Carex hirta	II	2 1-3
Veronica chamaedrys	II	1-2
Cerastium arvense	II	1-4
Ononis repens	II	1-8

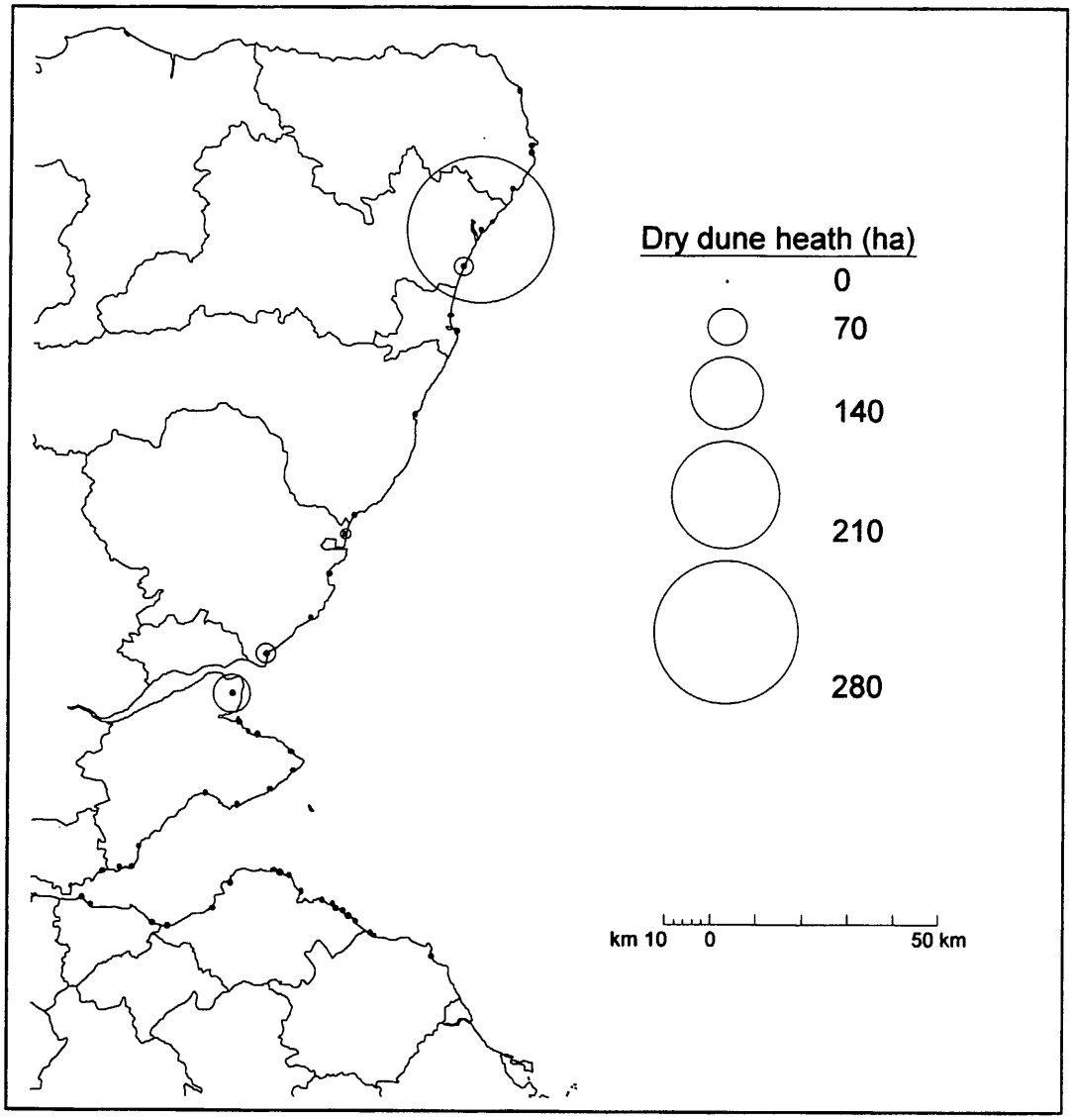
41 species with constancy class I excluded from table

Species per quadrat 12.19 (based on 27 quadrats)

Table 2.30 MG1b *Arrhenatherum elatius* coarse grassland, *Urtica dioica* sub-community

	Constancy	Domin range
Arrhenatherum elatius	V	3-6
Urtica dioica	V	4-8
Galium aparine	V	3-5
Conium maculatum	IV	1-5
Dactylis glomerata	IV	6-5
Holcus lanatus	III	3-5
Agrostis capillaris	II	2-4
Montia perfoliata	II	1-2
Cirsium arvense	I	2
Cruciata laevipes	I	2
Heracleum sphondylium	I	1

Species per quadrat 6.60 (based on 5 quadrats)



Map 2.8 Dry dune heath (ha) in East Coast sites

H11b *Calluna vulgaris* - *Carex arenaria* dune heath, *Empetrum nigrum* sub-community (Table 2.31)

This vegetation is locally extensive (260.7 ha plus 20.5 ha of intermediates) but it is restricted as H11b to only two sites, with H11a/b and H11b/c intermediates occurring in a third location (Tentsmuir). The bulk of this type occurs at Sands of Forvie (241.6 ha), with a further 19.2 ha at Newburgh to Bridge of Don. The H11b sub-community is considered the typical dune heath type of northeast Scotland and available quadrats (Table 2.31) are close to the NVC description. A notable feature of H11b at Sands of Forvie is the reduced constancy of *Calluna vulgaris* (class III) in comparison with *Empetrum nigrum*, a feature explained by the role of *E. nigrum* as a pioneer species, readily invading SD6, SD7, SD11 and SD12 vegetation to form clonal colonies which develop as circular areas, eventually coalescing to form a dwarf-shrub carpet. *Calluna vulgaris* usually invades after the *E. nigrum* carpet is established. The large extents of this dune heath at Sands of Forvie are remarkable and develop quickly behind the quite active parabolic dune areas which are another fine feature of this outstanding site. The *E. nigrum* at Sands of Forvie persists over time, even in tall, old *Calluna vulgaris* and the H11b type does not seem to part of a succession to H11c vegetation. Given the quantity of this type at Sands of Forvie and the extents of H11a/b and H11b/c present at Tentsmuir, it is strange that H11b does not at Barry Links within the Arbroath to Broughty Ferry site. Accidental heath fires are common at Barry Links as a result of military training (particularly night exercises using parachute flares) and if these have been a feature over several decades they might have eradicated the H11b type from the area.

H11c *Calluna vulgaris* - *Carex arenaria* dune heath, species-poor sub-community (Table 2.32)

This form of dune heath is the most widespread on the East Coast (it occurs in seven sites) but total extent is low (13.5 ha, plus 2.3 ha of intermediates). Large extents (>2 ha excluding intermediates) are present at Arbroath to Broughty Ferry (8.3 ha, mainly at Barry Links) and Charleton & Kinnaber Links to Montrose (3.8 ha). Some of the most southern populations of dune heath form rough upon golf courses, e.g. at St Andrews. This type covers mature and old heaths. Quadrat data differ slightly from its Moray Firth equivalent (*Hypnum jutlandicum* has a high cover and constancy in the Moray Firth but is not recorded on the East Coast). Little direct management takes place, other than avoiding cutting as part of golf course maintenance except at Newburgh Golf Course where several small areas are mown.

SD11 *Carex arenaria* - *Cornicularia aculeata* community (Table 2.33, 2.34, 2.35)

This is a lichen dune community and its distribution is similar to H11 vegetation. Total extent including intermediates is 99.3 ha, distributed between six sites. Only two sites have large areas (>10 ha): Sands of Forvie (46.4 ha) and Tentsmuir (45.7 ha). Elsewhere (Newburgh to Bridge of Don, Arbroath to Broughty Ferry, Aberlady Point to Milsey Bay, Tyninghame Shore) it is rare and occasionally fragmented, with some occurrences as an intermediate with acidic dune grassland (SD11a/SD12yy, 4.6 ha - see Table 2.35). The SD11a *Ammophila arenaria* sub-community (Table 2.33) is most extensive (61.0 ha, mostly at Sands of Forvie and Tentsmuir), with 31.8 ha of the SD11b *Festuca ovina* sub-community (Table 2.34) restricted to Tentsmuir.

At Sands of Forvie the H11 and SD11 types forming local successions on ground disturbed by blowouts. The SD11a *Ammophila arenaria* sub-community (Table 2.33) is an early colonist of slopes behind an advancing blowout but is then replaced by H11b as *Empetrum nigrum* invades and forms a dwarf shrub heath. Some SD11a continues in areas of persistent exposure which maintain local patches of bare sand, especially the tops of low dune hummocks. At Tentsmuir a slightly different pattern is present. The SD11a *Ammophila arenaria* sub-community occurs relatively close to the shore and the SD11b *Festuca ovina* type is present well-inland and seems to occur on the strongly leached tops of dune hummocks, sometimes in mosaic with SD12yy lichen-rich grassland.

Table 2.31 H11b *Calluna vulgaris - Carex arenaria* dune heath, *Empetrum nigrum* sub-community

	Constancy	Domin range
Calluna vulgaris	III	3-8
Carex arenaria	V	2-5
Empetrum nigrum ssp. *nigrum*	V	1-10
Pleurozium schreberi	III	4-7
Ammophila arenaria	III	3-6
Anthoxanthum odoratum	III	2-4
Festuca ovina	III	3-7
Galium saxatile	III	2-5
Holcus lanatus	III	1-4
Hylocomium splendens	III	5-8
Hypnum cupressiforme	III	4-7
Cladonia arbuscula	III	1-7
Hypogymnia physodes	III	2-3
Rhytidiadelphus triquetrus	II	2-6
Agrostis capillaris	II	3-6
Lotus corniculatus	II	3-4
Luzula campestris	II	3-4
Poa pratensis	II	2-3
Dicranum scoparium	II	1-6
Achillea millefolium	I	2-3
Juncus squarrosus	I	1-2
Senecio jacobaea	I	1
Trifolium repens	I	1-3
Veronica officinalis	I	1-3
Pseudoscleropodium purum	I	4-7
Rhytidiadelphus squarrosus	I	3-5
Agrostis canina	I	2
Bellis perennis	I	1
Campanula rotundifolia	I	1
Cerastium fontanum triviale	I	2
Erica cinerea	I	7
Erica tetralix	I	2
Festuca rubra	I	5
Hypochoeris radicata	I	4
Leontodon autumnalis	I	2
Prunella vulgaris	I	2
Rumex acetosella	I	2
Salix repens agg.	I	4
Danthonia decumbens	I	2
Vaccinium myrtillus	I	2
Valeriana officinalis	I	3
Viola canina	I	2
Polytrichum juniperinum	I	2
Frullania tamarisci	I	2
Lophocolea cuspidata	I	1
Cetraria islandica	I	2
Cladonia fimbriata	I	2
Cladonia furcata	I	5
Hypnum jutlandicum	I	3
Dactylorhiza sp.	I	1
Species per quadrat 13.30 (based on 10 quadrats)		

Table 2.32 H11c *Calluna vulgaris - Carex arenaria* dune heath, Species-poor sub-community

	Constancy	Domin range
Calluna vulgaris	V	6-10
Carex arenaria	V	2-5
Festuca ovina	V	1-5
Dicranum scoparium	IV	1-5
Cladonia ciliata var. *tenuis*	IV	1-8
Anthoxanthum odoratum	III	1-4
Hypnum cupressiforme	III	1-6
Pleurozium schreberi	III	1-8
Deschampsia flexuosa	II	1-4
Nardus stricta	II	1-3
Hypogymnia physodes	II	1-2
Plantago lanceolata	II	1-2
Teucrium scorodonia	II	3
Pseudoscleropodium purum	II	2-4
Cornicularia aculeata	II	1-3
Agrostis capillaris	II	3-4
Galium saxatile	II	1-3
Cladonia coccifera	I	1
Cladonia gracilis	I	1-2
Cladonia uncialis	I	1-3
Ammophila arenaria	I	2-3
Carex flacca	I	3-6
Festuca rubra	I	3-4
Galium verum	I	1-2
Hypochoeris radicata	I	1
Lotus corniculatus	I	1
Hieracium pilosella group	I	1-2
Potentilla erecta	I	1-2
Danthonia decumbens	I	1
Veronica officinalis	I	1
Viola riviniana	I	1
Agrostis stolonifera	I	1
Arrhenatherum elatius	I	2
Crataegus monogyna	I	1
Dactylis glomerata	I	3
Equisetum arvense	I	4
Holcus lanatus	I	3
Poa pratensis	I	3
Rosa canina agg.	I	1
Rumex acetosella	I	1
Senecio jacobaea	I	1
Thymus praecox arcticus	I	1
Veronica chamaedrys	I	1
Eurhynchium praelongum	I	2
Polytrichum piliferum	I	2
Rhytidiadelphus squarrosus	I	1
Frullania tamarisci	I	3
Ptilidium ciliare	I	1
Cetraria islandica	I	1
Cladonia arbuscula	I	1
Hypnum cupressiforme var. *lacunosum*	I	2

Species per quadrat 11.59 (based on 17 quadrats)

Table 2.33 SD11a *Carex arenaria - Cornicularia aculeata* dune community, *Ammophila arenaria* sub-community

	Constancy	Domin range
Carex arenaria	V	3-5
Cornicularia aculeata	III	2-5
Ammophila arenaria	V	4-6
Cladonia pyxidata	V	2-4
Holcus lanatus	IV	1-3
Cladonia arbuscula	IV	3-7
Hypogymnia physodes	IV	2-4
Agrostis capillaris	III	2-4
Luzula campestris	III	3-4
Dicranum scoparium	III	2-5
Cladonia floerkeana	III	2-4
Aira praecox	II	2
Anthoxanthum odoratum	II	2
Empetrum nigrum nigrum	II	2-7
Teesdalia nudicaulis	II	1-2
Viola canina	II	1-3
Ceratodon purpureus	II	2-5
Rhytidiadelphus triquetrus	II	4-5
Cladonia gracilis	II	4-5
Peltigera rufescens	II	2
Bellis perennis	I	2
Campanula rotundifolia	I	3
Festuca ovina	I	4
Galium saxatile	I	2
Plantago coronopus	I	4
Poa pratensis	I	3
Prunella vulgaris	I	1
Senecio jacobaea	I	1
Hylocomium splendens	I	5
Hypnum cupressiforme	I	5
Pleurozium schreberi	I	8
Pseudoscleropodium purum	I	4
Rhytidiadelphus squarrosus	I	6
Tortula ruralis ssp. *ruraliformis*	I	4
Frullania tamarisci	I	2
Lophocolea bidentata	I	3
Cetraria islandica	I	5
Cladonia crispata	I	4
Cladonia uncialis	I	2
Peltigera canina	I	4
Polypodium vulgare agg.	I	1
Species per quadrat 16.20 (based on 5 quadrats)		

Table 2.34 SD11b *Carex arenaria - Cornicularia aculeata* dune, *Festuca ovina* sub-community

	Constancy	Domin range
Carex arenaria	IV	2-6
Cornicularia aculeata	IV	2-5
Festuca ovina	IV	4-6
Agrostis capillaris	IV	1-4
Rumex acetosella	IV	1-4
Cladonia arbuscula	IV	1-8
Galium verum	III	1-3
Dicranum scoparium	III	2-5
Cladonia gracilis	III	2-7
Aira praecox	II	2-4
Thymus praecox arcticus	II	2-5
Hypnum cupressiforme	II	3-4
Polytrichum piliferum	II	2-7
Cladonia portentosa	II	4-8
Ammophila arenaria	II	3-5
Carex flacca	II	1-3
Hypochoeris radicata	II	2-4
Koeleria macrantha	II	2-4
Hieracium pilosella group	II	1-2
Plantago lanceolata	II	2-3
Sedum anglicum	II	2-4
Hypogymnia physodes	II	1-3
Linum catharticum	I	1
Vicia lathyroides	I	1-3
Viola canina	I	1
Brachythecium albicans	I	3-5
Pseudoscleropodium purum	I	2-3
Frullania dilatata	I	3-4
Ptilidium ciliare	I	1-4
Cladonia coccifera	I	2-3
Cladonia furcata	I	3-4
Aira caryophyllea	I	3
Anthoxanthum odoratum	I	2
Arrhenatherum elatius	I	2
Carex pilulifera	I	3
Cerastium semidecandrum	I	1
Epilobium angustifolium	I	5
Erica cinerea	I	2
Erodium cicutarium	I	5
Galium saxatile	I	2
Holcus lanatus	I	1
Leontodon taraxacoides	I	4
Lotus corniculatus	I	2
Luzula campestris	I	2
Ononis repens	I	1
Plantago coronopus	I	1
Poa pratensis	I	2
Senecio jacobaea	I	3
Danthonia decumbens	I	3
Trifolium repens	I	2
Ceratodon purpureus	I	5
Climacium dendroides	I	3
Tortula ruralis ssp. *ruraliformis*	I	2

Cladonia squamosa	I	2
Cladonia uncialis	I	3
Taraxacum seedling/sp.	I	1
Species per quadrat 14.70 (based on 10 quadrats)		

Table 2.35 SD11a/SD12 intermediate between *Carex arenaria - Cornicularia aculeata* dune, *Ammophila arenaria* sub-community and *Carex arenaria - Festuca ovina - Agrostis capillaris* dune grassland

	Constancy	Domin range
Carex arenaria	III	1-3
Cornicularia aculeata	I	3-5
Ammophila arenaria	IV	1-4
Festuca ovina	V	3-5
Agrostis capillaris	IV	1-3
Luzula campestris	V	1-5
Hieracium pilosella group	V	1-9
Cladonia ciliata var. *tenuis*	V	2-6
Hypnum cupressiforme var. *lacunosum*	V	2-6
Senecio jacobaea	V	1
Thymus praecox arcticus	V	3-5
Cladonia rangiformis	V	1-5
Dicranum scoparium	V	1-5
Astragalus danicus	IV	1-4
Galium verum	IV	3
Vicia lathyroides	IV	2-3
Sedum acre	IV	1-4
Veronica chamaedrys	IV	1-3
Bellis perennis	III	1-3
Holcus lanatus	III	1-3
Myosotis ramosissima	III	1-3
Bryum caespiticium	III	1-3
Rhytidiadelphus triquetrus	III	1-4
Cladonia furcata	III	1-4
Cerastium semidecandrum	III	1-3
Peltigera canina	III	1-3
Arenaria serpyllifolia	II	1-2
Hypochoeris radicata	II	1-4
Valerianella locusta	II	1-3
Veronica officinalis	II	3-4
Climacium dendroides	II	1-3
Tortula ruralis ssp. *ruraliformis*	II	1-3
Taraxacum seedling/sp.	II	1
Anthoxanthum odoratum	II	1-4
Centaurium erythraea	II	1
Geranium molle	II	1-3
Saxifraga tridactylites	II	2-3
Barbula unguiculata	II	1
Frullania tamarisci	II	1-5
Cladonia cervicornis	II	1-3
23 species with constancy class I excluded from table		
Species per quadrat 25.27 (based on 11 quadrats)		

2.9 Maritime cliff grassland (MC8, MC9)

Modest amounts of vegetation similar to maritime cliff grassland are developed upon blown sand along the southern shoreline of the region, usually reflecting vegetation under the influence of a splash zone close to cliffs in the corners of bay dunes or more extensively on blown sand above exposed cliffs (as at Sands of Forvie). Total extent is 15.3 ha on the East Coast (0.13% of potential vegetated sand area, 11566 ha). Extents (Map 2.9) >1 ha are present at Sands of Forvie (10.2 ha), Aberlady Point to Milsey Bay (1.7 ha) and Inverallochy to Peterhead (1.7 ha).

MC8 *Festuca rubra - Armeria maritima* maritime grassland

This is rare (0.2 ha) and intermediates (MC8/SD7, MC8/SD8) are more common (12.0 ha), with 10.2 ha of MC8/SD8 occurring in the northeast of the Sands of Forvie site on blown sand above steep cliffs. All these occurrences probably represent the most spray-soaked cases of dune grassland on the East Coast. This vegetation is close to existing NVC descriptions.

MC9 *Festuca rubra - Holcus lanatus* maritime grassland

This community is rare, with 2.2 ha (including intermediates) scattered in six sites. Only two sites have more than trivial extents (>0.5 ha): Inverallochy to Peterhead where MC9 occurs on dune grassland above low cliffs in the very north of the site, and Port Seton to Craigielaw along the edges of the most exposed parts of the area. Only the MC9dPrimula vulgaris sub-community is identified (0.2 ha at Coldingham Bay at the base of cliffs at the south end of the site).

2.10 Wet neutral grasslands (MG9, MG10, MG11, MG12, MG13)

This habitat is locally extensive on the East Coast (89.1 ha, Map 2.10) but scattered within ten sites. It represents 0.8% of potential vegetated sand area (11566 ha). Large quantities (>10 ha) are present only at Inverallochy to Peterhead (44.5 ha), Tentsmuir (15.8 ha) and Newburgh to Bridge of Don (12.1 ha). It occupies damp and wet ground, most of which is flooded in winter and is often termed inundation grassland. In addition to its large area, the habitat can also be significant in linking drier ground to dune slacks, marsh and swamp.

MG9 *Holcus lanatus - Deschampsia cespitosa* coarse grassland

This grassland is restricted to four sites, with a total area of 11.1 ha, mainly present at Inverallochy to Peterhead (9.5 ha). The distinctive tussocks of *Deschampsia cespitosa* mark the type, with MG9/S28 and MG9/U5 intermediates also recorded. Constancy data for MG9 are given in the report for Orkney.

MG10 *Holcus lanatus - Juncus effusus* rush pasture

This vegetation type is locally extensive (42.2 ha), mostly at Inverallochy to Peterhead, Tentsmuir and Newburgh to Bridge of Don. It generally marks ground with old attempts at drainage. *Juncus effusus* has since invaded the disturbed soil, together with *Holcus lanatus*. Regional examples are probably close to existing NVC descriptions.

