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Monitoring of Beaches and Dunes of the Wadden Sea Islands

Introduction

In the Trilateral Monitoring and Assessment Program (TMAP), monitoring of dunes and beaches is carried out to get basic information about location and area of different dune types and the natural dune succession in order to assess the implementation of the Targets as laid down in the trilateral Wadden Sea Plan ("increased natural dynamics of beaches, primary dunes, beach planes and primary dune valleys in connection with the offshore zone; an increased presence of a complete natural vegetation succession; favorable conditions for migrating and breeding birds").

The current monitoring of dunes and beaches is carried out in each country with different objectives, frequencies, techniques and classification keys. A common classification of the different types of dunes and beaches is required to enable an assessment on the trilateral level.



Embryonic dunes
(Photo: J. Petersen)

EU Habitat classification

A number of classification keys for coastal habitats have been developed on the national and international level. These systems have many similarities but are not identical and the use for monitoring and reporting in the Wadden Sea or at the European level is therefore difficult. Since 1995, the European Environment Agency (EEA) and its European Topic Center for Nature Protection and Biodiversity (ETC/NPB) has been working on the development of a common parameter-based European habitat classification frame, the EUNIS habitat classification (Davies and Moss, 1999). It builds upon the previous initiatives of the CORINE habitat classification and its successor the (ongoing) Palaearctic classification, developed by

the Council of Europe (Devillers and Devillers-Terschuren, 1996). The marine sector of the EUNIS classification is also currently being refined by marine conventions (OSPAR, Helcom, Barcelona Convention).

In future, the EUNIS system will be used for all EU related reporting requirements like the EU Directive. Therefore, a proposal of a common habitat classification for beaches and dunes in the Wadden Sea was developed based on the EUNIS system which can be applied in the TMAP and serve as a common denominator for all Wadden Sea countries.

In order to make the EUNIS habitat classification operational for the TMAP, the proposed common habitat classification entails a more detailed description of the main vegetation communities. This concerns:

- 1) a selection of EUNIS beach and dune habitats, which are relevant for the Wadden Sea islands and should be monitored in the TMAP,
- 2) a detailed description of the vegetation types of the selected habitats based on the existing classification systems in the three countries, in order to be able to implement the proposed EUNIS habitat classification in the TMAP.

Method

The description of the vegetation or biotope types takes into account the main phytosociological systems used in the three countries (Dierssen 1988, Preising et al. 1990,1995, Pott 1995, Schaminée et al. 1995, 1996, 1998, Stortelder et al. 1999, Petersen 2000, von Drachenfels 1996). Furthermore, cross-references to the Annex I habitats of the EU Habitat Directive and to the Red List of biotopes (Nordheim et al. 1996) were given and supplemented with, if available, other classification systems (Connor et al. 1997, Devillers and Devillers-Terschuren 1996, Helsinki Commission 1998, OSPAR Commission 2000).

Most of the relevant dune and beach habitats in the Wadden Sea could be assigned to the EUNIS habitat units. For practical reasons, only habitat units were selected which can be in a routine monitoring via aerial photograph in combination with ground truth surveys. Furthermore, habitat units, which occur only in relatively small areas and also have minor importance for management, e.g. small patches within a dominant natural vegetation, have not been described as a separate

habitat unit. The hierarchical structure of the EUNIS classification allows to add these habitat units, if necessary, or to specify the habitat units at lower levels. A characteristic habitat unit of the Wadden Sea dune area, which has been added to the EUNIS classification, is the open non-vegetated dune areas in older dunes (wind blown out) or large shifting dunes which occur, e.g., on Sylt.

Classification of Wadden Sea Habitats

The EUNIS habitat classification system entails nine types of coastal dune and sand habitats. Several sub-types have been defined for each of these types. In Table 1 an overview of the sub-types, which are relevant for the Wadden Sea, is given.

In total, 14 habitat types of dunes, dune slacks and beaches can be distinguished in the Wadden Sea. Most of them can easily be identified by aerial

photographs. The identification of differences between dry and wet heath, fens and reedbeds and the identification of pioneer dune slack vegetation may be difficult by aerial photographs alone. Ground truth surveys have to be carried out in these areas or additional information has to be obtained from other sources, e.g. recent vegetation maps (Petersen 2000). More subtypes can easily be added to the system if a more detailed description is required.