MG11 *Festuca rubra - Agrostis stolonifera - Potentilla anserina* inundation grassland

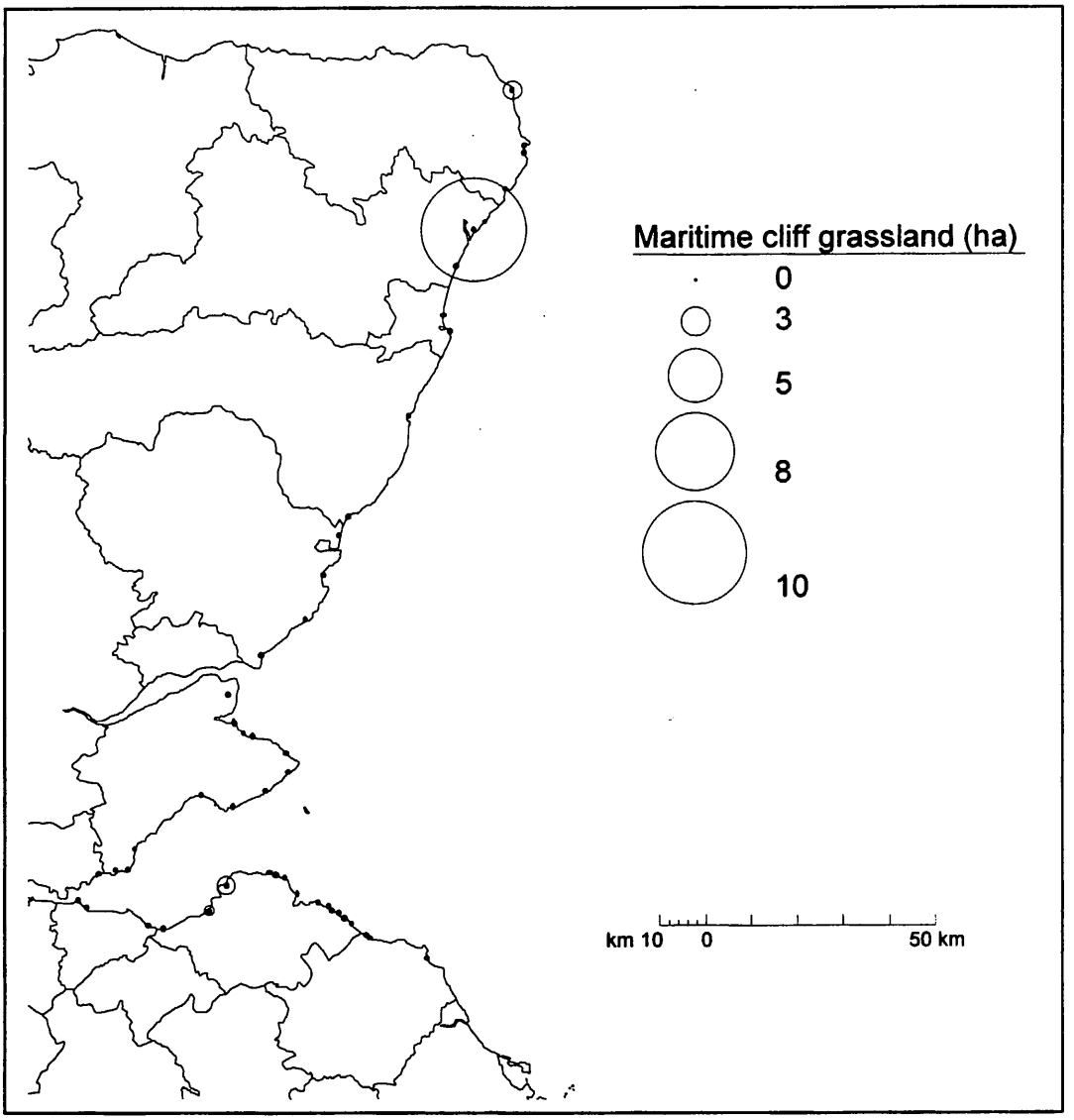
This is uncommon (25.5 ha) and is largely confined to a single site (Inverallochy to Peterhead, with 24.8 ha of MG11/MG13 and MG11/SD17a intermediates occurring within distinctive winter lochs running parallel with the coastline inside a single foredune ridge). This type is very extensive indeed in the Western Isles and Orkney where it is the major type of wet neutral grassland on dune soils. It is a characteristic vegetation type of damp machair environments and possibly requires an oceanic climate. This might explain its restriction to the northern parts of the East Coast. Constancy data are given in the Western Isles report.

MG12 *Festuca arundinacea* coarse grassland

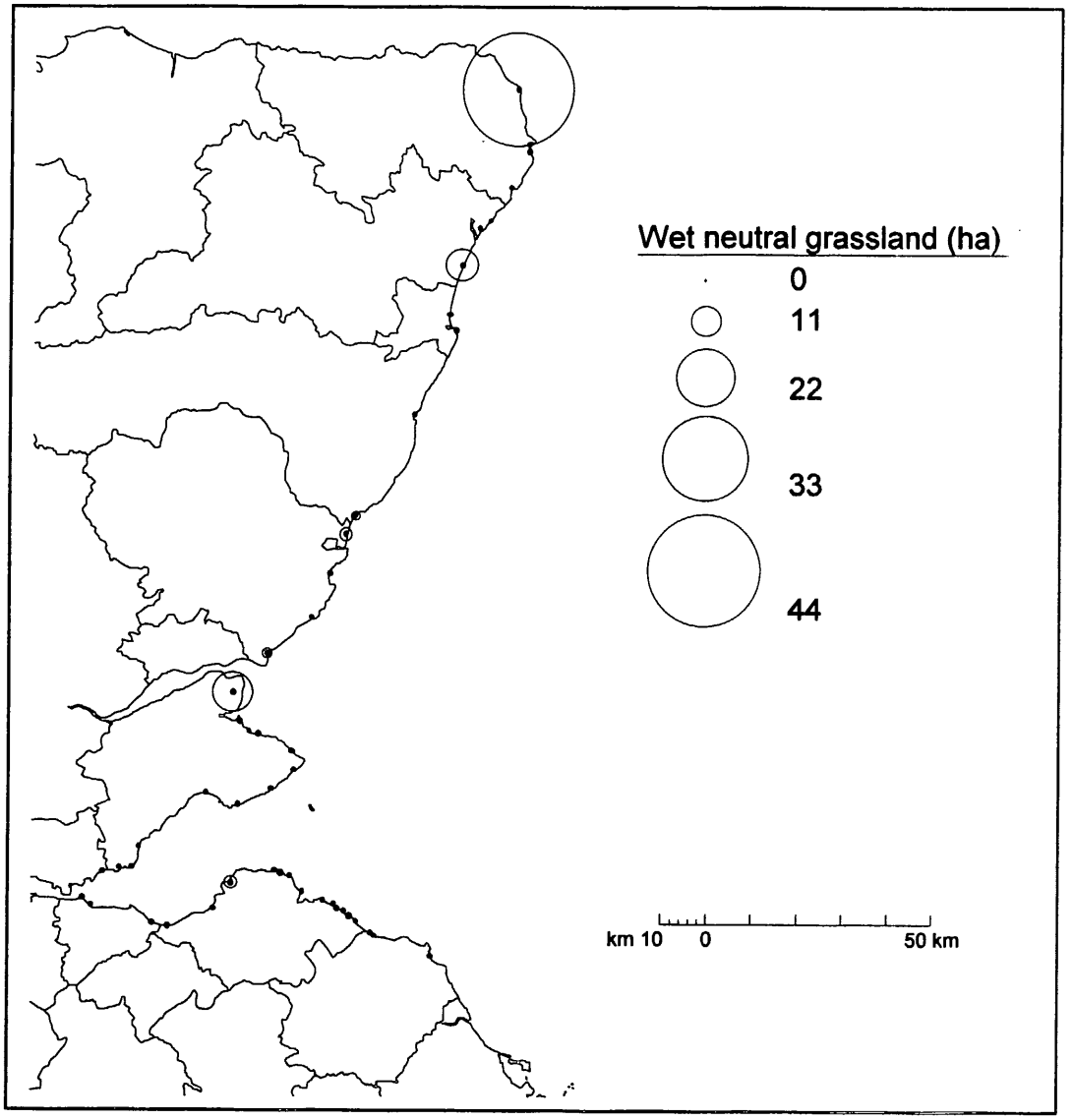
Only 7.2 ha of this wet grassland type is present on dunes on the East Coast, where it forms parts of transitions from saltmarsh at Aberlady Bay (4.9 ha) and St Cyrus (2.1 ha). It therefore seems to tolerate occasional saltwater inundation.

MG13 *Agrostis stolonifera - Alopecurus geniculatus* inundation grassland

This type is rare, with a total area of 3.2 ha, mainly at Inverallochy to Peterhead (in winter lochs) and at Aberdeen in wet depressions within a golf course which probably mark old winter loch areas. It is most frequent in poorly drained depressions or close to the edge of water bodies where it marks areas with winter flooding. Regional examples are close to the existing NVC description (Rodwell 1991 *et seq.*).



Map 2.9 Maritime cliff grassland (ha) on sand in East Coast sites



Map 2.10 Wet neutral grassland (ha) in East Coast sites

2.11 Wet dune heath (M16)

This habitat is locally extensive on the East Coast but is restricted to five sites (Map 2.11). Total area is 144.5 ha, representing 1.25% of potential vegetated area (11566 ha). The largest extent is at Sands of Forvie (101.6 ha), with other occurrences at Arbroath to Broughty Ferry (27.9 ha, mainly at Barry Links), Tentsmuir (9.4 ha), Newburgh to Bridge of Don (5.4 ha) and Charleton & Kinnaber Links to Montrose (0.3 ha). It is developed on wet acidic sands and usually forms mosaics with slack and rushy mire vegetation. All vegetation in this aggregate appears to belong to the M16x provisional new NVC type, apart from a small amount (0.4 ha) of M16/SD16 intermediate (present at Tentsmuir).

M16x *Erica tetralix* - *Sphagnum compactum* wet heath, provisional species-poor sub-community (Table 2.36)

Damp sands with this vegetation have *Erica tetralix* as a constant but *Sphagnum compactum* is absent and other *Sphagna* are rare (though *S. capillifolium* and *S. papillosum* are recorded with constancy scores of I). This low presence and frequent absence of *Sphagnum* spp. on wet dune heaths is a characteristic feature of wet dune heaths throughout Britain (Radley 1994). Poor affinities with existing M16 NVC descriptions have led to mapping as undifferentiated M16, but the overall pattern emerging over Scotland for this type is that it appears to be a distinct species-poor form restricted to sand dune conditions. The only major full constant (class V) is *Erica tetralix*, and the more constant species in Table 2 (classes III and IV) suggest a vegetation type which is an amalgam within the overlap zone of H11b dune heath, SD12 acidic dune grassland, SD15 *Salix repens - Calliergon cuspidatum* slack and U5 *Nardus stricta - Galium saxatile* acidic grassland. Occurrences at Sands of Forvie, the main extent of this type, almost always have *Empetrum nigrum* in the sward and it occurs commonly in mosaics with H11b and SD11a vegetation. The presence of *Empetrum nigrum* is significant, placing this vegetation in the EC Habitats Directive priority habitat type Decalcified fixed dunes with *Empetrum nigrum* (along with H11b).

2.12 Dune slack (SD13, SD15, SD16, SD17)

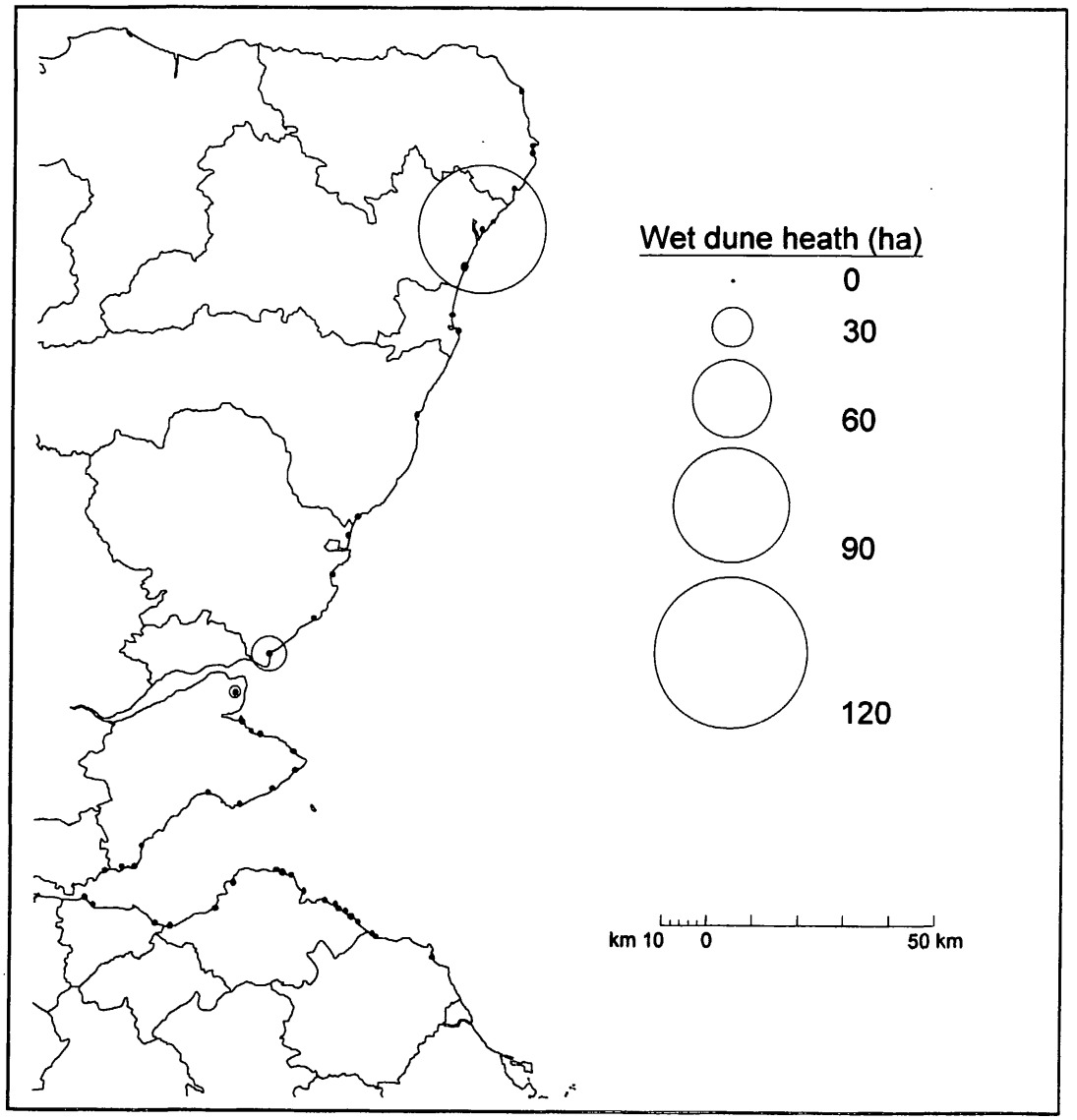
This habitat is locally extensive (Map 2.12), with a total area, including intermediates, of 202.8 ha (1.75% of potential vegetated area, 11566 ha). Slack vegetation occurs in only eight sites, with significant quantities (>5 ha) in six locations: Arbroath to Broughty Ferry (107.6 ha, mainly Barry Links), Tentsmuir (31.4 ha), Inverallochy to Peterhead (29.9 ha), Newburgh to Bridge of Don (13.7 ha), Sands of Forvie (13.0 ha) and Aberlady Point to Milsey Bay (6.3 ha). Dune slacks develop in wet and damp depressions under the influence of a fluctuating watertable. Three main forms of slack occur on the East Coast. In the first, slacks form in the deflation floors of blowouts (e.g. at Barry Links and Sands of Forvie). Second, slacks develop in succession from saltmarsh as a beach progrades seawards (the main process at Tentsmuir). Third, slack conditions develop in the floors of winter lochs which run parallel with the shore inside a single foredune ridge. Winter lochs are long and narrow water bodies which have open water in winter but dry out in summer, often with large areas of cracked mud floor and a zonation of slack and wet neutral grassland along upper margins. They may represent a particular type of progradational slack. Winter lochs occur only at Inverallochy to Peterhead, together with deflation types.

SD13 *Salix repens - Bryum pseudotriquetrum* dune slack

This type covers the early stages of some slack successions and clear cases of its presence have not been found. An SD13/SD16 intermediate is mapped at Newburgh to Bridge of Don (0.2 ha in a deflation slack) and provides some evidence that new slacks are forming.

SD15 *Salix repens - Calliergon cuspidatum* dune slack

This is rare, with 3.9 ha recorded in four sites (3.3 ha at Tentsmuir, 0.4 ha at Newburgh to Bridge of Don, 0.2 ha at Tentsmuir, 0.04 ha at Tyninghame Shore). Quadrat records are insufficient to construct floristic tables but mapping suggests that undifferentiated SD15 (1.8 ha) and the SD15a *Carex nigra* and SD15b *Equisetum variegatum* sub-communities are all present. Small amounts of a proposed new SD15x *Erica tetralix* sub-community are mapped at Newburgh to Bridge of Don (0.4 ha) and Tentsmuir (0.2 ha). This type is close to M16x wet heath but occurs in areas with clear slack vegetation (*Salix repens* accompanied by *Calliergon cuspidatum*), sometimes on lower ground within M16x vegetation. This is more extensive in the Moray Firth and a floristic table is given in the report for that region.



Map 2.11 Wet dune heath habitat (ha) in East Coast sites

Table 2.36: M16x *Erica tetralix - Sphagnum compactum* wet heath, provisional Species-poor sub-community

	Constancy	Domin range
Erica tetralix	V	3-9
Nardus stricta	IV	1-8
Calluna vulgaris	IV	1-9
Carex arenaria	IV	1-4
Salix repens agg.	IV	1-8
Pleurozium schreberi	IV	1-8
Festuca ovina	III	1-5
Potentilla erecta	III	2-5
Agrostis canina	III	1-5
Juncus squarrosus	III	1-7
Anthoxanthum odoratum	II	1-4
Hypnum cupressiforme	II	1-6
Empetrum nigrum nigrum	II	2-8
Holcus lanatus	II	1-4
Polytrichum commune	II	2-6
Deschampsia flexuosa	II	1-5
Carex nigra	II	1-8
Danthonia decumbens	II	1-3
Hylocomium splendens	II	5-8
Hypogymnia physodes	II	1-3
Carex panicea	I	1-2
Galium saxatile	I	1-4
Agrostis capillaris	I	2-3
Juncus effusus	I	2-4
Luzula multiflora	I	1-3
Dicranum scoparium	I	1-4
Cladonia arbuscula	I	1-4
Juncus conglomeratus	I	1-4
Aulacomnium palustre	I	2-7
Pseudoscleropodium purum	I	1-4
Rhytidiadelphus squarrosus	I	1-6
Molinia caerulea	I	3-5
Viola canina	I	1
Rhytidiadelphus triquetrus	I	2-6
Calypogeia muelleriana	I	1-4
Achillea ptarmica	I	3
Agrostis stolonifera	I	5
Campanula rotundifolia	I	1
Drosera rotundifolia	I	4
Galium verum	I	1
Luzula pilosa	I	2
Pedicularis palustris	I	3
Ranunculus acris	I	2
Senecio jacobaea	I	4
Succisa pratensis	I	2
Viola palustris	I	4
Viola tricolor	I	2
Campylium stellatum	I	5
Drepanocladus aduncus	I	5
Pohlia nutans	I	4
Sphagnum capillifolium	I	2
Sphagnum papillosum	I	2
Odontoschisma sphagni	I	2
Peltigera rufescens	I	2
Hypnum jutlandicum	I	1

Species per quadrat 12.68 (based on 25 quadrats)

SD16 *Salix repens - Holcus lanatus* slack (Table 2.36b)

This slack type is the most extensive on the East Coast, with a total area of 132.7 ha. Large totals are present at Barry Links (103.8 ha) and Tentsmuir (23.7 ha), with a modest extent at Sands of Forvie (8.9 ha). Quadrat data from the main expanse at Barry Links (Table 2.36) suggests no clear sub-community and much of the slack resource at this site is close to an SD12/SD16 intermediate. Its very grassy character and the absence of much wetter ground in the lowest parts of slacks suggest that ground here might have dried out over time. An area of slack has also been mown as part of management of firing ranges for military activity. A very small area (0.01 ha) of the SD16a *Ononis repens* sub-community is mapped at Newburgh to Bridge of Don. The SD16c *Prunella vulgaris - Equisetum variegatum* sub-community is recorded at Tentsmuir (6.8 ha). The SD16d *Agrostis stolonifera* sub-community is recorded at Sands of Forvie (2.6 ha), Newburgh to Bridge of Don (2.2 ha) and Charleton & Kinnaber Links to Montrose (0.6 ha).

SD17 *Potentilla anserina - Carex nigra* dune slack (Tables 2.37, 2.38, 2.39)

This slack community is locally common, with 59.1 ha in eight sites. Many occurrences are difficult to place in terms of sub-community (Table 2.37) and are only mapped as SD17 (28.4 ha). All four sub-communities are recorded, plus an SD17b/c intermediate and a provisional new SD17x protoslack type.

SD17a *Potentilla anserina-Carex nigra* slack, *Festuca rubra - Ranunculus repens* sub-community

Total extent is 8.0 ha, with most extent at Inverallochy to Peterhead (4.3 ha) and Newburgh to Bridge of Don (3.5 ha). This occupies the highest, driest ground of SD17 types and usually occurs on the East Coast in association with wet neutral grassland (notably on the sides of winter lochs). There are insufficient quadrats to produce a floristic table.

SD17b *Potentilla anserina-Carex nigra* slack, *Carex flacca* sub-community

Total extent is 3.7 ha, with occurrences in four sites. Most extent (2.2 ha) is at Inverallochy to Peterhead where it occurs in a deflation slack. It is close to the NVC description. There are insufficient quadrats to produce a floristic table.

SD17c *Potentilla anserina-Carex nigra* slack, *Caltha palustris* sub-community

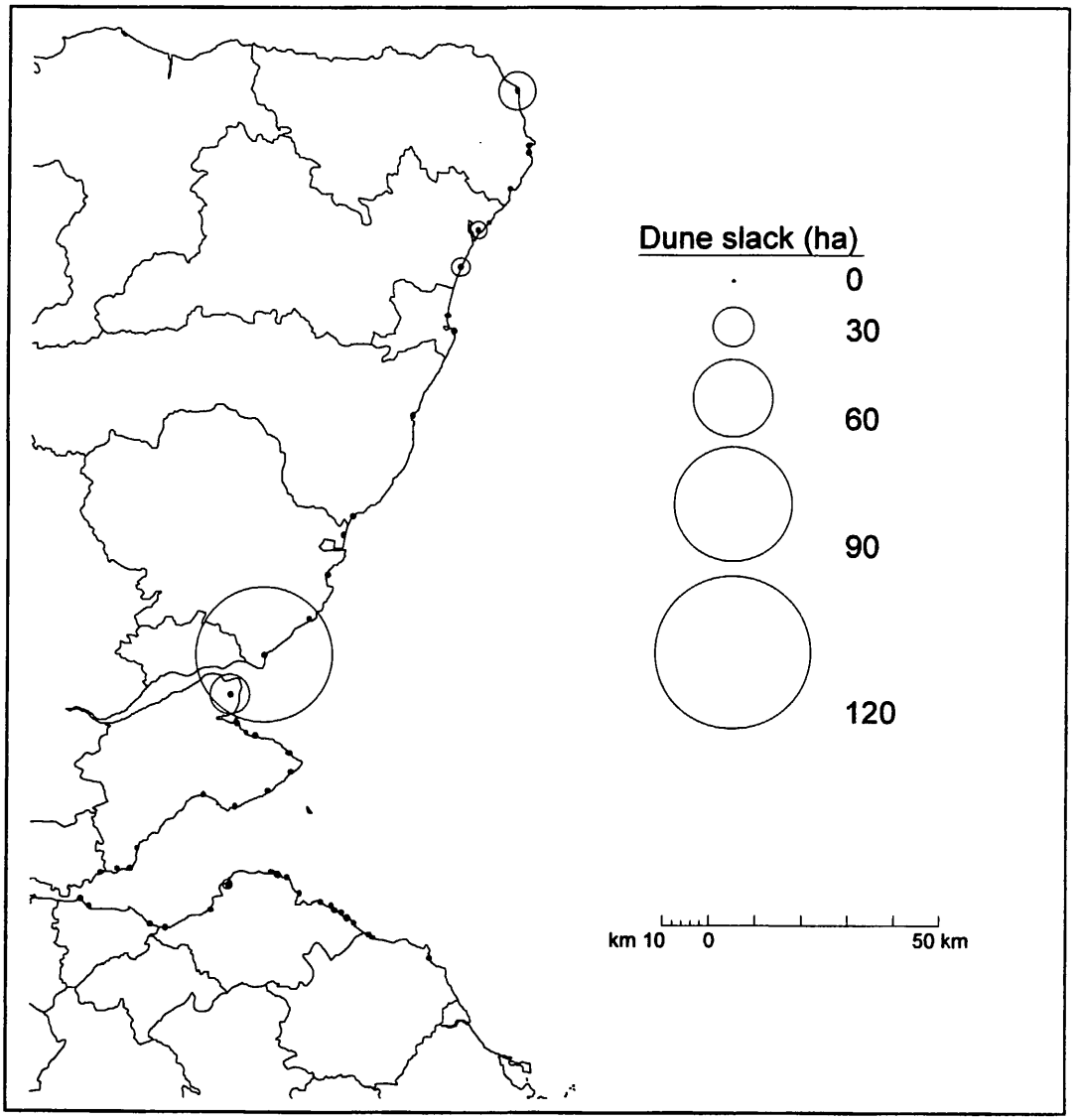
Total extent is 2.6 ha, with occurrences at Aberlady Point to Milsey Bay (1.5 ha) and Inverallochy to Peterhead (1.1 ha). This type seems to prefer slacks with waterlogged soils for much of the year. There are insufficient quadrats to produce a floristic table.

SD17d *Potentilla anserina-Carex nigra* slack, *Hydrocotyle vulgaris - Ranunculus flammula* sub-community (Table 2.38)

This is locally common, with a total extent of 12.0 ha present in five sites. It is present in quantity (>1 ha) at Inverallochy to Peterhead (6.5 ha), Aberlady Point to Milsey Bay (3.3 ha) and Arbroath to Broughty Ferry (1.2 ha). In the north of the region it occurs along the sides of winter lochs and elsewhere it occurs on very wet ground which dries out in the summer. *Ranunculus flammula* is uncommon but *Hydrocotyle vulgaris* is always present. *Parnassia palustris, Pinguicula vulgaris* and the nationally scarce *Equisetum variegatum* are often present in the sward.

SD17x *Potentilla anserina-Carex nigra* slack, provisional *Agrostis stolonifera* protoslack sub-community (Table 2.39)

Total extent is 4.5 ha, with occurrences at Sands of Forvie (3.5 ha) and Newburgh to Bridge of Don (0.9 ha). This provisional sub-community marks the early stages of SD17 slack development and occurs in deflation hollows to the rear of blowouts, These areas of wet ground are often small and irregular in form, with patchy vegetation development. *Carex nigra* seems to arrive later in succession and only has a constancy score of II. *Agrostis stolonifera* is present in all samples and forms near-circular colonies in the early stages of the local succession. *Parnassia palustris* and *Juncus articulatus* are also common features of this ground. The current NVC division into four sub-communities does not recognise an early slack type and the form described here occurs elsewhere in Scotland.



Map 2.12 Dune slack habitat (ha) in East Coast sites

Table 2.36b SD16 *Salix repens - Holcus lanatus* dune-slack

	Constancy	Domin range
Salix repens agg.	V	5-9
Holcus lanatus	V	1-3
Anthoxanthum odoratum	V	3-6
Carex arenaria	V	2-5
Festuca rubra	V	3-8
Lotus corniculatus	IV	1-3
Plantago lanceolata	IV	1-2
Trifolium repens	IV	1-2
Rhytidiadelphus squarrosus	IV	1-3
Galium verum	III	1-2
Koeleria macrantha	III	1-2
Poa pratensis	III	1-2
Pseudoscleropodium purum	III	2-3
Dactylis glomerata	III	1
Senecio jacobaea	III	1
Cirsium arvense	II	1-2
Lathyrus pratensis	II	1
Potentilla erecta	II	1
Danthonia decumbens	II	1-2
Veronica chamaedrys	II	1
Achillea millefolium	I	2
Agrostis stolonifera	I	6
Ammophila arenaria	I	1
Carex flacca	I	1
Carex nigra	I	6
Cerastium fontanum triviale	I	3
Festuca ovina	I	5
Galium saxatile	I	3
Hydrocotyle vulgaris	I	5
Ranunculus acris	I	1
Ranunculus repens	I	2
Rhinanthus minor	I	1
Polytrichum commune	I	6
Species per quadrat 13.71 (based on 7 quadrats)		

Table 2.37 SD17 *Potentilla anserina - Carex nigra* dune-slack

	Constancy	Domin range
Potentilla anserina	V	1-6
Carex nigra	V	4-9
Galium palustre	III	1-2
Trifolium repens	III	1-4
Calliergon cuspidatum	III	3-6
Agrostis stolonifera	II	5
Agrostis capillaris	II	3-4
Eleocharis palustris	II	2-3
Filipendula ulmaria	II	1-5
Holcus lanatus	II	3-4
Juncus articulatus	II	1-3
Ranunculus repens	II	2-3
Salix repens agg.	II	7-9
Senecio jacobaea	II	1-2
Bryum pseudotriquetrum	II	1
Achillea millefolium	I	2
Anthoxanthum odoratum	I	4
Bellis perennis	I	3
Cardamine pratensis	I	2
Carex arenaria	I	2
Cerastium fontanum triviale	I	1
Cirsium palustre	I	1
Equisetum arvense	I	1
Hydrocotyle vulgaris	I	5
Juncus effusus	I	4
Leontodon autumnalis	I	1
Lotus corniculatus	I	3
Poa annua	I	1
Poa pratensis	I	3
Prunella vulgaris	I	3
Ranunculus flammula	I	2
Sagina procumbens	I	4
Trifolium pratense	I	2
Vicia cracca	I	2
Viola canina	I	2
Viola palustris	I	2
Climacium dendroides	I	6
Drepanocladus sendtneri	I	5
Rhytidiadelphus squarrosus	I	2
Dactylorhiza sp.	I	1
Species per quadrat 12.80 (based on 5 quadrats)		

Table 2.38 SD17d *Potentilla anserina - Carex nigra* dune-slack, *Hydrocotyle vulgaris - Ranunculus flammula* sub-community

	Constancy	Domin range
Potentilla anserina	III	2-5
Carex nigra	V	2-5
Hydrocotyle vulgaris	V	1-5
Ranunculus flammula	II	1
Carex arenaria	IV	2-4
Equisetum palustre	IV	1-4
Trifolium repens	IV	1-4
Calliergon cuspidatum	IV	2-8
Carex panicea	III	2-3
Equisetum variegatum	III	2-4
Parnassia palustris	III	3
Prunella vulgaris	III	2-7
Rhinanthus minor	III	3
Dactylorhiza incarnata	III	2
Euphrasia officinalis agg.	III	2-4
Festuca ovina	III	3-5
Holcus lanatus	III	3-6
Juncus articulatus	III	2-6
Lotus corniculatus	III	1-3
Pinguicula vulgaris	III	2-3
Danthonia decumbens	III	1-5
Vicia cracca	III	2-3
Achillea ptarmica	II	2-6
Agrostis stolonifera	II	3-4
Agrostis capillaris	II	2-4
Anagallis tenella	II	1-4
Anthoxanthum odoratum	II	2-4
Briza media	II	5-6
Cirsium palustre	II	4-5
Galium palustre	II	2-3
Lathyrus pratensis	II	1-2
Plantago lanceolata	II	2-3
Poa pratensis	II	2-3
Ranunculus acris	II	1-2
Viola palustris	II	3-4
Species per quadrat 20.57 (based on 7 quadrats)		

Table 2.39 SD17x *Potentilla anserina - Carex nigra* dune-slack, provisional new *Agrostis stolonifera* protoslack sub-community

	Constancy	Domin range
Potentilla anserina	IV	1-7
Carex nigra	II	2-5
Agrostis stolonifera	V	4-8
Rumex crispus	III	1
Holcus lanatus	III	1-4
Parnassia palustris	III	1-5
Phragmites australis	III	1
Calliergon cuspidatum	III	7-10
Cardamine pratensis	II	3
Eleocharis palustris	II	1-4
Juncus articulatus	II	3-5
Myosotis laxa caespitosa	II	3-4
Ranunculus flammula	II	3
Trifolium repens	II	3-6
Triglochin maritima	II	1-3
Carex flacca	II	1-3
Centaurium erythraea	II	3
Epilobium parviflorum	II	1-2
Equisetum arvense	II	4-5
Hippophae rhamnoides	II	1
Hydrocotyle vulgaris	II	5-7
Pedicularis palustris	II	1-3
Prunella vulgaris	II	1-2
Ranunculus repens	II	1
Trifolium campestre	II	2
Barbula tophacea	II	5-8
Elymus repens	I	1
Anagallis tenella	I	2
Bellis perennis	I	3
Carex arenaria	I	3
Carex disticha	I	1
Carex otrubae	I	2
Cirsium palustre	I	1
Dactylorhiza majalis purpurella	I	1
Eleocharis quinqueflora	I	2
Empetrum nigrum nigrum	I	2
Equisetum variegatum	I	3
Festuca rubra	I	5
Galium palustre	I	1
Juncus bufonius	I	3
Juncus effusus	I	2
Juncus gerardi	I	1
Littorella uniflora	I	3
Mentha aquatica	I	2
Polygonum amphibium	I	4
Potentilla palustris	I	2
Radiola linoides	I	2
Salix repens agg.	I	5
Drepanocladus aduncus	I	4
Sphagnum capillifolium	I	4

Species per quadrat 12.22 (based on 9 quadrats)

2.13 Mire (excluding Mx provisional new rich fen types) (M23, M25, M27, M28)

This aggregation of mire types includes existing NVC types found on dunes on the East Coast. It excludes a set of Mx rich-fen mires which, though not described in the NVC, are so characteristic of dunes and dune margins in northern and western Scotland that they are treated separately in Section 2.14. NVC mire types on dunes of the East Coast are not diverse, involving only 4 communities, but overall extent is moderate (151.4 ha) and represents 1.3% of potential vegetated blown sand (11566 ha). Large areas (>10 ha) are restricted to four sites: Tentsmuir (59.4 ha), Sands of Forvie (38.5 ha), Aberlady Point to Milsey Bay (19.9 ha) and Arbroath to Broughty Ferry (18.4 ha) (Map 2.13). The largest occurrences of mire are all in slack topography (wet depressions) and the most extensive types, the rush-dominated *Juncus acutiflorus/effusus* community, probably represent a late successional stage in slack evolution within grazed dunes. In the absence of grazing it is likely that wet woodland would develop in such ground, a process which is clear in parts of Tentsmuir (Earlshall and Ward's Muir).

M23 *Juncus effusus/acutiflorus - Galium palustre* rush pasture (Table 2.40)

This community is by far the largest mire type on wet sand, with a regional total of 115.2 ha. The two dominant rush species, *Juncus effusus* and *J. acutiflorus*, are often present together, especially at Tentsmuir where this vegetation is only mapped as M23 community (61.2 ha), occurring mainly in sub-parallel inland, linear depressions representing former progradational slacks. Many are also being invaded by wet woodland and scrub. Old deflation slacks at Sands of Forvie hold large extents of the M23b *Juncus effusus* sub-community (37.8 ha, out of a regional total of 50.5 ha for this type). Intermediates (M23/MG9, M23/SD17) are also recorded but their extent is very low. Quadrat data for the region show vegetation which is a combination of the two NVC sub-communities, but with M23b dominant in terms of species frequency (Table 2.40).

M25 *Molinia caerulea - Potentilla erecta* mire

A very small (0.8 ha) area of more peaty ground at Sands of Forvie has both *Molinia caerulea* and *Potentilla erecta* present and is classifiable under this type. It is scattered in very small quantities on dunes elsewhere in Scotland.

M27 *Filipendula ulmaria - Angelica sylvestris* tall-herb fen (Table 2.41)

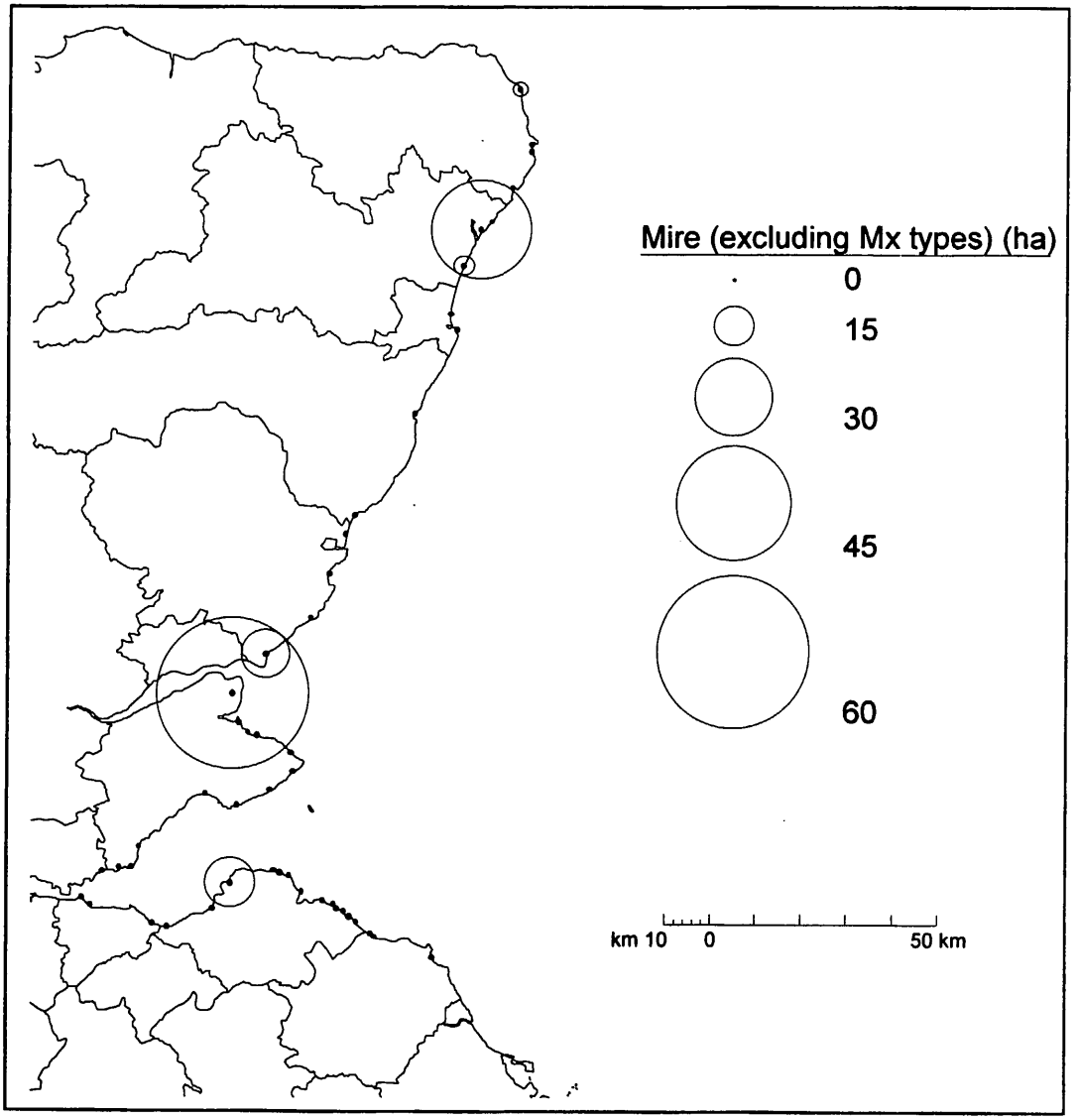
This distinctive fen type has a total extent of 35.4 ha including intermediates, occurring ten sites. The largest extents are at Aberlady Point to Milsey Bay (18.5 ha of the M27b *Urtica dioica - Vicia cracca* sub-community) where this vegetation probably represents late slack succession in areas with moderate nutrient levels in flushed slacks on or at the base of hillslopes. Elsewhere the M27 community is mapped in similar circumstances (11.4 ha total extent), especially at Barry Links which has 6.6 ha of this type, plus 1.0 ha of an M27/MG12 intermediate. Quadrat data (Table 2.41) for this vegetation show abundant *Filipendula ulmaria* but *Angelica sylvestris* is uncommon (constancy class I). There is also much *Vicia cracca*, suggesting the M27b sub-community is the closest form for ground mapped simply as M27. The moderate frequency of *Hydrocotyle vulgare* suggests links with SD17d vegetation.

M28 *Iris pseudacorus - Filipendula ulmaria* mire

This is very rare, with 0.04 ha mapped at Tentsmuir.

2.14 Mx *Carex nigra* provisional new rich fen NVC types (Mxbd)

In contrast to published mire types, there are areas of marsh on the inner edge of some dune systems with vegetation which is poorly covered by existing NVC published descriptions (Rodwell 1991 *et seq.*). It is described here as Mx *Carex nigra* rich fen and is particularly extensive in the Western Isles (especially South Uist). Extent on dunes on the East Coast (Map 2.14) is very low, with only 1.2 ha recorded at Inverallochy to Peterhead. The Mxbd *Carex nigra - Prunella vulgaris - Molinia caerulea* rich fen is mapped here, its most southerly location on the eastern coast of Scotland. The Mx type requires very wet and poorly drained conditions, but not a long period of inundation which would probably develop into swamp conditions. Moderate nutrient levels are also probably important, since most stands have a rich-fen appearance and high species diversity. The sward is often tall, with bright, colourful herbs such as *Lychnis flos-cuculi* making it a distinctive element of the wetter dune environment. The habitat is characterised by the constant presence of *Carex nigra* and only rare occurrences of *Potentilla anserina*, showing links with the SD17 *Potentilla anserina - Carex nigra* dune slack community. Constancy information is given in reports for the Western Isles and Inner Hebrides.



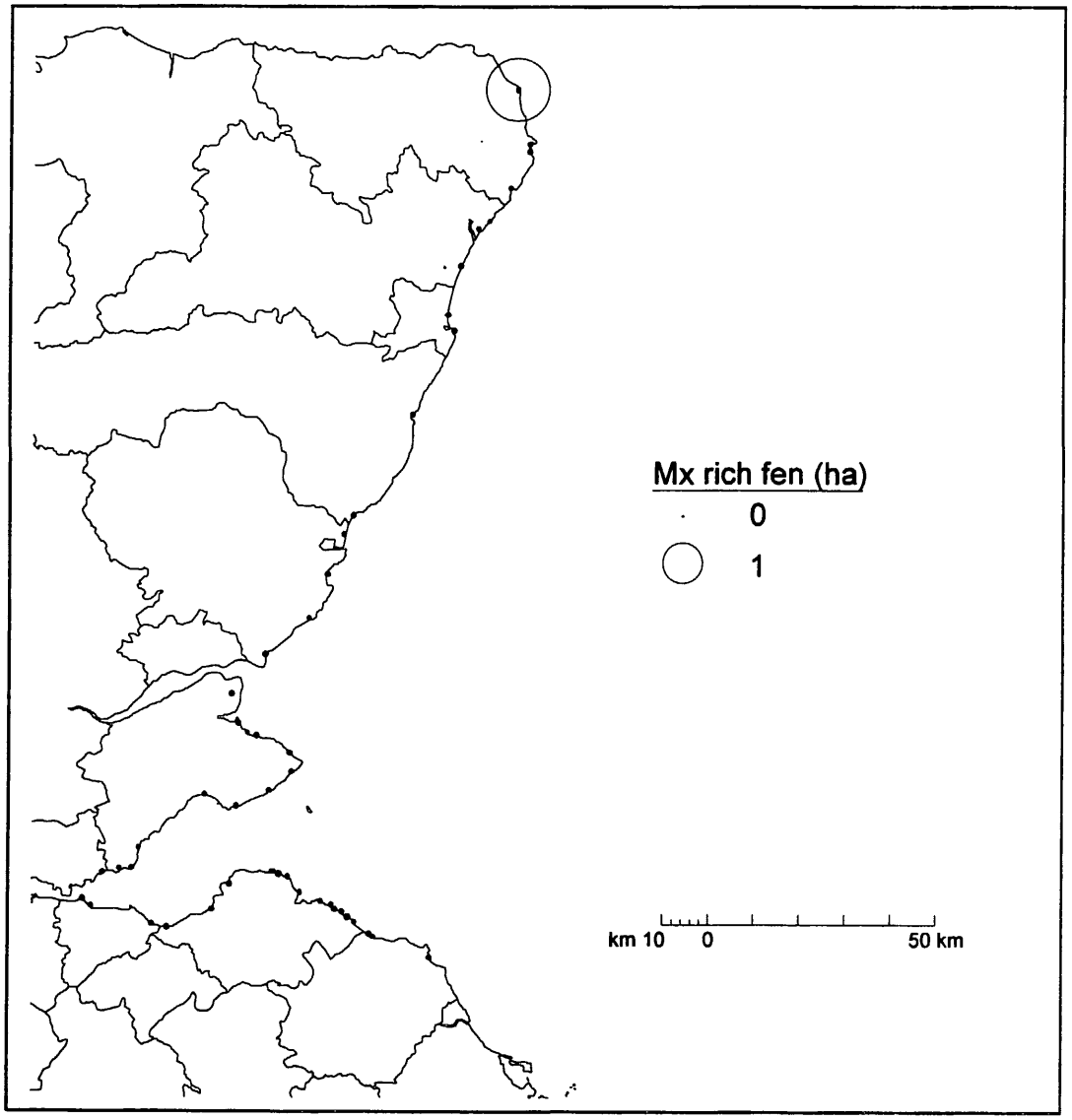
Map 2.13 Non-Mx mire vegetation (ha) in East Coast sites

Table 2.40 M23a/b *Juncus effusus/acutiflorus - Galium palustre* rush pasture, intermediate between M23b *J. effusus* and M23a *J. acutiflorus* sub-communities

	Constancy	Domin range
Juncus effusus	V	5-9
Juncus acutiflorus	II	6-7
Galium palustre	V	3-4
Agrostis stolonifera	III	3-5
Cardamine pratensis	III	1-3
Holcus lanatus	III	2-4
Agrostis canina	II	2-5
Cirsium palustre	II	1-6
Epilobium palustre	II	3
Hydrocotyle vulgaris	II	3-6
Myosotis scorpioides	II	4
Potentilla palustris	II	1-4
Alopecurus geniculatus	I	3
Angelica sylvestris	I	1
Caltha palustris	I	3
Carex curta	I	4
Carex nigra	I	4
Carex rostrata	I	4
Deschampsia cespitosa cespitosa	I	1
Equisetum palustre	I	4
Festuca rubra	I	2
Juncus bufonius	I	4
Nardus stricta	I	2
Lythrum portula	I	4
Poa pratensis	I	3
Polygonum persicaria	I	1
Potentilla erecta	I	2
Ranunculus acris	I	3
Ranunculus flammula	I	4
Ranunculus repens	I	6
Rumex acetosa	I	4
Trifolium repens	I	1
Calliergon cuspidatum	I	7
Rhytidiadelphus squarrosus	I	3
Sphagnum recurvum	I	8
Species per quadrat 11.20 (based on 5 quadrats)		

Table 2.41 M27 *Filipendula ulmaria - Angelica sylvestris* tall-herb fern

	Constancy	Domin range
Filipendula ulmaria	V	5-10
Angelica sylvestris	I	2
Vicia cracca	V	1-4
Arrhenatherum elatius	IV	2-6
Hydrocotyle vulgaris	III	3-5
Centaurea nigra	III	1-5
Equisetum palustre	III	2-4
Lychnis flos-cuculi	III	1-3
Calliergon cuspidatum	III	3-4
Carex arenaria	II	2-4
Carex panicea	II	2-3
Cirsium arvense	II	1
Cirsium palustre	II	2-4
Festuca arundinacea	II	3-4
Festuca ovina	II	2-5
Festuca rubra	II	3-4
Holcus lanatus	II	3-4
Luzula campestris	II	1-2
Oenanthe crocata	II	1-3
Poa pratensis	II	1-2
Potentilla anserina	II	2
Urtica dioica	II	3-4
Achillea ptarmica	I	3
Agrostis stolonifera	I	4
Anthoxanthum odoratum	I	3
Carex disticha	I	9
Carex hirta	I	1
Carex nigra	I	3
Carex pilulifera	I	1
Carex pulicaris	I	1
Deschampsia cespitosa cespitosa	I	5
Equisetum arvense	I	2
Erica cinerea	I	4
Galium palustre	I	1
Galium saxatile	I	3
Galium verum	I	1
Hypericum tetrapterum	I	1
Juncus inflexus	I	4
Lotus corniculatus	I	1
Potentilla erecta	I	1
Pulicaria dysenterica	I	1
Ranunculus acris	I	1
Rhinanthus minor	I	1
Sonchus asper	I	1
Triglochin maritima	I	1
Dicranum scoparium	I	2
Pleurozium schreberi	I	9
Pseudoscleropodium purum	I	1
Rhytidiadelphus squarrosus	I	1
Cladonia arbuscula	I	4
Species per quadrat 12.57 (based on 7 quadrats)		



Map 2.14 Mx rich fen vegetation (ha) in East Coast sites

2.15 Swamp (S4, S5, S6, S8, S9, S10, S11, S12, S14, S18, S19, S20, S21, S26, S28)

Swamp habitat (45.3 ha) on blown sand is only locally extensive on the East Coast (Map 2.15), covering 0.4% of the potential vegetated sand area (11566 ha). A large number of swamp communities (15) is recorded. Swamp occurs in fifteen sites, with large (>5 ha) extents at Tentsmuir (10.3 ha, mainly at Morton Lochs in an area excavated early this century as fishing lakes and hence atypical), Newburgh to Bridge of Don (9.6 ha), Arbroath to Broughty Ferry (8.8 ha) and Inverallochy to Peterhead (8.6 ha). Most types fit existing NVC descriptions and several occurrences are in locations, like Morton Lochs, which are the result of past excavations to create open water. A striking feature of swamp distribution in the north of this region is the repeated occurrence of S5 *Glyceria maxima* swamp in streambeds cutting through dune systems from catchments inland, often extending through much of the outer foredune ridge. S5 swamp is not common elsewhere on dunes in Scotland and its presence in this manner probably reflects the large extent of arable land in the dune hinterland, with probable enhanced nutrient flows from these catchments. *Glyceria maxima* is acknowledged as an indicator of water enrichment.

S4 *Phragmites australis* reedbed

Moderate areas of reedbed are present at Tentsmuir (6.2 ha, mainly at Morton Lochs) and Arbroath to Broughty Ferry (4.4 ha, at Barry Links in the valley of the Buddon Burn), making up most of a regional extent of 13.3 ha. *Phragmites australis* is usually monodominant, but an S4/S28 intermediate with abundant *Phalaris arundinacea* is recorded at Arbroath to Broughty Ferry (0.3 ha).

S5 *Glyceria maxima* swamp

This swamp type (8.8 ha) is mainly present at Newburgh to Bridge of Don (8.0 ha), with a further 0.7 ha at Barry Links and very small amounts at St Cyrus and Charleton & Kinnaber Links to Montrose. As discussed above, it is consistently present in streams draining through dune systems and may well be an indicator of water enrichment by agriculture.

S6 *Carex riparia* swamp

A small area (0.2 ha) of this swamp type (very rare on blown sand) is mapped at Aberlady Point to Milsey Bay, adjacent to the Peffer Burn in Aberlady Bay.

S8 *Scirpus lacustris* swamp

A small area (0.1 ha) of this swamp type is mapped at Aberlady Point to Milsey Bay, in a former curling pond with hydroseral margins.

S9 *Carex rostrata* swamp

This is rare, with 2.0 ha at Sands of Forvie (1.8 ha on the edge of open water in the north of the site) and Inverallochy to Peterhead.

S10 *Equisetum fluviatile* swamp

This is rare, with 0.3 ha mapped at sands of Forvie in very wet streambeds draining climbing dunes over impermeable till in the northern sector of the site.

S11 *Carex vesicaria* swamp

This is rare, with 0.2 ha mapped in an area of former open water (possibly a pond excavated for wildfowling) at Tyninghame Shore

S12 *Typha latifolia* swamp

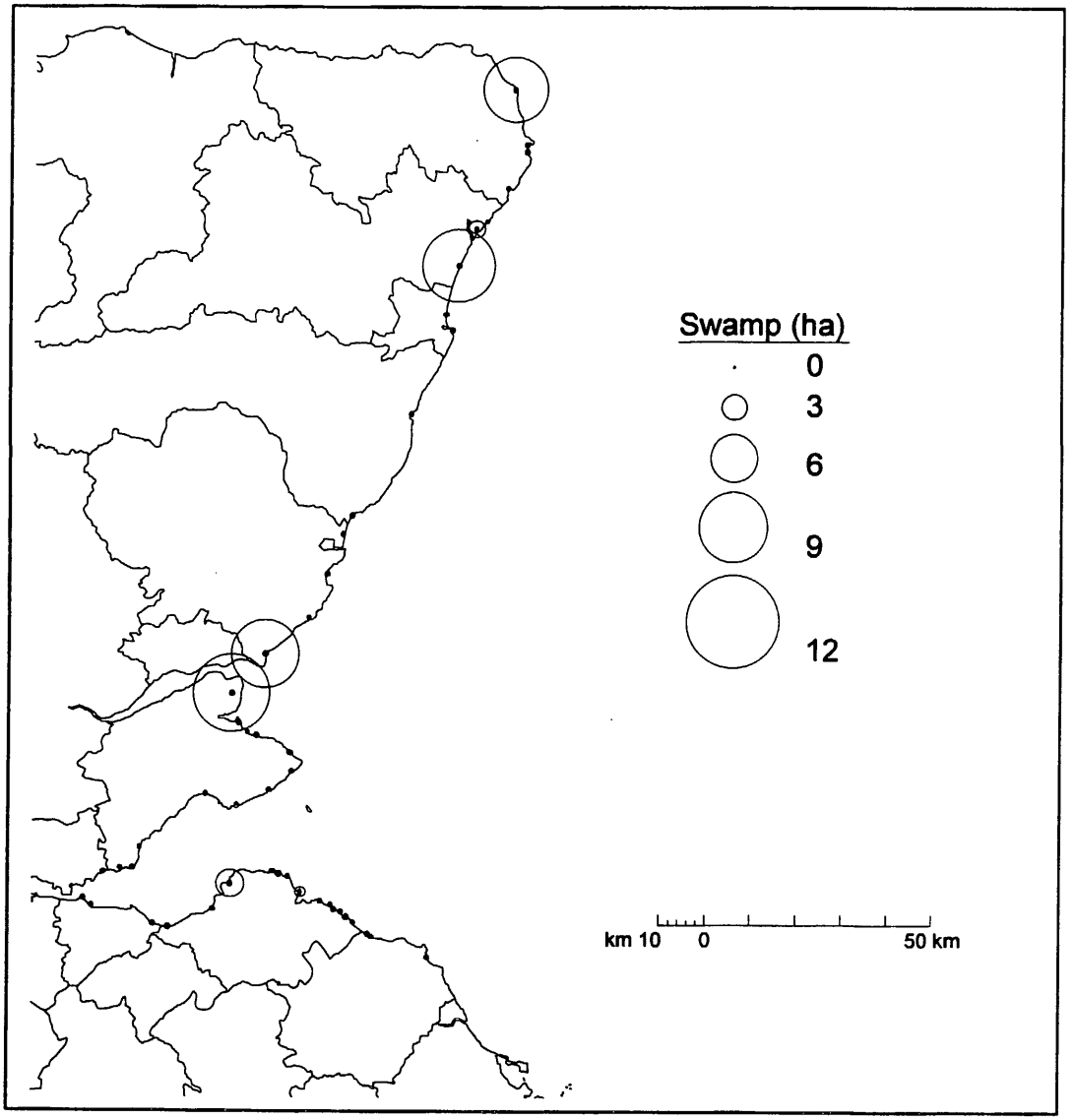
A small area (0.1 ha) of this swamp type is mapped at Aberlady Point to Milsey Bay, in a former curling pond with hydroseral margins.

S14 *Sparganium erectum* swamp

This is rare, with 0.4 ha at Inverallochy to Peterhead in an area of poor drainage created by failed drainage changes, plus a trivial area at Newburgh to Bridge of Don adjacent to S5 *Glyceria maxima* swamp.

S18 *Carex otrubae* swamp

A moderately large (1.7 ha) area of intermediate S18/SM16 swamp is present at the rear of saltmarsh in Aberlady Bay and is part of a fine transition from saltmarsh to mature slack below climbing dune in this site.



Map 2.15 Swamp vegetation (ha) in East Coast sites

S19 *Eleocharis palustris* swamp

Modest extents of this common swamp type are present in the region, often occurring in very small, very wet depressions within dune slacks or mosaics of slacks. The total area is 4.3 ha, most (2.8 ha) of it present at Inverallochy to Peterhead on the edges of open water areas possibly used for wildfowling in the past. All three published sub-communities are mapped: S19a *Eleocharis palustris* (2.2 ha), S19b *Littorella uniflora* (0.03 ha at Tyninghame Shore), and S19c *Agrostis stolonifera* (1.4 ha).

S20 *Scirpus lacustris* ssp. *tabernaemontani* swamp

This is rare, with 0.7 ha confined to Aberlady Bay where it occurs on wet transition areas of upper saltmarsh flushed by water draining from adjacent climbing dunes and mature M27 slack.

S21 *Scirpus maritimus* swamp

This is uncommon, with 3.1 ha occurring in six sites, most of it at Tentsmuir on the upper edges of saltmarsh where there is slight freshwater flushing (2.1 ha) and Tyninghame Shore along upper saltmarsh edges and in a slack area with a drainage channel subject to occasional tidal influence. *Scirpus maritimus* is generally monodominant (S21a vegetation) but 0.1 ha of the S21b *Atriplex prostrata* sub-community is mapped at Tyninghame Shore.

S26 *Phragmites australis* - *Urtica dioica* tall-herb fen

This is rare, with 0.8 ha confined to Tentsmuir and mapped on the edges of Morton Lochs.

S28 *Phalaris arundinacea* tall-herb fen

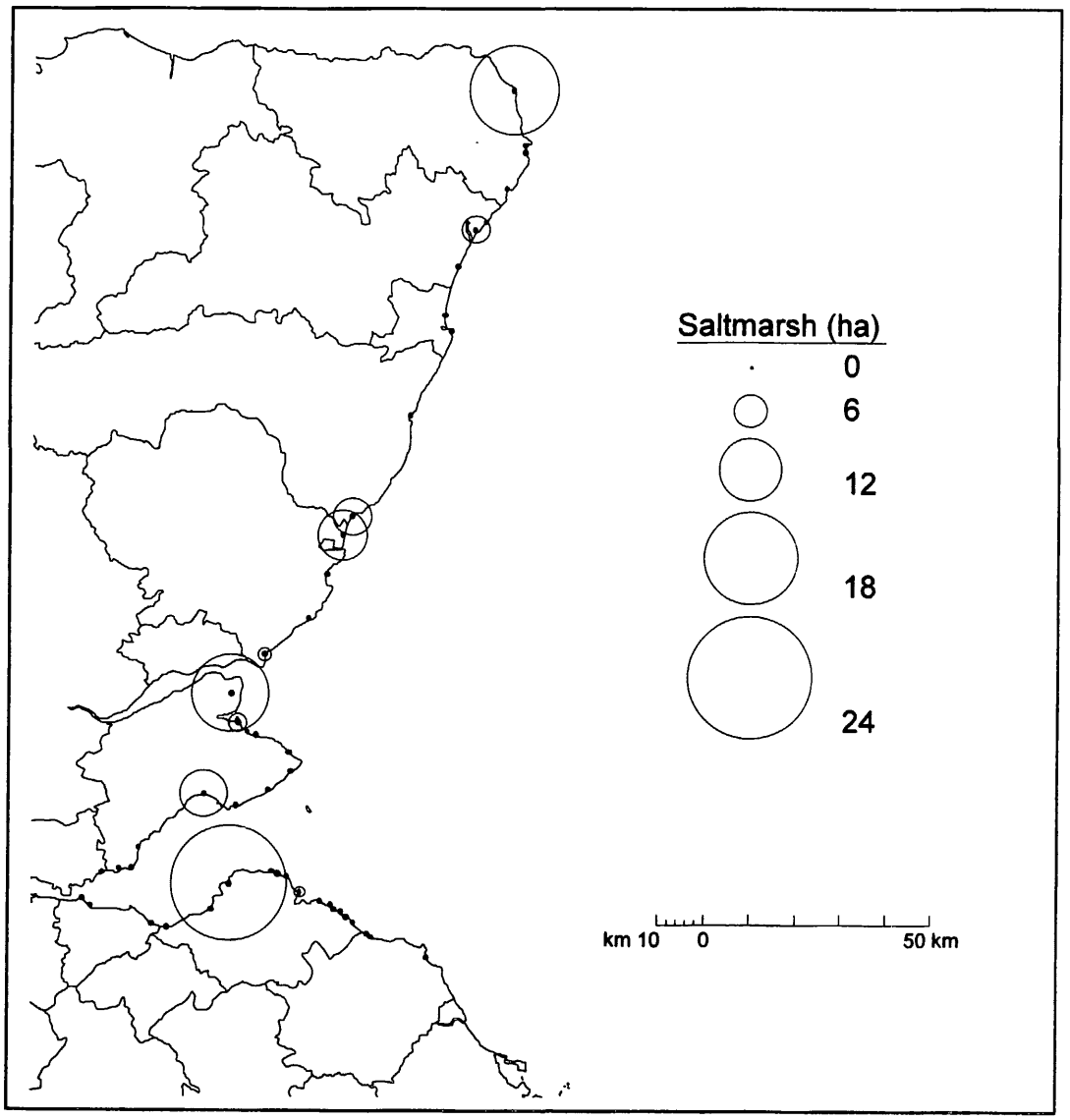
This is uncommon, with a total area of 9.4 ha recorded in five sites. The largest extents include 4.2 ha at Inverallochy to Peterhead (close to the wet margins of Loch of Strathbeg), 3.1 ha at Arbroath to Broughty Ferry (at Barry Links in the floor of the Buddon Burn), and 1.7 ha at Newburgh to Bridge of Don where it occurs on the edges of S5 *Glyceria maxima* swamp.

2.16 Saltmarsh (SM6, SM8, SM9, SM10, SM13, SM16, SM18, SM28)

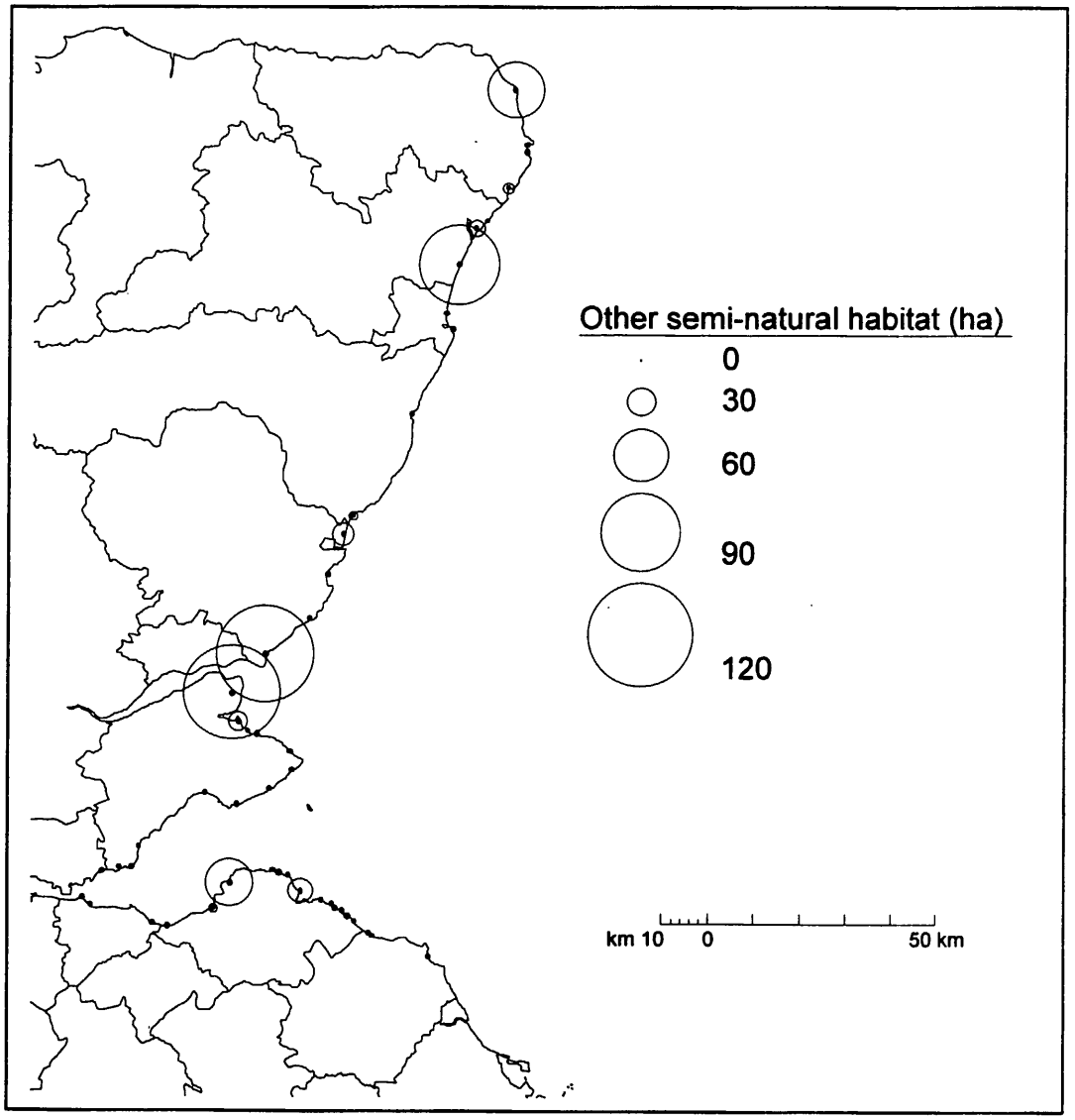
This habitat aggregate is present adjacent to sand dunes in fifteen sites, including transition zones between dune vegetation and saltmarsh which are marked by intermediate vegetation types (e.g. the SD8/SM16 type). The total extent of saltmarsh vegetation mapped (Map 2.16) is 95.0 ha. Great care should be taken with saltmarsh extent data because most survey only concentrated on transitions from dune and did not necessarily cover all saltmarsh in a site (e.g. it is extensive but not mapped in parts of Tyninghame Shore). Most of the saltmarsh at Tentsmuir has probably been mapped (but not all saltmarsh within the Eden Estuary) but much is only to community level, as in several other sites. Formal saltmarsh NVC survey to sub-community level should be undertaken if up-to-date information and detail are needed.

2.17 Other semi-natural habitats (BIS, BMC, BR, BSCRUB, BURNT, OSCRUB, OV26, OV27, OW, RUD, RUDPh, RUNWAT, SD18, U20, W1, W6, W11, W18, W21, W22, W23, W24, W25)

This aggregate is a miscellany of habitats which is difficult to group with other types. Its total extent is 586.5 ha, with most larger assemblages having some cover (Map 2.17). Unvegetated areas around saltmarsh and below high water mark were mapped in some sites as bare intertidal sand (BIS, 20.4 ha). Several categories involve habitats which are not significant in terms of the nature conservation interest of vegetation, notably bare maritime cliff (BMC, 13.9 ha), bare rock (BR, 0.7 ha), open water (OW, 16.8 ha, largely ignored as a habitat because it is surveyed in Britain using a specialist non-NVC system) and running water (RUNWAT, 8.2 ha). However, four habitat groups remain (ruderal/other vegetation, bracken habitats, scrub and woodland) and these need a more careful evaluation.



Map 2.16 Saltmarsh (ha) in East Coast sites



Map 2.17 Other semi-natural vegetation (ha) in East Coast sites

Ruderal and other vegetation of disturbed ground (OV26, OV27, RUD, RUDPh)

Damp ground at two locations has a small (0.2 ha) quantity of the OV26 *Epilobium hirsutum* community: Coldingham Bay (0.13 ha on disturbed and flushed sand-covered till cliffs at the rear of the site) and Port Seton to Craigielaw (0.1 ha in an area possibly disturbed in the past to provide better drainage for a tidal stream).

The OV27 *Chamerion angustifolium* community was mapped on dunes in 1999, with a total extent of 4.8 ha which includes 2.4 ha of the OV27e *Ammophila arenaria* sub-community. Quadrats are given in site reports. This vegetation is a showy type in mid to late summer and seems to prefer ground in the early stages of semi-fixed dune development (and also the SD6x vegetation type) where there is plenty of bare sand. Only three sites are recorded with extents >0.5 ha: Newburgh to Bridge of Don (1.6 ha), Cruden Bay (1.4 ha) and St Cyrus (0.8 ha). The full extent of this community is unknown because it was not mapped in earlier surveys, although there are scattered references in target notes. It is particularly common in clear-felled areas of Tentsmuir Forest and the OV27e type occurs in uncertain quantity at Sands of Forvie. The long-term impacts of this community on other dune vegetation are uncertain but are not likely to pose a serious threat based on harmonisation work in 1999, re-visiting some sites mapped up to 11 years previously.

Stock feeding, especially the importation of silage as supplementary winter fodder, is locally extensive on the East Coast. Stock concentrate around feeding stations and create bare ground by trampling, as well as spreading dung and urine. If pigs are involved much of the soil is thoroughly churned by foraging activity. Nutriphiles and other ruderal vegetation (e.g. *Arctium minus, Urtica dioica, Stellaria media, Poa annua*) invade such areas if grazing is relaxed in the summer or pasture is abandoned for a time. A parallel effect occurs on ground infested with rabbits, with *Senecio jacobaea, Cirsium vulgare* and *C. arvense* sometimes exploding with a high cover. Grassland (and occasionally stock) with more than 10% cover of ruderal vegetation was mapped as a mosaic, recording the ruderal content with the code RUD. Such ground totals 65.2 ha on the East Coast, with three areas having large extents (>5 ha): Inverallochy to Peterhead (32.4 ha, a mix of winter feeding of cattle, ruderal invasion of rabbit-infested ground and past stocking with pigs), Newburgh to Bridge of Don (18.2 ha, winter feeding of stock) and Tyninghame Shore (8.0 ha, mainly stocking with pigs).

Ground infested with *Petasites hybridus* was mapped separately as RUDPh, a practice established in the Western isles where this species is a serious invasive threat to some damp dune pastures where it shades other vegetation and produces a species-poor sward. It is rare on the East Coast, with 0.5 ha in damp ground at Port Seton to Craigielaw (0.4 ha) and Arbroath to Broughty Ferry (0.1 ha). It is therefore not a threat to these regional dunes.

Bracken on sand dunes of the East Coast

Bracken is mapped as either U20 *Pteridium aquilinum - Galium saxatile* or W25 *Pteridium aquilinum - Rubus fruticosus* agg. In many cases neither category is a satisfactory coding because, on dunes in this region, *Galium saxatile* is usually absent from U20 stands and *Rubus fruticosus* agg. from W25. However, the invasion of bracken into dune habitats generally creates a ranker sward which has fewer species than adjacent conditions and can be considered a threat to overall diversity. The total extent of U20 and W25 vegetation excluding intermediates is 16.8 ha and this probably represents ground fully covered in bracken (0.15% of potential vegetated area, 11566 ha). In addition there are intermediates with other vegetation types (MG1/W25, MG1a/W25, MG1b/W25, MG1e/W25, SD9a/W25, SD12/U20, SD12z/W25) which represent partial invasion by bracken and these total 11.3 ha. Bracken influence therefore extends to 28.1 ha of dune on the East Coast, 0.24% of potential vegetated area. Four sites have a large extent of bracken and bracken intermediates and at these locations bracken is likely to reduce interest in the long term: Tyninghame Shore (11.7 ha), Elie East Links to Earlsferry Links (5.9 ha), Tentsmuir (4.0 ha) and St Cyrus (2.4 ha). Overall, there is only a local bracken problem on blown sand habitats on the East Coast.

Scrub on sand dunes of the East Coast (Tables 2.42, 2.43. 2.44)

Scrub types are covered by BSCRUB scrub birch, OSCRUB (non-NVC scrub types, including cases dominated by *Rosa* spp. and exotics such as *Cotoneaster* spp.), SD18 *Hippophae rhamnoides* dune scrub, W23 *Ulex europaeus* scrub and W24 *Rubus fruticosus* agg. - *Holcus lanatus* underscrub types.

BSCRUB is present and locally extensive in two sites, with a total area of 46.3 ha: Tentsmuir (35.8 ha) and Arbroath to Broughty Ferry (10.5 ha, all at Barry Links). Thick young birch has invaded slacks and some dry dunes at Tentsmuir and experimental attempts at control were made using a combination of hand clearance and goats. More recently cutting and Highland cattle have been used. The area data for Tentsmuir is based on an early NVC survey (Robertson, 1988) and is likely to be out of date - birch scrub expansion will have continued in some locations and control measures will have reduced cover elsewhere.

OSCRUB vegetation is rare, with a total area of 1.5 ha, mostly at Charleton & Kinnaber Links to Montrose (0.3 ha), Aberlady Point to Milsey Bay (0.3 ha) and Arbroath to Broughty Ferry (0.3 ha).

Hippophae rhamnoides is a nationally scarce species but only in south-eastern England. It has been introduced in large quantity to parts of this region, particularly since the 1960s at the Aberlady Point to Milsey Bay site as part of measures to stabilise great erosion and control visitor numbers. Total extent on the East Coast is 77.3 ha, mapped as just the SD18 *Hippophae rhamnoides* community (8.3 ha), the SD18a *Festuca rubra* sub-community (14.5 ha) and the SD18b *Urtica dioica - Arrhenatherum elatius* sub-community (54.6 ha). This scrub type is concentrated at Aberlady Point to Milsey Bay (50.0 ha), Tyninghame Shore (10.3 ha), Arbroath to Broughty Ferry (6.7 ha), Port Seton to Craigielaw (5.9 ha) and Tentsmuir (2.6 ha). Trivial quantities are also present at Seacliff, Largo Bay, Quarrel Sand to Tantallon Castle, and Newburgh to Bridge of Don. A further 1.8 ha is mapped as intermediates, suggesting early stages of SD18 invasion: SD5c/SD18a (0.4 ha at Port Seton to Craigielaw), SD7a/SD18a (0.9 ha at Tyninghame Shore, 0.1 ha at Aberlady Point to Milsey Bay) and SD9a/SD18a (0.4 ha at Tyninghame Shore). These figures suggest a vegetation type which is becoming slowly invasive in a limited number of sites, particularly in East Lothian (Aberlady Point to Milsey Bay, Tyninghame Shore, Port Seton to Craigielaw). Control measures are already practised and areas of recently cut *Hippophae rhamnoides* were noted in several localities. In terms of total area, SD18 extent is almost three times that of bracken types and can be considered a local threat to other dune vegetation types. Its extent should therefore be monitored and selective control exercised, accepting that it does have a useful role to play in channelling visitors to the shore and providing food and shelter for considerable numbers of passerine birds. Quadrat data (Tables 2.42, 2.43) from existing surveys show SD18 vegetation close to the NVC descriptions, apart from a lack of *Arrhenatherum elatius* in SD18b samples. The SD18a samples suggest SD18 invading SD7c semi-fixed dune and some SD9 vegetation. The current two sub-communities do not properly cover the structural and species variation in this scrub type, particularly old stands on dry ground which often contain much *Sambucus nigra* (a feature of some parts of the East Lothian coast) and mature stands on the edges of slacks which are mixed with willow (a feature of some SD18 vegetation at Barry Links, where a structure similar to continental *Hippophae rhamnoides* scrub has evolved since the shrub was introduced). There are not sufficient quadrat data to support these views in Scotland at present but in the longer term a UK revision of this category will probably be needed.

W23 *Ulex europaeus - Rubus fruticosus* agg. scrub is locally extensive, reflecting the extent of acidic sands in this region and its widespread use as scrub rough on links golf courses. Total extent is 194.0 ha, divided between the undifferentiated W23 community (168.0 ha), W23a *Anthoxanthum odoratum* sub-community, (0.03 ha), W23b *Rumex acetosella* sub-community (0.2 ha) and a provisional new W23x *Cytisus scoparius* sub-community (25.8 ha). Undifferentiated W23 scrub is extensive or locally common (>2.5 ha) at Newburgh to Bridge of Don (63.6 ha), Arbroath to Broughty Ferry (31.3 ha), South Eden Estuary to St Andrews (21.2 ha), Tentsmuir (16.9 ha), Charleton & Kinnaber Links to Montrose (15.2 ha), Cruden Bay (6.6 ha), St Cyrus (4.8 ha) and Aberdeen (2.8 ha). Apart from St Cyrus, the bulk of W23 distribution in these sites is associated with golf courses where most is subject to occasional management and it is not an important invasive threat. However, it does seem to be expanding locally at St Cyrus. The W23x provisional sub-community has a distribution similar to undifferentiated W23, with large extents (>2.5 ha) at Arbroath to Broughty Ferry (10.7 ha), Charleton & Kinnaber Links to Montrose (6.4 ha) and Tentsmuir (6.0 ha). Quadrat data (Table 2.44) are close to the W23 community but *Cytisus scoparius* is a class V constant and the high frequency for acidic grassland species suggests that it is characteristic of early succession conditions in scrub development.

Small quantities of other scrub are mapped for this region. The W21 *Crataegus monogyna - Hedera helix* community has a total area of 1.1 ha and is present at Coldingham Bay (0.6 ha), Arbroath to Broughty Ferry (0.3 ha) and Tyninghame Shore (0.2 ha). The W22 *Prunus spinosa - Pteridium aquilinum* community has a total area of 0.7 ha and is mapped at Coldingham Bay (0.5 ha) and Port Seton to Craigielaw (0.3 ha). The W24 *Rubus fruticosus* agg. - *Holcus lanatus* bramble scrub community has a total extent of 0.3 ha, mostly at Silversand Bay (0.1 ha), Port Seton to Craigielaw (0.1 ha) and Largo Bay (0.1 ha). It does not seem to pose an invasive threat to other dune habitats.

Woodland on sand dunes of the East Coast (Table 2.45)

A range of woodland types is mapped on blown sand in this region, with a total area of 85.9 ha, most of it located at Tentsmuir (44.6 ha) and Arbroath to Broughty Ferry (39.0 ha). W1 *Salix cinerea - Galium palustre* woodland is mapped at Tentsmuir (17.6 ha), Arbroath to Broughty Ferry (5.2 ha) and Newburgh to Bridge of Don (1.2 ha). This type invades mature slacks and is a rare example of wet woodland developed on dunes.

A second type of wet woodland is represented by the W6 *Alnus glutinosa - Urtica dioica* community, with a total mapped area of 6.6 ha at Tentsmuir (4.4 ha), Arbroath to Broughty Ferry (1.1 ha) and Charleton & Kinnaber Links to Montrose (1.1 ha). This is also an invader of dune slacks but is of low extent. Given the rarity of wet woodland on dunes in Scotland it would be best to maintain and perhaps increase the current stock. Harmonising at Tentsmuir in 1999 suggested that a large proportion of that mapped by Robertson (1988) had been felled as part of scrub control.

Semi-mature and mature birch woodland, perhaps classified as W11 *Quercus petraea - Betula pubescens - Oxalis acetosella* woodland, is mapped at Barry Links (32.6 ha within the Arbroath to Broughty Ferry site). This is the source of seed for BSCRUB vegetation which is concentrated around the edges of the more mature W11 vegetation. Quadrat data are lacking for this habitat and the precise status of this vegetation is uncertain.

A very small area (0.03 ha) of W15 *Fagus sylvatica - Deschampsia flexuosa* woodland is recorded at Tentsmuir by Robertson (1988) but this is likely to be the result of planting. No quadrat data are available and it is an insignificant element of the regional dune woodland resource.

Dry ground in self-seeded patches of pine woodland at Tentsmuir are classified as W18 *Pinus sylvestris - Hylocomium splendens* woodland (22.5 ha) by Robertson (1988) and 1999 samples from within coniferous plantation belong to the W18a *Erica cinerea - Goodyera repens* sub-community (Table 2.45). The full extent of this type is uncertain because time was not available to search every compartment at Tentsmuir for this vegetation. It is significant and, like stands in several Moray Firth locations, demonstrates that good-quality dune woodland very close to NVC types is achievable within coniferous plantations.

2.18 Beach above MHWS (BBS, BSH)

Total extent (306.8 ha, 2.6% of potential vegetated area, 11566 ha) was mapped as bare beach sand (BBS, 281.6 ha) and bare shingle (BSH, 25.0 ha), with large extents recorded for sites with a long coastal frontage (Map 2.18). Eight sites have beach areas >10 ha: Newburgh to Bridge of Don (47.3 ha), Arbroath to Broughty Ferry (41.3 ha), Tentsmuir (37.7 ha), Inverallochy to Peterhead (37.6 ha), Aberlady Point to Milsey Bay (17.4 ha), Sands of Forvie (14.7 ha), Tyninghame Shore (14.1 ha) and Charleton & Kinnaber Links to Montrose (13.9 ha).

Table 2.42 SD18a *Hippophae rhamnoides* scrub, *Festuca rubra* sub-community

	Constancy	Domin range
Hippophae rhamnoides	V	7-9
Festuca rubra	V	3-8
Ammophila arenaria	IV	2-6
Bellis perennis	IV	1-4
Hypochoeris radicata	IV	3-4
Lotus corniculatus	IV	2-3
Senecio jacobaea	IV	1-2
Taraxacum seedling/sp.	IV	3-4
Holcus lanatus	III	3-5
Ononis repens	III	2-4
Brachythecium rutabulum	III	1-3
Cirsium arvense	II	1-3
Plantago lanceolata	II	1-2
Rhytidiadelphus squarrosus	II	1-7
Arrhenatherum elatius	I	1
Carex arenaria	I	8
Cerastium fontanum triviale	I	2
Epilobium angustifolium	I	3
Dactylis glomerata	I	2
Dryopteris dilatata	I	4
Echium vulgare	I	1
Fragaria vesca	I	1
Galium verum	I	3
Moehringia trinervia	I	2
Hieracium pilosella group	I	1
Poa pratensis	I	3
Sonchus asper	I	2
Tussilago farfara	I	4
Urtica dioica	I	1
Brachythecium albicans	I	3
Species per quadrat 10.86 (based on 7 quadrats)		

Table 2.43 SD18b *Hippophae rhamnoides* scrub, *Urtica dioica - Arrhenatherum elatius* sub-community

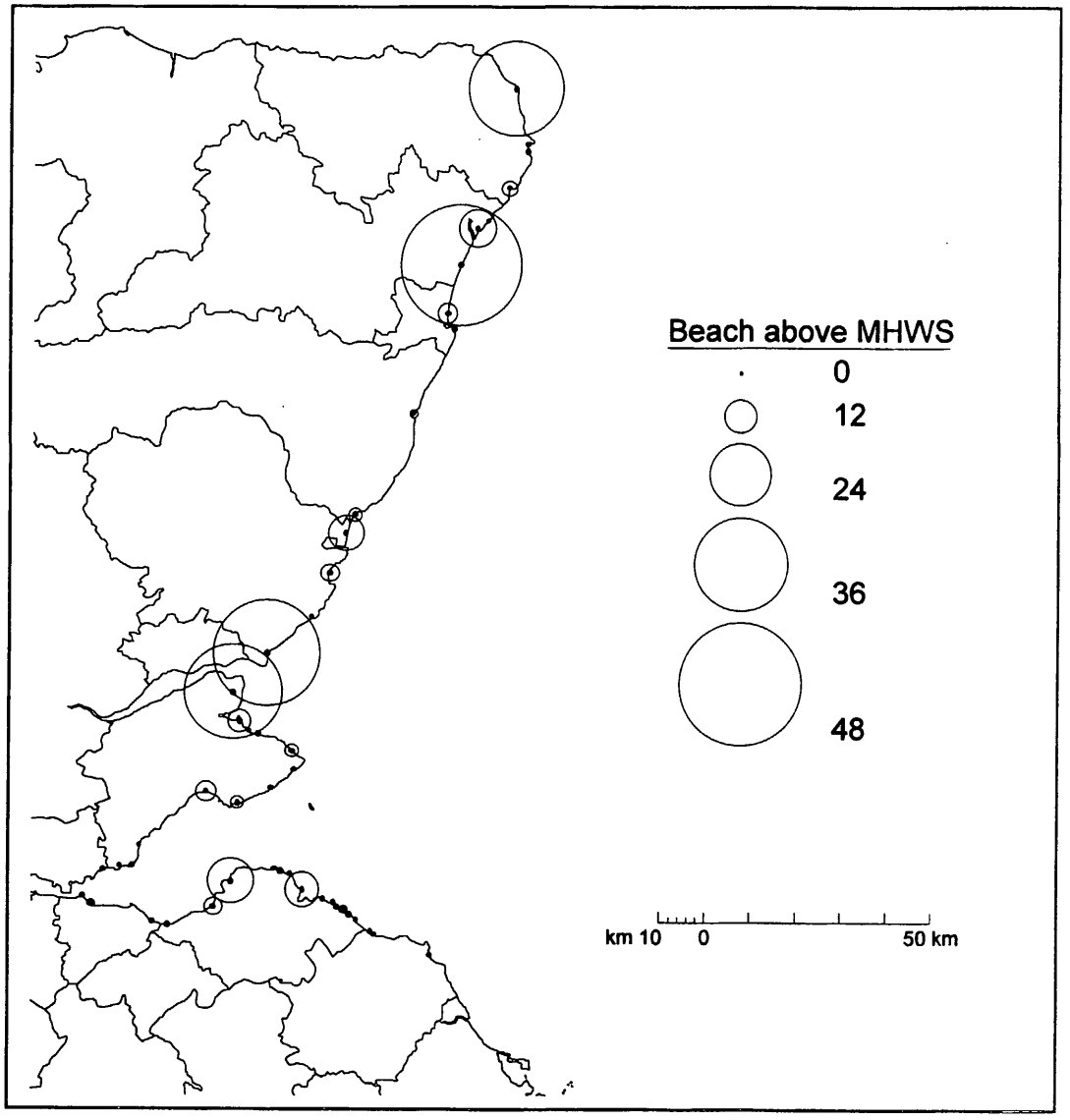
	Constancy	Domin range
Hippophae rhamnoides	V	7-9
Urtica dioica	V	3-9
Galium aparine	V	3-5
Holcus lanatus	IV	2-5
Montia perfoliata	III	5-8
Stellaria media	III	2-4
Dactylis glomerata	III	1-3
Cirsium arvense	II	1-3
Festuca rubra	II	1-2
Glechoma hederacea	II	2-3
Sambucus nigra	II	5-6
Brachythecium rutabulum	II	3-4
Agrostis capillaris	I	4
Anthriscus caucalis	I	2
Bryonia cretica dioica	I	3
Cerastium fontanum triviale	I	1
Senecio jacobaea	I	1
Taraxacum seedling/sp.	I	1
Species per quadrat 7.43 (based on 7 quadrats)		

Table 2.44 W23x *Ulex europaeus - Rubus fruticosus* agg. scrub, provisional *Cytisus scoparius* sub-community

	Constancy	Domin range
Ulex europaeus	4 - 7	IV
Rubus fruticosus agg.	4 - 5	II
Cytisus scoparius	5 - 8	V
Arrhenatherum elatius	3 - 5	IV
Holcus lanatus	4 -5	IV
Agrostis capillaris	4	III
Dactylis glomerata	4	II
Eurynchium praelongum	3	II
Festuca rubra	2 - 4	II
Rumex acetosella	2	II
Ammophila arenaria	4	I
Calluna vulgaris	1	I
Elymus repens	4	I
Urtica dioica	5	I
Viola riviniana	2	I
Species per quadrat 7.0 (based on 5 quadrats)		

Table 2.45 W18 *Pinus sylvestris* - *Hylocomium splendens* conifer plantation

	Constancy	Domin range
Pinus sylvestris	IV	5-8
Hylocomium splendens	II	4
Goodyera repens	V	2-3
Erica cinerea	III	3-4
Carex arenaria	V	2-4
Festuca ovina	V	2-4
Pleurozium schreberi	V	7-10
Deschampsia flexuosa	IV	2-4
Dryopteris dilatata	IV	1-5
Galium saxatile	IV	2-4
Pinus nigra	IV	4-8
Anthoxanthum odoratum	III	2
Calluna vulgaris	III	1-4
Dicranum majus	III	2-4
Plagiothecium undulatum	III	4
Chamerion angustifolium	II	1-2
Luzula multiflora	II	3-4
Agrostis capillaris	I	4
Betula pubescens	I	1
Carex pilulifera	I	2
Erica tetralix	I	1
Hypnum jutlandicum	I	4
Hypochoeris radicata	I	2
Luzula pilosa	I	2
Rhytidiadelphus triquetrus	I	7
Species per quadrat 13.2 (based on 5 quadrats)		



Map 2.18 Beach area (ha) above MHWS in East Coast sites

2.19 Bare sand (BS)

Beach sand (BBS) was separated from bare sand (BS) occurring within the main area of vegetated dune to obtain an indirect measure of the combined extent of blowouts, large deflation sheets and sand bared by rabbit activity around burrows. Total extent (201.7 ha, Map 2.19a, 1.7% of potential vegetated area) shows the largest areas (>5 ha) at Newburgh to Bridge of Don (79.5 ha), Inverallochy to Peterhead (58.3 ha), Sands of Forvie (26.3 ha), Tyninghame Shore (13.4 ha) and South Eden Estuary to St Andrews Links (6.4 ha). This site list correctly identifies the three first assemblages as areas with large deflation sheets and active blowouts. The bare sand extent at Tyninghame Shore is anomalous and occurs on ground used for raising pigs, a major feature of agriculture in the north of this site. The high extent at South Eden Estuary to St Andrews is a mix of bare sand created by pigs (in the west of the site) and ground bared by visitor trampling and blowouts along the exposed eastern side of the site. For the majority of sites the general position is one of stability, with little evidence of severe internal erosion. However, the ranking pattern using simple BS area is strongly controlled by site size and fails to identify clearly sites with a high proportion of blown sand. When bare sand is expressed as a percentage of potential vegetated sand area (Map 2.19b) the following sites have >2.5% blown sand: Newburgh to Bridge of Don (7.3%), Inverallochy to Peterhead (4.6%), Tyninghame Shore (3.3%), Peatdraught Bay (3.2%), St Cyrus (3.0%) and Sands of Forvie (3.0%).

This list identifies sites with a variety of causes of erosion. Natural deflation is very active in large blowout complexes at Newburgh to Bridge of Don and Inverallochy to Peterhead. The extent of bare sand in blowouts to the north and south of Rattray Head (Inverallochy to Peterhead) might also be partly due to quadbike damage which is a particular feature of this stretch of coast. Pig damage is the main cause of bare sand at Tyninghame Shore and this is controlled by regular reseeding with improved grassland swards. An eroding shoreline and high exposure at Hound Point in the Firth of Forth, creating small blowouts, combine to produce bare sand at Peatdraught Bay. A recent breach of the dunes at St Cyrus has left bare sand sheets undergoing rapid succession and this is by main explanation of bare sand area in this site. The large extent at Sands of Forvie is due to natural deflation activity, especially in the south of the site at the mouth of the River Ythan where near-permanent sand sheets are present on a large shingle spit.

2.20 Arable and fallow land (Arable crops, MG1F, SD8F, SD12F)

Total arable extent is high, with 1138.6 ha total extent (9.8% of potential vegetated area, 11566 ha), with large totals (>50 ha) at Tentsmuir (643.7 ha), Newburgh to Bridge of Don (91.3 ha), Tyninghame Shore (85.7 ha), Sands of Forvie (73.2 ha), South Eden Estuary to St Andrews (70.2 ha) and Arbroath to Broughty Ferry (62.6 ha) (Map 2.20). Barley (770 ha) is by far the major crop on blown sand but a wide range of additional types is cultivated (carrots, field beans, oats, oilseed rape, peas, potatoes, wheat, turnips) Land left fallow after cultivation is very rare (4.2 ha at Arbroath to Broughty Ferry, Map 2.21), with small amounts of SD8F and an MG1F/SD8F intermediate.

2.21 Improved grassland (MG6, MG7) (Table 2.46)

Grassland improvement for pasture (MG6 *Lolium perenne - Cynosurus cristatus* neutral grassland), pasture/silage (MG7 *Lolium perenne* ley), especially recreation (MG7M, mainly golf course greens, fairways and tees) is extensive upon dunes on the East Coast (Map 2.21a), with a total area of 2021.2 ha (17.5% of potential vegetated area) for MG6 and MG7 types, including intermediates. MG6 improved grassland excluding intermediates totals 100.1 ha, with large extents (>10 ha) only at Inverallochy to Peterhead (41.7 ha), largo Bay (29.2 ha) and Arbroath to Broughty Ferry (13.8 ha). MG7 improved grassland excluding intermediates totals 834.9 ha. Large extents (>50 ha) occur at Inverallochy to Peterhead (197.4 ha), Newburgh to Bridge of Don (183.1 ha), Tentsmuir (119.7 ha), Sands of Forvie (94.9 ha) and Largo Bay (69.9 ha). A further 973.2 ha is mown as amenity grassland (MG7M, principally on golf course), with the largest extents (>50 ha) at Arbroath to Broughty Ferry (213.7 ha covering mainly golf courses at Arbroath, Carnoustie and Monifieth), Aberlady Point to Milsey Bay (155.3 ha of golf course at Luffness Links, Gullane Links, Muirfield, and North Berwick), South Eden Estuary to St Andrews (134.1 ha, covering the St Andrews golf courses), Aberdeen (86.8 ha, covering Aberdeen City courses), Charleton & Kinnaber Links to Montrose (51.0 ha, covering courses at Montrose) and Largo Bay (50.3 ha, covering courses at Lundin Links.

Most of this improvement has probably been at the expense of SD8 and SD12 dune grassland, plus some dune heath (H11) and scrub (mainly W23 gorse and broom). These habitat losses are probably not recent,

since both agriculture and golf courses are long-established in this region. The extent of improvement is disguised in Map 2.21a by the great variation in site size and the proportion of improvement (Map 2.21b) shows that it has had a major impact on many sites, including many smaller dune systems. This second map is based on expressing the total of MG6, MG6 intermediates, MG7 and MG7 intermediates as a percentage of potential vegetated sand area, i.e. degree of improvement and semi-improvement. It shows that many sites have a third of their area as improved or semi-improved pasture, or as golf course and other amenity grassland. This scale of improvement is concentrated in the south of the region in Fife and East Lothian. Few quadrats were collected for MG6 or MG7 swards but they are likely to be similar in composition to NVC descriptions (Rodwell 1991 *et seq.*). Quadrat data (Table 2.46) are available for MG7M fairways at Gullane Links and show swards dominated by Chewing's fescue *Festuca rubra commutata* (Tidswell, 1998).

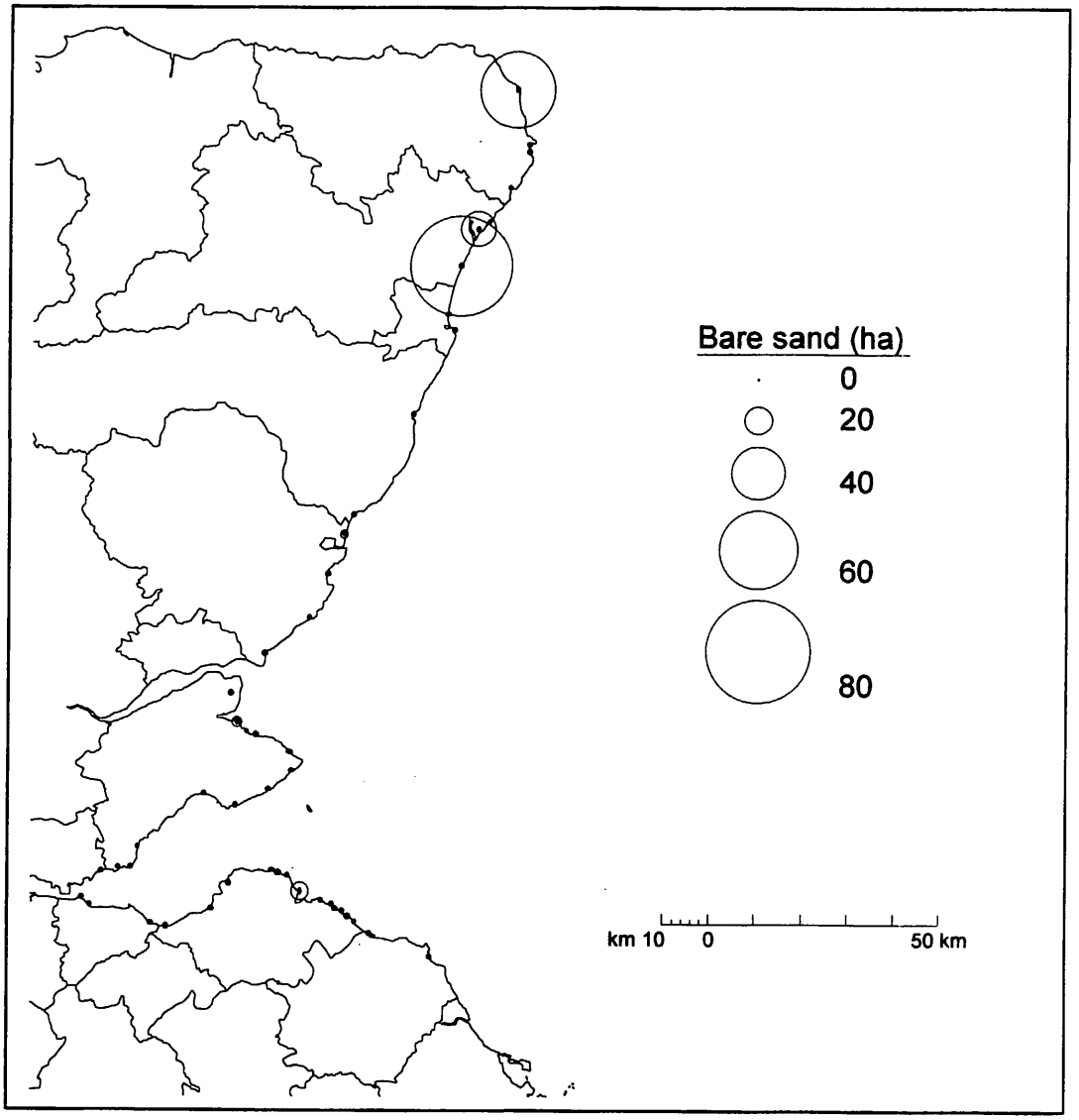
2.22 Other anthropogenic habitat (AIRFIELD, BBG, CMTY, CP, DP, MP, PIT, QUARRY, RAILWAY, ROAD, TIP, WALL) (Tables 2.47, 2.48)

This aggregate contains a miscellany of diverse anthropogenic habitats and has a total area of 2974.0 ha (25.7% of blown sand area, 11566 ha). The component types represent various forms of land take, most of which involve a loss of natural or semi-natural habitat. Most too have little nature conservation interest, although some types of plantation in some sites do hold species and habitat conditions of great importance, particularly coniferous plantation at Tentsmuir. This has been discussed in Section 2.17 and is raised again here. The major component of this habitat group is coniferous plantation (CP, 1616.5 ha) and one site (Tentsmuir) dominates the pattern of distribution (Map 2.22).

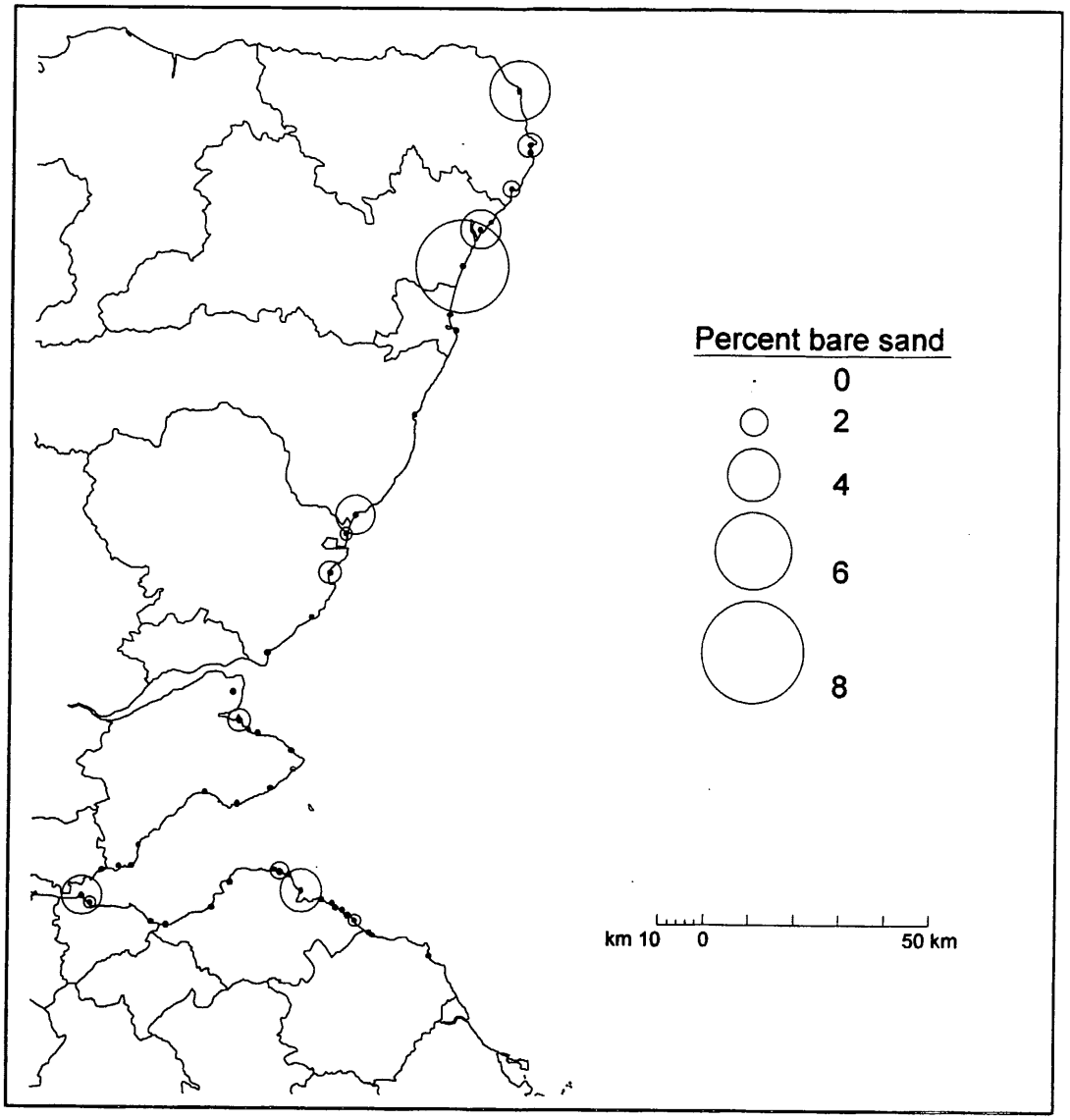
A large airfield (AIRFIELD) at RAF Leuchars overlaps blown sand and surfaced runway, taxiing routes and surfaced standing occupies 35.4 ha within the Tentsmuir site. Buildings, gardens and bare ground within farms, residential areas and industrial estates was mapped as BBG (678.0 ha), mainly concentrated in the south of the region around some of the largest settlements in Scotland. Cemeteries (CMTY, 0.7 ha) are scattered in a few dune sites. Railway track (RAILWAY, 48.4 ha) is common on some dune systems, particularly Arbroath to Broughty Ferry which carries the main line to Aberdeen. This site also has military target railways included in this total. Roads and tracks (ROAD) are common on dunes and total area is 396.10 ha. The largest concentrations are in forestry plantations and these combine with plantation area to reinforce the dominance of forestry operations within this habitat aggregate.

Active sand pits (PIT, total area 1.2 ha) are rare and small. common but are generally very small and have only a very localised impact on dune habitats. An old stone quarry (QUARRY, 0.7 ha) is present at Aberlady Bay. Rubbish tips (TIP, 6.2 ha) are uncommon in this region, although large landfill areas have been developed close to Aberdeen in the Newburgh to Bridge of Don site. Seawall (WALL, total area 23.6 ha) is common, protecting property and some golf courses. The largest example runs along most of the eastern side of Barry Links, primarily to protect military target practice areas which are close to the coastal edge. A riprap barrier here extends from above high water to low water spring tide levels and this armour has stopped this shore contributing to local sediment budgets.

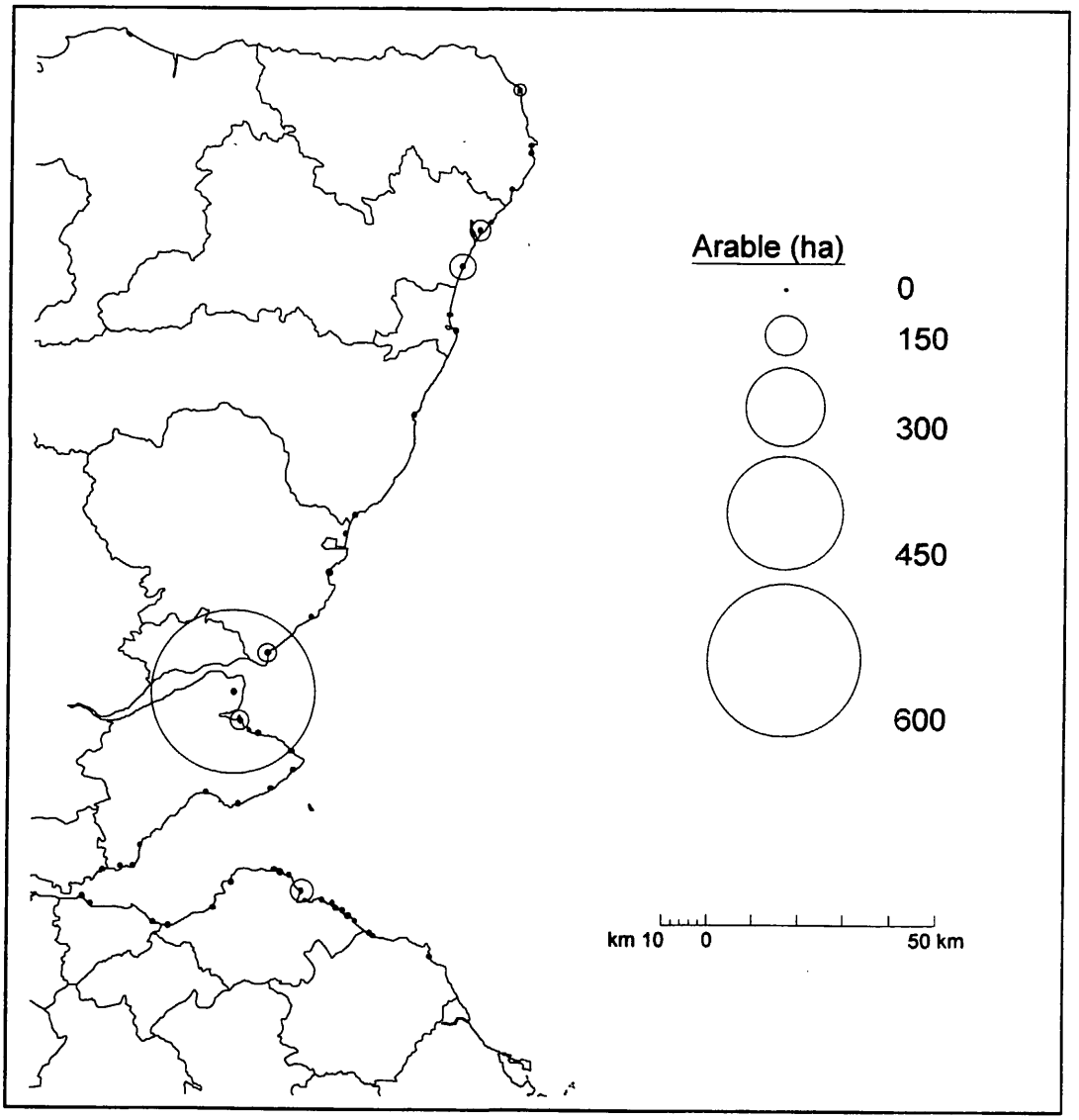
The bulk of this miscellaneous grouping of anthropogenic land covers is made of coniferous plantation (CP, 1616.5 ha), deciduous plantation (DP, 43.7 ha), and mixed plantations (MP, 123.6 ha). Natural tree cover on Scottish dunes is almost absent and is the result of a very long history of grazing, perhaps following clearance of woodland which might have established on dunes in earlier times. Plantations were first established on a commercial scale on East Coast dunes in the nineteenth century, and most effort has been placed at Tentsmuir. Most dune soils can support reasonable timber yields from a limited range of commercial tree species. As with most commercial conifer plantations, there is little nature conservation interest in the early decades and ground layer vegetation can only develop in quantity following thinning. Thereafter, interesting species and vegetation types can develop and vegetation equivalent to W18 *Pinus sylvestris - Hylocomium splendens* pine woodland can developing (including the W18a *Erica cinerea - Goodyera repens* sub-community, see Tables 2.45 and 2.47). Given this build up of interest over several decades, plantations cannot be dismissed simply as anthropogenic habitat of no nature conservation value. Their scale on the East Coast is even larger than the traditional arable cultivation and agricultural fallows on machair in the Western Isles. The latter habitats are recognised as essential to the economic survival of local communities as well as maintaining considerable ecological interest. This should also be the case for plantations and nature conservation interest is integrated into management planning at Tentsmuir. Forested dunes at Tentsmuir are also extremely important for recreation, with a large and very popular car parking area developed at Kinshaldy. In the long term such plantations offer the prospect of near-natural dune woodland, with considerable recreational and nature conservation benefits in addition to commercial timber.



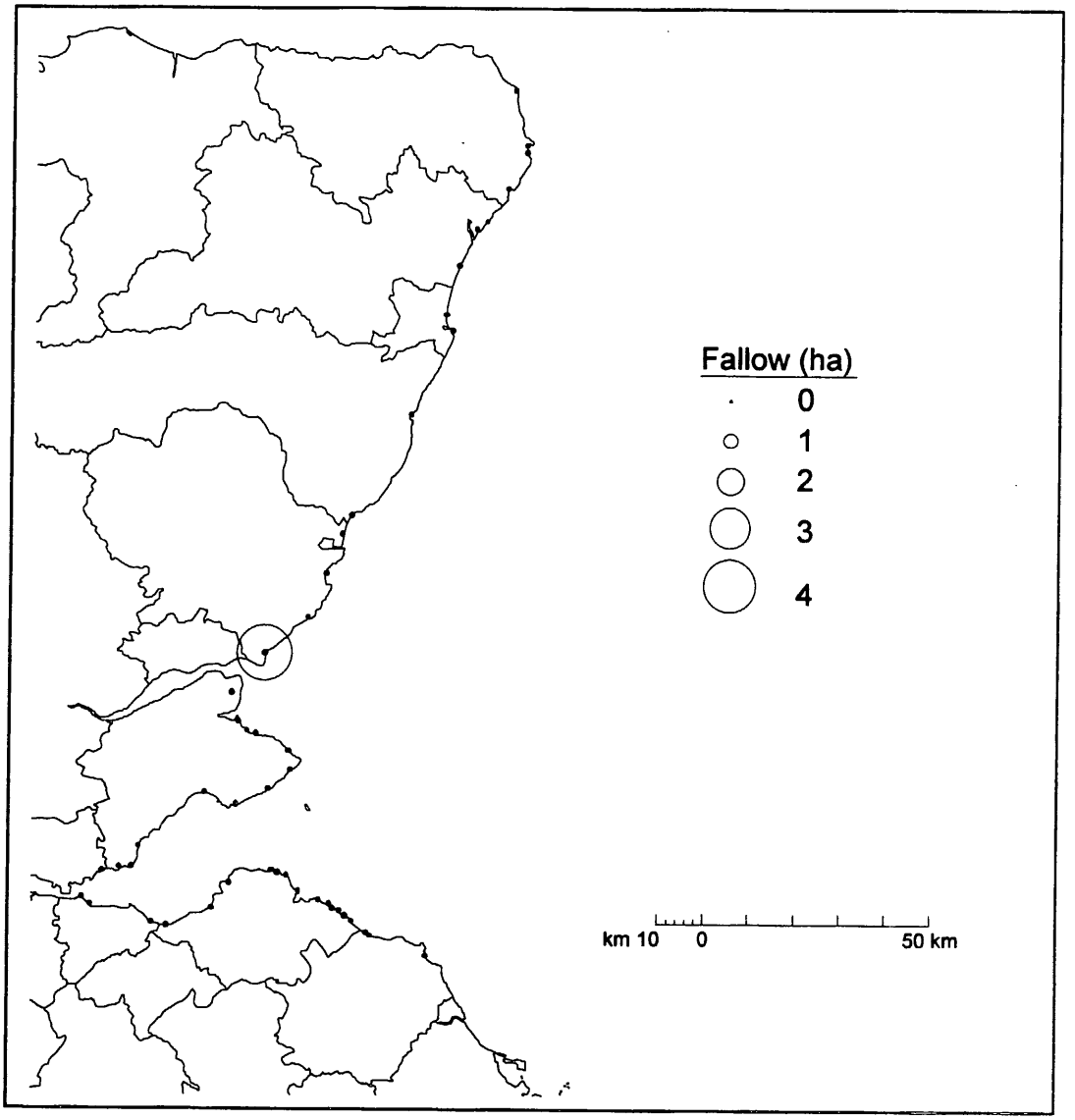
Map 2.19a Bare sand (ha) in East Coast sites



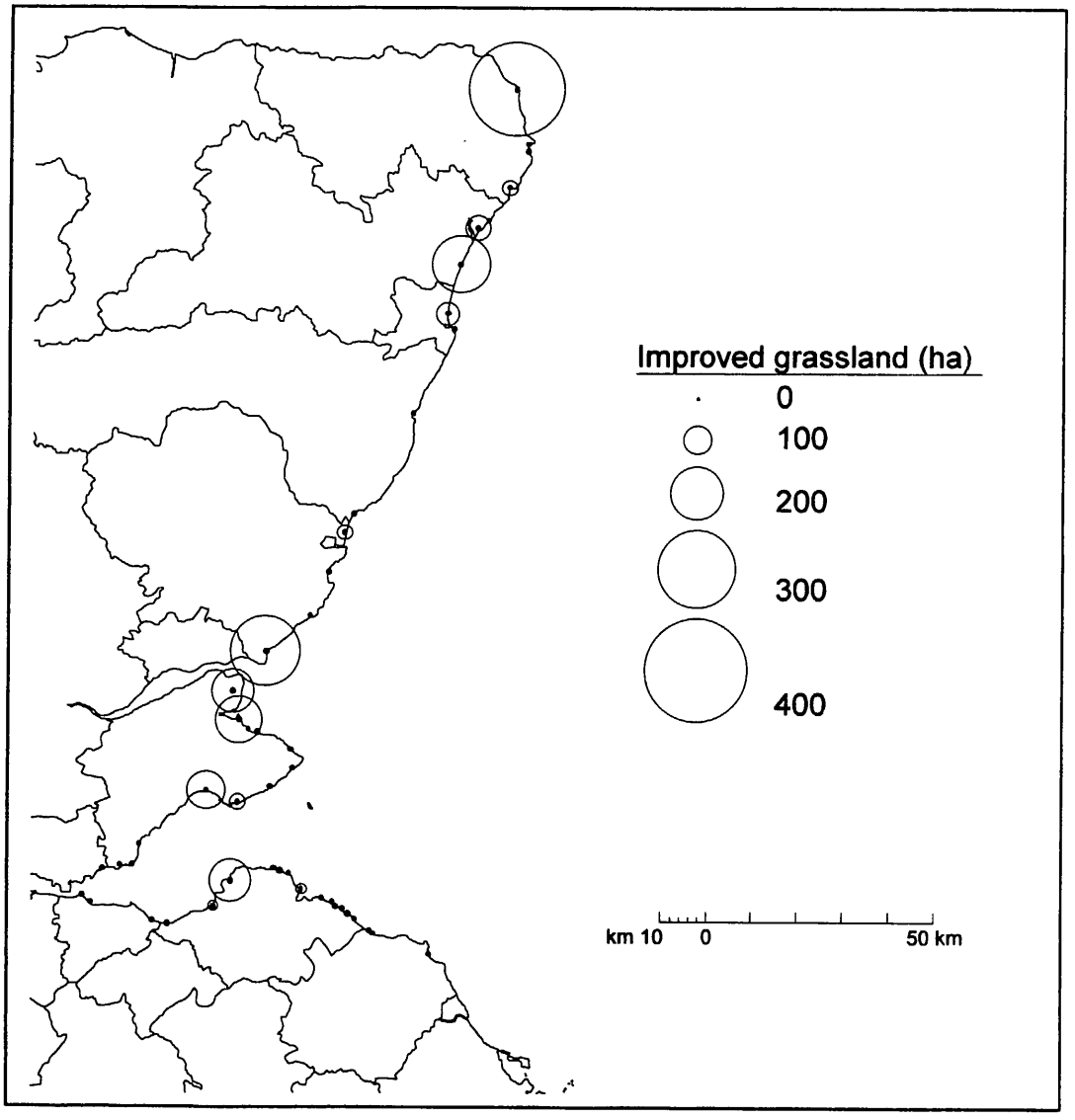
Map 2.19b Bare sand as percentage of site area on East Coast



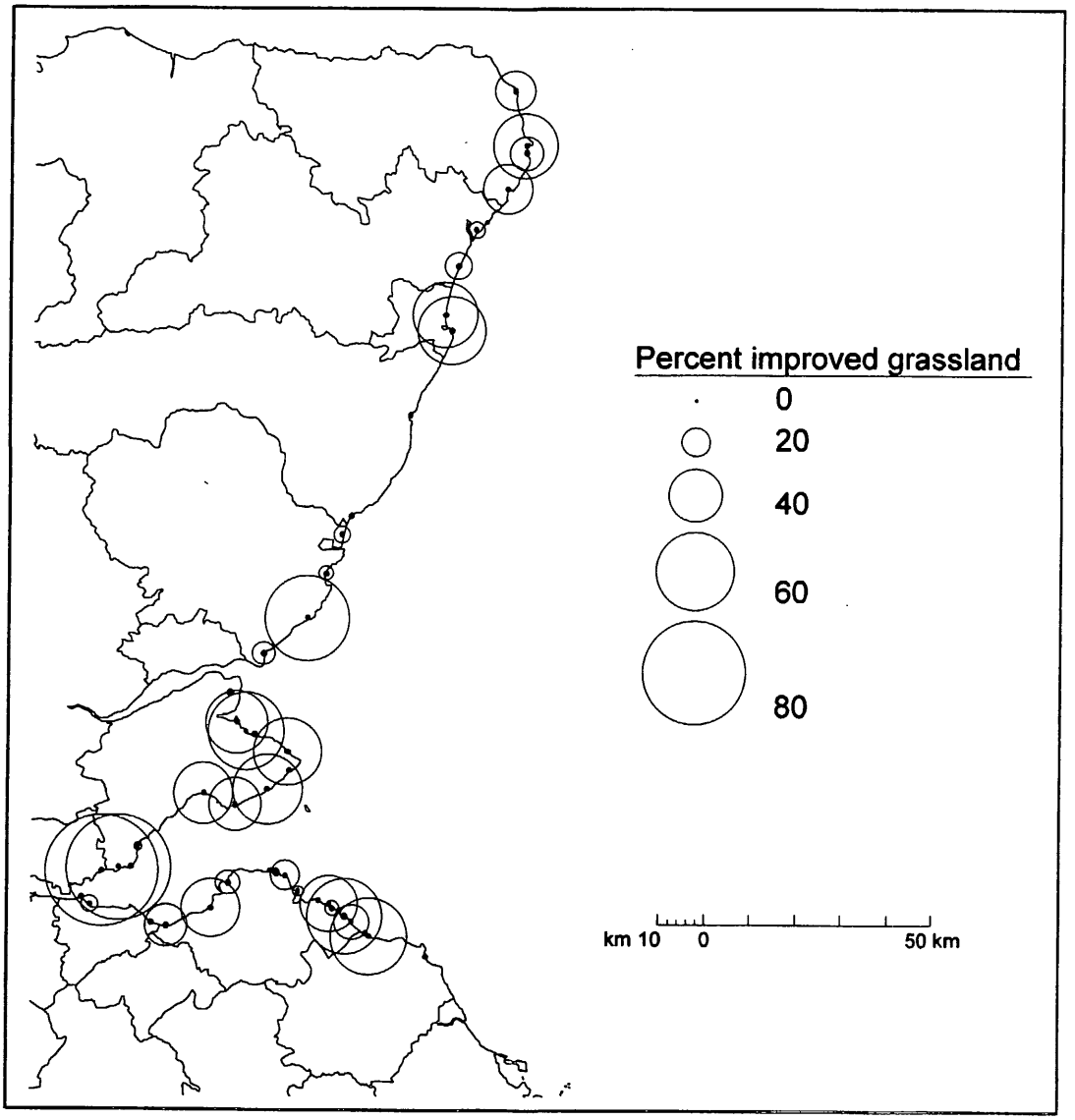
Map 2.20a Arable land (ha) in East Coast sites



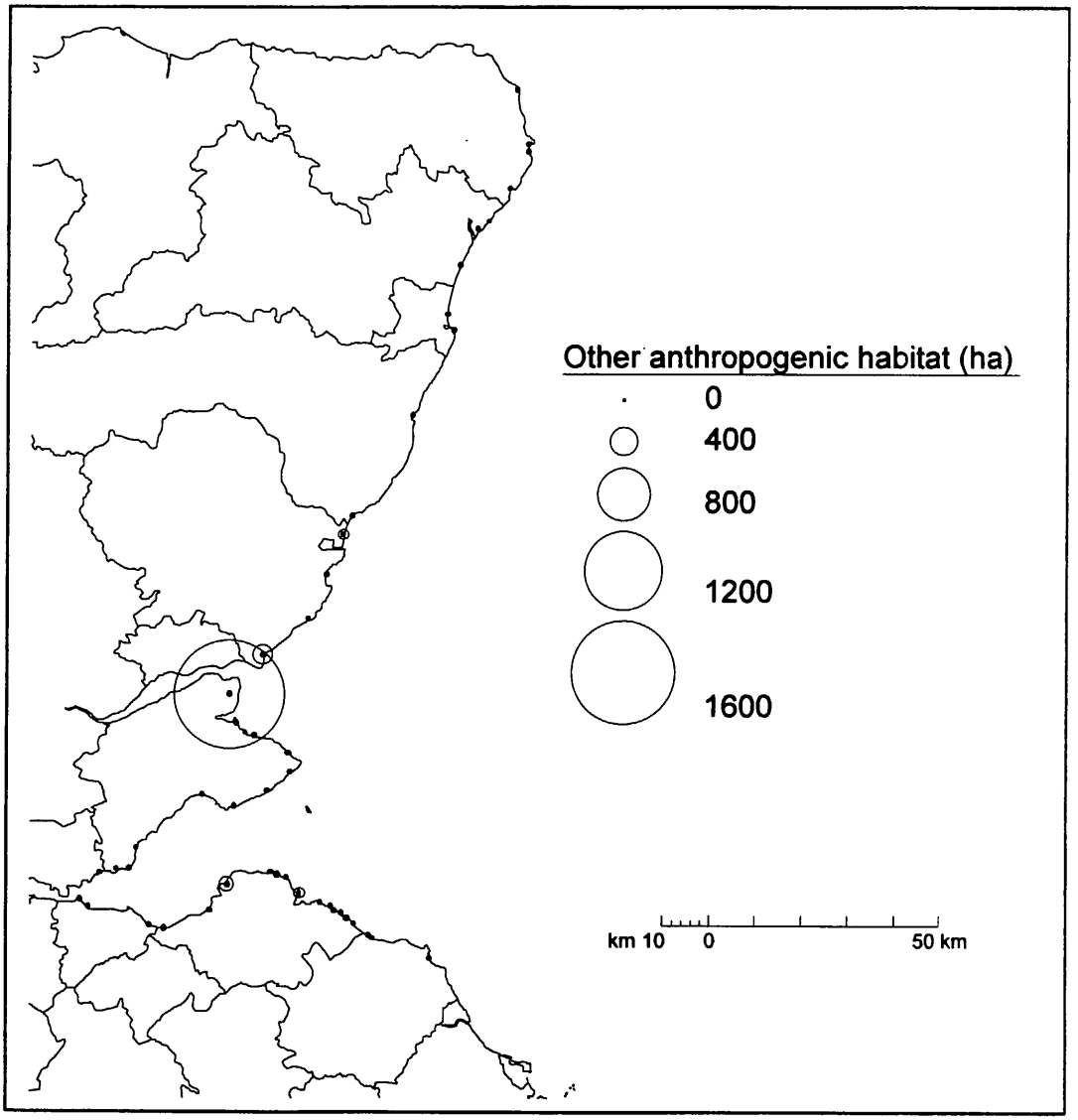
Map 2.20b Fallow land (ha) in East Coast sites



Map 2.21a Improved grassland (ha) in East Coast sites



Map 2.21b Improved grassland as percentage of site area



Map 2.22 Other anthropogenic habitat (ha) in East Coast sites

Table 2.46 MG7M *Lolium perenne* - mown golf course fairways (amenity grassland)

	Constancy	Domin range
Lolium perenne	I	5-8
Festuca rubra commutata	V	3-10
Agrostis capillaris	IV	3-7
Achillea millefolium	III	3-5
Poa pratensis	III	2-6
Bellis perennis	III	2-4
Trifolium repens	III	2-4
Koeleria macrantha	II	2-5
Luzula campestris	II	1-3
Festuca pratensis	II	2-3
Holcus lanatus	II	2-4
Carex arenaria	I	1-3
Galium verum	I	3-4
Poa annua	I	2-4
Veronica chamaedrys	I	2-4
Rhytidiadelphus squarrosus	I	2-4
Briza media	I	3
Campanula rotundifolia	I	2
Cerastium fontanum triviale	I	2
Plantago lanceolata	I	2-4
Carex caryophyllea	I	5
Carex hirta	I	3
Equisetum arvense	I	1
Gentianella amarella	I	1
Linum catharticum	I	3
Lotus corniculatus	I	1
Ranunculus repens	I	2
Selaginella selaginoides	I	3
Calliergon cuspidatum	I	2
Pseudoscleropodium purum	I	4
Tortula ruralis ssp. *ruraliformis*	I	3
Taraxacum seedling/sp.	I	1
Species per quadrat 7.73 (based on 15 quadrats)		

Table 2.47 Conifer plantation

	Constancy	Domin range
Pinus sylvestris (c)	IV	6-9
Pinus contorta (c)	II	8-9
Betula pendula (c)	II	2-7
Festuca ovina	V	1-5
Carex arenaria	V	5-7
Dicranum scoparium	V	2-5
Pleurozium schreberi	V	2-9
Lophocolea bidentata	IV	1-4
Hypnum jutlandicum	IV	2-4
Agrostis canina	III	4-6
Anthoxanthum odoratum	III	2-6
Galium saxatile	III	2-3
Hylocomium splendens	III	3-5
Epilobium angustifolium	II	3-6
Hieracium pilosella group	II	1-2
Viola canina	II	1
Rhytidiadelphus squarrosus	II	4
Rhytidiadelphus triquetrus	II	2-3
Cladonia arbuscula	II	3-4
Hypogymnia physodes	II	2-3
Agrostis capillaris	I	2
Dryopteris dilatata	I	3
Erica cinerea	I	6
Galium verum	I	1
Hypochoeris radicata	I	2
Poa pratensis	I	3
Potentilla erecta	I	2
Senecio jacobaea	I	1
Veronica officinalis	I	3
Eurhynchium praelongum	I	3
Hypnum cupressiforme	I	8
Pseudoscleropodium purum	I	2
Ptilidium ciliare	I	5
Species per quadrat 12.67 (based on 6 quadrats)		

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Annex 1 Areas (ha) of NVC and land cover types mapped on the East Coast

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
ACAR	Arable – carrots	8.71
AIRFIELD	Airfield runway, taxiing and apron surfaces	35.38
AP	Arable – potatoes	66.25
AR	Arable	99.33
ARAP	Arable – oilseed rape	48.30
ARB	Arable – barley	769.53
ARBEAN	Arable – field beans	9.61
ARO	Arable – oats	26.58
ARPEA	Arable – peas	4.11
ATUR	ATUR Arable - turnips	12.40
AWHEAT	Arable – wheat	93.82
BBG	Buildings, bare ground and gardens	677.98
BBS	Bare beach sand (above MHWS, below vegetated dune zone)	281.59
BIS	BIS Intertidal sand (no vegetation)	20.38
BMC	Maritime cliff with little vegetation	13.89
BR	Bare rock outcrop	0.72
BS	Bare sand (within vegetated sand zone)	201.78
BSCRUB	Birch scrub	46.27
BSH	Bare shingle	24.99
BURNT	Burnt ground, NVC type uncertain	7.63
CMTY	Graveyard	0.69
CP	Coniferous plantation	1616.47
DP	Deciduous woodland plantation	43.68
H11	H11 *Carex arenaria - Calluna vulgaris* heath	25.32
H11/M16x	Intermediate between H11/M16x	1.07
H11a	H11a *Carex arenaria - Calluna vulgaris* heath, *Erica cinerea* sub-community	24.65
H11a/SD12xy	Intermediate between H11a/SD12xy	3.45
H11a/U6b	Intermediate between H11a/U6b *Juncus squarrosus - Festuca ovina* grassland, *Carex nigra - Calypogeia trichomanis* sub-community	0.91
H11ab	H11a/b intermediate	13.44
H11b	H11b *Carex arenaria - Calluna vulgaris* heath, *Empetrum nigrum* sub-community	260.72
H11b/SD12	H11b/SD12 intermediate	2.80
H11b/U6d	Intermediate between H11b/U6d	1.95
H11bc	H11b/c intermediate	2.28
H11c	H11c *Carex arenaria - Calluna vulgaris* heath, Species-poor sub-community	13.45
H11c/SD12xy	Intermediate between H11c/SD12xy	0.01
H11M	H11M *Carex arenaria - Calluna vulgaris* heath, mown (mostly golf fairway)	1.33
M16/SD16	M16/SD16 intermediate	0.36
M16x	M16x *Erica tetralix - Sphagnum compactum* wet heath, Species-poor sub-community (PROVISIONAL NEW NVC TYPE)	144.16
M23	M23 *Juncus effusus/acutiflorus - Galium palustre* rush pasture	61.19
M23/MG9	M23/MG9 intermediate	1.06
M23/SD17	M23/SD17 intermediate	0.34
M23a	M23a *Juncus effusus/acutiflorus - Galium palustre* rush pasture, *J. acutiflorus* sub-community	0.32
M23ab	M23a/b intermediate	0.96

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
M23b	M23b *Juncus effusus/acutiflorus - Galium palustre* rush pasture, *J. effusus* sub-community	50.45
M23b/MG9	Intermediate between M23b/MG9	0.49
M23b/SD17	Intermediate between M23b/SD17	0.35
M25a	M25a *Molinia caerulea - Potentilla erecta* mire, *Erica tetralix* sub-community	0.77
M27	M27 *Filipendula ulmaria - Angelica sylvestris* tall-herb fen	11.36
M27/MG12	Intermediate between M27/MG12	0.99
M27/MG9	Intermediate between M27/MG9	3.36
M27/SD17	M27/SD17 intermediate	0.73
M27/SD17b	Intermediate between M27/SD17b	0.49
M27b	M27b *Filipendula ulmaria - Angelica sylvestris* tall-herb fen, *Urtica dioica - Vicia cracca* sub-community	18.46
M28	M28 *Iris pseudacorus - Filipendula ulmaria* mire	0.04
MC8	MC8 *Festuca rubra - Armeria maritima* maritime grassland	0.17
MC8/SD7	MC8/SD7 intermediate	1.02
MC8/SD8	MC8/SD8 intermediate	10.93
MC9	MC9 *Festuca rubra - Holcus lanatus* maritime grassland	2.89
MC9/SD4	Intermediate between MC9/SD4	0.10
MC9d	MC9d *Festuca rubra - Holcus lanatus* maritime grassland, *Primula vulgaris* sub-community	0.16
MG1	MG1 *Arrhenatherum elatius* coarse grassland	33.07
MG1/SD12	MG1/SD12 intermediate	11.02
MG1/SD12M	Intermediate between MG1/SD12, mown	77.16
MG1/SD12z	Intermediate between MG1/SD12z	5.90
MG1/SD5c	MG1/SD5c intermediate	0.64
MG1/SD8	MG1/SD8 intermediate	3.44
MG1/SD8a	MG1/SD8a intermediate	4.29
MG1/W25	MG1/W25 intermediate	0.83
MG1a	MG1a *Arrhenatherum elatius* coarse grassland, *Festuca rubra* sub-community	339.46
MG1a/MG7	Intermediate between MG1a/MG7	0.17
MG1a/SD5c	Intermediate between MG1a/SD5c	0.30
MG1a/SD8a	MG1a/SD8a intermediate	3.91
MG1a/W25	Intermediate between MG1a/W25	0.12
MG1ab	MG1a/b intermediate	14.04
MG1b	MG1b *Arrhenatherum elatius* coarse grassland, *Urtica dioica* sub-community	11.72
MG1b/W25	Intermediate between MG1b/W25	1.17
MG1c	MG1c *Arrhenatherum elatius* coarse grassland, *Filipendula ulmaria* sub-community	0.19
MG1d	MG1d *Arrhenatherum elatius* coarse grassland, *Pastinaca sativa* sub-community	1.62
MG1e	MG1e *Arrhenatherum elatius* coarse grassland, *Centaurea nigra* sub-community	46.46
MG1e/W25	Intermediate between MG1e/W25	0.34
MG1F/SD8F	Intermediate between MG1F/SD8F, FALLOW	3.36
MG1M	MG1M *Arrhenatherum elatius* coarse grassland, MOWN	45.37

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
MG6	MG6 *Lolium perenne - Cynosurus cristatus* pasture	85.76
MG6/SD8	MG6/SD8 intermediate	0.19
MG6a	MG6a *Lolium perenne - Cynosurus cristatus* pasture, Typical sub-community	0.62
MG6b	MG6b *Lolium perenne - Cynosurus cristatus* pasture, *Anthoxanthum odoratum* sub-community	13.51
MG7	MG7 *Lolium perenne* leys	834.92
MG7/MG13	MG7/MG13 intermediate	9.80
MG7/RUD	MG7/RUD intermediate	5.53
MG7/SD8	MG7/SD8 intermediate	5.31
MG7/SD8b	MG7/SD8b intermediate	4.85
MG7/SD12	MG7/SD12 intermediate	5.41
MG7/SD17	MG7/SD17 intermediate	1.02
MG7a	MG7a *Lolium perenne - Trifolium repens* leys	80.99
MG7M	MG7 *Lolium perenne* leys, MOWN	973.21
MG9	MG9 *Holcus lanatus - Deschampsia cespitosa* grassland	6.95
MG9/S28	MG9/S28 intermediate	3.76
MG9/U5	MG9/U5 intermediate	0.12
MG9a/S28	Intermediate between MG9a *Holcus lanatus - Deschampsia cespitosa* grassland, *Poa trivialis* /S28	0.27
MG10	MG10 *Holcus lanatus - Juncus effusus* rush pasture	25.03
MG10a	MG10a *Holcus lanatus - Juncus effusus* rush pasture, Typical sub-community	17.21
MG11	MG11 *Festuca rubra - Agrostis stolonifera - Potentilla anserina* inundation grassland	0.40
MG11/MG13	MG11/MG13 intermediate	15.18
MG11/S28	MG11/S28 intermediate	0.27
MG11/SD17a	MG11/SD17a intermediate	9.55
MG12	MG12 *Festuca arundinacea* coarse grassland	7.17
MG13	MG13 *Agrostis stolonifera - Alopecurus geniculatus* inundation grassland	3.15
MP	Mixed plantation	123.58
Mxbd	Mxbd *Carex nigra - Prunella vulgaris - Molinia caerulea* mire (PROVISIONAL NEW NVC TYPE)	1.21
NO LABEL	Unlabelled polygon	11.00
NOT SAND	Not windblown sand	8.26
OSCRUB	OSCRUB	1.51
OV26	OV26 *Epilobium hirsutum* community	0.22
OV27	OV27 *Chamerion angustifolium* community	2.34
OV27e	OV27 *Chamerion angustifolium* community, *Ammophila arenaria* sub-community	2.44
OW	Open water	16.76
PIT	Active sand pit or rock quarry	1.19
QUARRY	Old quarry (Aberlady)	0.73
RAILWAY	RAILWAY Railway line	48.42
ROAD	Road and track	396.07
RUD	Ruderal-dominated vegetation	65.21
RUDPh	Ruderal vegetation dominated by *Petasites hybridus*	0.51
RUNWAT	Running water	8.20

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
S4	S4 *Phragmites australis* reedbed	6.66
S4/S28	S4/S28 intermediate	0.29
S4a	S4a *Phragmites australis* reedbed, *P. australis* sub-community	6.34
S5a	S5a *Glyceria maxima* reedbed, *G. maxima* sub-community	8.77
S6	S6 *Carex riparia* swamp	0.22
S8	S8 *Scirpus lacustris* swamp	0.07
S9	S9 *Carex rostrata* swamp	1.82
S9a	S9a *Carex rostrata* swamp, *C. rostrata* sub-community	0.14
S10	S10 *Equisetum fluviatile* swamp	0.27
S11	S11 *Carex vesicaria* swamps	0.21
S12	S12 *Typha latifolia* reedbed	0.12
S14	S14 *Sparganium erectum* swamp	0.43
S18/SM16	Intermediate between S18 *Carex otrubae* swamp /SM16	1.71
S19	S19 *Eleocharis palustris* swamp	0.75
S19a	S19a *Eleocharis palustris* swamp, *E. palustris* sub-community	2.16
S19b	S19b *Eleocharis palustris* swamp, *Littorella uniflora* sub-community	0.03
S19c	S19c *Eleocharis palustris* swamp, *Agrostis stolonifera* sub-community	1.35
S20	S20 *Scirpus lacustris* ssp. *tabernaemontani* swamp	0.67
S21	S21 *Scirpus maritimus* swamp	1.63
S21a	S21a *Scirpus maritimus* swamp, *S. maritimus* sub-community	1.39
S21b	S21a *Scirpus maritimus* swamp, *Atriplex prostata* sub-community	0.08
S26a	S26a *Phragmites australis - Urtica dioica* fen, *Filipendula ulmaria* sub-community	0.17
S26c	S26c *Phragmites australis - Urtica dioica* fen, *Oenanthe crocata* sub-community	0.59
S28	S28 *Phalaris arundinacea* tall-herb fen	8.82
S28c	S28 *Phalaris arundinacea* tall-herb fen, *Elymus repens - Holcus lanatus* sub-community	0.60
SD2	SD2 *Cakile maritima-Honkenya peploides* strandline	6.67
SD2/SD4	SD2/SD4 intermediate	2.26
SD2/SD5b	SD2/SD5b intermediate	0.14
SD2/SDy	SD2/SDy intermediate	0.48
SD3	SD3 *Matricaria maritima-Galium aparine* strandline	0.37
SD3/SDy	SD3/SDy intermediate	0.25
SD4	SD4 *Elymus farctus* foredune	18.27
SD4/SD8c	SD4/SD8c intermediate	0.10
SD4/SDy	SD4/SDy intermediate	0.03
SD4/SM16	SD4/SM16 intermediate	0.67
SD5	SD5 *Leymus arenarius* mobile dune	0.23
SD5a	SD5a *Leymus arenarius* mobile dune, Species-poor sub-community	2.45
SD5b	SD5b *Leymus arenarius* mobile dune, *Elymus farctus* sub-community	25.72
SD5b/SD8c	SD5b/SD8c intermediate	0.92
SD5b/SM16c	SD5b/SM16c intermediate	0.29
SD5c	SD5c *Leymus arenarius* mobile dune, *Festuca rubra* sub-community	15.77
SD5c/SD18a	SD5c/SD18a intermediate	0.43

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
SD6	SD6 *Ammophila arenaria* mobile dune community	0.55
SD6a	SD6a *Ammophila arenaria* mobile dune, *Elymus farctus* sub-community	64.23
SD6ab	SD6a/b intermediate	0.90
SD6ae	SD6a/e intermediate	10.92
SD6b	SD6b *Ammophila arenaria* mobile dune, *Leymus arenarius - Elymus farctus* sub-community	32.00
SD6be	SD6b/e intermediate	0.57
SD6c	SD6c *Ammophila arenaria* mobile dune, *Leymus arenarius* sub-community	8.87
SD6c/SD6e	SD6c/SD6e intermediate	0.42
SD6d	SD6d *Ammophila arenaria* mobile dune, Typical sub-community	94.93
SD6e	SD6e *Ammophila arenaria* mobile dune, *Festuca rubra* sub-community	53.82
SD6f	SD6f *Ammophila arenaria* mobile dune, *Poa pratensis* sub-community	6.80
SD6g	SD6f *Ammophila arenaria* mobile dune, *Carex arenaria* sub-community	1.73
SD6x	SD6x *Ammophila arenaria* mobile dune, *Brachythecium albicans* sub-community (PROVISIONAL NEW NVC TYPE)	33.83
SD7/SD12	SD7/SD12 intermediate	2.40
SD7/SD8	SD7/SD8 intermediate	0.47
SD7/SD8a	SD7SD8a intermediate	2.57
SD7/SD8b	SD7/SD8c intermediate	5.46
SD7/SD9a	SD7/SD9a intermediate	2.98
SD7a	SD7a *Ammophila arenaria-Festuca rubra* semi-fixed dune, Typical sub-community	47.71
SD7a/SD18a	SD7a/SD18a intermediate	0.96
SD7a/SD9a	SD7a/SD9a intermediate	12.13
SD7b	SD7b *Ammophila arenaria-Festuca rubra* semi-fixed dune, *Hypnum cupressiforme* sub-community	14.45
SD7b/SD7c	SD7b/SD7c intermediate	0.88
SD7b/SD9a	SD7b/SD9a intermediate	2.23
SD7c	SD7c *Ammophila arenaria-Festuca rubra* semi-fixed dune, *Ononis repens* sub-community	38.81
SD7c/SD9a	SD7c/SD9a intermediate	66.23
SD7c/SD9b	SD7c/SD9b intermediate	2.02
SD7d	SD7d *Ammophila arenaria-Festuca rubra* semi-fixed dune, *Tortula ruralis* ssp. *ruraliformis* sub-community	62.78
SD7d/SD7x	SD7d/SD7x intermediate	2.61
SD7d/SD9a	SD7d/SD9a intermediate	1.60
SD7x	SD7x *Ammophila arenaria-Festuca rubra* semi-fixed dune, *Galium verum* sub-community (PROVISIONAL NEW NVC TYPE)	260.71
SD7x/SD8b	SD7x/SD8b intermediate	20.65
SD7y	SD7y *Ammophila arenaria-Festuca rubra* semi-fixed dune community, *Hylocomium splendens* sub-community (PROVISIONAL NEW NVC TYPE)	11.27

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
SD8	SD8 *Festuca rubra-Galium verum* fixed dune grassland	4.51
SD8/SD12	SD8/SD12 intermediate	10.64
SD8/SD17	SD8/SD17 intermediate	1.40
SD8/SM16	SD8/SM16 intermediate	0.08
SD8a	SD8a *Festuca rubra-Galium verum* fixed dune grassland, Typical sub-community	48.23
SD8b	SD8b *Festuca rubra-Galium verum* fixed dune grassland, *Luzula campestris* sub-community	99.58
SD8b/SD11	SD8b/SD11 intermediate	0.17
SD8b/SD12a	SD8b/SD12a intermediate	18.93
SD8b/SD8c	SD8b/SD8c intermediate	0.18
SD8bc	SD8b/c intermediate	0.38
SD8c	SD8c *Festuca rubra-Galium verum* fixed dune grassland, *Tortula ruralis* ssp *ruraliformis* sub-community	8.96
SD8F	SD8F *Festuca rubra-Galium verum* fixed dune grassland, FALLOW	2.19
SD8M	SD8M MOWN (mainly golf fairway)	26.97
SD8x	SD8x *Festuca rubra - Galium verum* fixed dune community, *Centaurea nigra - Daucus carota* sub-community (PROVISIONAL NEW NVC TYPE)	15.18
SD9/M16x	SD9/M16x	0.35
SD9a	SD9a *Ammophila arenaria - Arrhenatherum elatius* grassland, *Arrhenatherum elatius* sub-community	309.86
SD9a/SD18a	SD9a/SD18a intermediate	0.39
SD9a/W25	SD9a/W25 intermediate	7.56
SD9b	SD9b *Ammophila arenaria - Arrhenatherum elatius* grassland, *Geranium sanguineum* sub-community	3.76
SD9x	SD9x *Ammophila arenaria - Arrhenatherum elatius* grassland, *Hylocomium splendens* sub-community (PROVISIONAL NEW NVC TYPE)	40.73
SD10	SD10 *Carex arenaria* dune community	1.91
SD10a	SD10a *Carex arenaria* dune community, *Festuca rubra* sub-community	0.41
SD11	SD11 *Carex arenaria - Cornicularia aculeata* dune	0.49
SD11a	SD11a *Carex arenaria - Cornicularia aculeata* dune, *Ammophila arenaria* sub-community	61.02
SD11a/H11b	SD11a/H11b intermediate	0.14
SD11a/SD12yy	SD11a/SD12yy intermediate	4.62
SD11b	SD11b *Carex arenaria - Cornicularia aculeata* dune, *Festuca ovina* sub-community	31.75
SD11M	SD11 *Carex arenaria - Cornicularia aculeata* dune, MOWN	1.22

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
SD12	SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland	98.79
SD12/SD16	SD12/SD16 intermediate	23.85
SD12/SD17	SD12/SD17 intermediate	0.94
SD12/U20	SD12/U20 intermediate	1.29
SD12a	SD12a *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Anthoxanthum odoratum* sub-community	163.31
SD12ab	SD12a/b intermediate	9.27
SD12b	SD12b *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Holcus lanatus* sub-community	139.68
SD12F	SD12F *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, FALLOW	2.69
SD12M	SD12M *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, MOWN (mainly golf fairway)	135.90
SD12x	SD12x *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Hylocomium splendens* sub-community (PROVISIONAL NEW NVC TYPE)	139.72
SD12x/SD16	SD12x/SD16 intermediate	3.02
SD12xx	SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Racomitrium canescens* sub-community (PROVISIONAL NEW NVC TYPE)	1.27
SD12xy	SD12xy *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Deschampsia flexuosa* sub-community (PROVISIONAL NEW NVC TYPE)	66.92
SD12y	SD12y *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Carex arenaria* sub-community	295.40
SD12yy	SD12yy *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Cladonia rangiformis - C. portentosa* sub-community (PROVISIONAL NEW NVC TYPE)	27.42
SD12z	SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland, *Ammophila arenaria* sub-community (PROVISIONAL NEW NVC TYPE)	166.27
SD12z/W23	SD12z/W23x intermediate	0.29
SD12z/W25	SD12z/W25 intermediate	0.02
SD13/SD16	Intermediate between SD13 *Salix repens - Bryum pseudotriquetrum* dune slack/SD16	0.24
SD15	SD15 *Salix repens – Calliergon cuspidatum* dune slack	1.77
SD15a	SD15a *Salix repens – Calliergon cuspidatum* dune slack, *Carex nigra* sub-community	1.50
SD15b	SD15b *Salix repens – Calliergon cuspidatum* dune slack, *Equisetum variegatum* sub-community	0.04
SD16x	SD16 *Salix repens - Holcus lanatus* slack, *Erica tetralix* sub-community (PROVISIONAL NEW NVC TYPE)	0.62
SD16	SD16 *Salix repens - Holcus lanatus* slack	124.91
SD16a	SD16a *Salix repens - Holcus lanatus* slack, *Ononis repens* sub-community	0.01
SD16c	SD16a *Salix repens - Holcus lanatus* slack, *Prunella vulgaris - Equisetum variegatum* sub-community	6.75
SD16d	SD16d *Salix repens - Holcus lanatus* slack, *Agrostis stolonifera* sub-community	5.43
SD16M	SD16 *Salix repens - Holcus lanatus* slack, MOWN	2.40

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
SD17	SD17 *Potentilla anserina-Carex nigra* dune-slack	28.36
SD17a	SD17a *Potentilla anserina-Carex nigra* slack, *Festuca rubra - Ranunculus repens* sub-community	7.97
SD17b	SD17b *Potentilla anserina-Carex nigra* slack, *Carex flacca* sub-community	3.69
SD17bd	SD17b/d intermediate	0.09
SD17c	SD17c *Potentilla anserina-Carex nigra* slack, *Caltha palustris* sub-community	2.58
SD17d	SD17d *Potentilla anserina-Carex nigra* slack, *Hydrocotyle vulgaris - Ranunculus flammula* sub-community	11.97
SD17x	SD17x *Potentilla anserina-Carex nigra* dune-slack, *Agrostis stolonifera* sub-community (PROVISIONAL NEW NVC TYPE)	4.48
SD18	SD18 *Hippophae rhamnoides* scrub	8.27
SD18a	SD18a *Hippophae rhamnoides* dune scrub, *Festuca rubra* sub-community	14.45
SD18b	SD18b *Hippophae rhamnoides* dune scrub, *Urtica dioica - Arrhenatherum elatius* sub-community	54.60
SDxx	SDxx *Leymus arenarius - Elymus repens* dune/saltmarsh strandline (PROVISIONAL NEW NVC TYPE)	1.00
SDy	SDy *Atriplex glabriuscula* strandline (PROVISIONAL NEW NVC TYPE)	4.02
SDy/SD6a	SDy/SD6a intermediate	0.01
SM6	SM6 *Spartina anglica* saltmarsh	0.06
SM8	SM8 Annual *Salicornia* saltmarsh	3.49
SM9	SM9 *Suaeda maritima* saltmarsh	1.23
SM10	SM10 Transitional low marsh vegetation	0.21
SM13	SM13 *Puccinellia maritima* saltmarsh	10.21
SM13a	SM13a *Puccinellia maritima* saltmarsh, *P. maritima* sub-community	0.77
SM13b	SM13b *Puccinellia maritima* saltmarsh, *Glaux maritima* sub-community	17.12
SM16	SM16 *Festuca rubra* saltmarsh	37.09
SM16b	SM16b *Festuca rubra* saltmarsh, *Juncus gerardi* sub-community	0.52
SM16c	SM16c *Festuca rubra* saltmarsh, *Glaux maritima* sub-community	11.34
SM16d	SM16d *Festuca rubra* saltmarsh, *Festuca rubra* sub-community	5.44
SM16f	SM16f *Festuca rubra* saltmarsh, *Carex flacca* sub-community	2.14
SM18	SM18 *Juncus maritimus* saltmarsh	0.28
SM28	SM28 *Elymus repens* saltmarsh	5.08
TIP	Rubbish tip	6.17
U2	U2 *Deschampsia flexuosa* grassland	0.78
U4	U4 *Festuca ovina - Agrostis capillaris - Galium saxatile* grassland	2.79
U4b	U4b *Festuca ovina - Agrostis capillaris - Galium saxatile* grassland, *Holcus lanatus - Trifolium* repens sub-community	3.23
U5	U5 *Nardus stricta - Galium saxatile* grassland	170.49
U5c	U5c *Nardus stricta - Galium saxatile* grassland, *Carex panicea - Viola riviniana* sub-community	0.76
U5d	U5d *Nardus stricta - Galium saxatile* grassland, *Calluna vulgaris - Danthonia decumbens* sub-community	0.01
U5M	U5 *Nardus stricta - Galium saxatile* grassland. MOWN (mainly golf)	7.49
U6d	U6d *Juncus squarrosus - Festuca ovina* grassland, *Agrostis capillaris - Luzula multiflora* sub-community	0.15
U20	U20 *Pteridium aquilinum - Galium saxatile* community	2.51

Map Codes	EAST COAST NVC VEGETATION AND LAND COVER TYPES	All East Coast sites
W1	W1 *Salix cinerea - Galium palustre* woodland	24.16
W6	W6 *Alnus glutinosa - Urtica dioica* woodland	6.58
W11	W11 *Quercus petraea - Betula pubescens - Oxalis acetosella* woodland	32.64
W15	W15 *Fagus sylvatica - Deschampsia flexuosa* woodland	0.03
W18	W18 *Pinus sylvestris - Hylocomium splendens* woodland	22.50
W21	W21 *Crataegus monogyna - Hedera helix* scrub	1.11
W22	W22 *Prunus spinosa - Pteridium aquilinum* scrub	0.73
W23	W23 *Ulex europaeus - Rubus fruticosus* agg. scrub	167.98
W23a	W23a *Ulex europaeus - Rubus fruticosus* agg. scrub, *Anthoxanthum odoratum* sub-community	0.03
W23b	W23b *Ulex europaeus - Rubus fruticosus* agg. scrub, *Rumex acetosella* sub-community	0.18
W23x	W23x *Ulex europaeus - Rubus fruticosus* agg. scrub, *Cytisus scoparius* sub-community (PROVISIONAL NEW NVC TYPE)	25.80
W24	W24 *Rubus fruticosus - Holcus lanatus* underscrub	0.31
W25	W25 *Pteridium aquilinum - Rubus fruticosus* agg. underscrub	14.32
WALL	WALL Seawall	23.63
Total (ha)		12035.99

Scottish Natural Heritage

Scottish Natural Heritage is an independent body established by Parliament in 1992, responsible to the Secretary of State for Scotland.

Our task is to secure the conservation and enhancement of Scotland's unique and precious natural heritage - the wildlife, the habitats, the landscapes and the seascapes - which has evolved through the long partnership between people and nature.

We advise on policies and promote projects that aim to improve the natural heritage and support its sustainable use.

Our aim is to help people to enjoy Scotland's natural heritage responsibly, understand it more fully and use it wisely so that it can be sustained for future generations.