Four sub-types of dune slacks can be differentiated with different vegetation characteristics but also with regard to different protection needs. For example, the pioneer dune slack habitat is the most threatened one compared to the other three types and requires specific management measures (Westhoff et al. 1993, Petersen 2000). Therefore, a monitoring of the different succession stages of wet dune slacks is necessary on the same level of detail as for the dry dune system.

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Table 1:
The habitat classification was supplemented with the classification system of the plant communities. All relevant hierarchical levels of the EUNIS has been worked out and put in a new Wadden Sea region list. The vegetation classification links to Dierssen (1988; *3), Preising et al. (1990,1995; *4), Pott (1995; *1), Schaminée et al. (1995, 1996, 1998; *2), Stortvedler al. (1999; *2) and Petersen (2000; *5). EUNIS classification (Davies and Moss, 1999; *6), Red List (Nordheim et al. 1996; *7), the biotope type classification links to von Drachenfels (1996, *8).

Description	Vegetation (*1/2/3/4/5)	EUNIS (6):	Habitat Directive	Red List (7)	Biotope type (8)
1 Beach driftline Dune area near to/on the shoreline, area of embryonic dunes.	General: <i>Cakiletum maritimae</i> (= vegetation with <i>Cakile maritima</i>); rare: <i>Crambe maritima</i> unit (= vegetation with <i>Crambe maritima</i>), [class: <i>Cakiletea maritimae</i> , union: <i>Salsolo-Honkenyon peploidis</i>]	B1.12 Middle European sand beach annual communities.	1210 Annual vegetation of drift lines.	09.02 Sandy beach.	3.7.1 (KSN)
2 Beach plains Above the driftline.	No vegetation	B1.21 Unvegetated sand beaches above the driftline.	-	09.02 Sandy beach.	3.7 (KS)
3 Embryonic dunes First small dunes near the shoreline.	General: <i>Elymo-Agropyretum</i> = <i>Honkenyo-Agropyretum juncei</i> (= vegetation with <i>Elymus farctus</i>), sometimes: <i>Honkenya peploides</i> unit (= vegetation with <i>Honkenya peploides</i>), [class: <i>Ammophiletea arenariae</i> , union: <i>Agropyro-Honkenyon peploidis</i>]	B1.31 (H-03.04.08) Embryonic shifting dunes.	2110 Embryonic shifting dunes.	10.01 Embryonic or primary dunes.	3.10.1 (KDV)
4 White dunes Primary dunes, normally the highest.	General: <i>Elymo-Ammophiletum</i> (vegetation with <i>Ammophila arenaria</i>) [class: <i>Ammophiletea arenariae</i> , union: <i>Ammophilion arenariae</i>]	B1.32 (H-03.04.02.01) White Dunes	2120 Shifting dunes along shoreline with <i>Ammophila arenaria</i> (white dunes).	10.02 White Dunes.	3.10.2 (KDW)
5 Dune grassland (a) Grey dunes/older second dunes. Coastal stable dunes with low grassland vegetation.	General: a. <i>Violo-Corynephorum</i> (vegetation with <i>Corynephorus canescens</i>), [class: <i>Koelerio-Corynephoretea</i> , union: <i>Corynephorion canescentis</i> (<i>Koelerion arenariae</i> , *4)] b. <i>Tortulo-Phleetum</i> = <i>Phleo-Tortuletum</i> (vegetation with <i>Phleum arenarium</i>) c. <i>Festuco-Galietum</i> (vegetation with <i>Galium verum</i>); [class: <i>Koelerio-Corynephoretea</i> , union: <i>Koelerion arenariae</i> (<i>Plantagini-Festucion</i> , *2)] d. <i>Airetum praecoxis</i> (vegetation with <i>Aira praecox</i>) [class: <i>Koelerio-Corynephoretea</i> , union: <i>Thero-Airion</i>] e. <i>Botrychio-Polygaletum</i> (vegetation with <i>Botrychium lunaria</i>) [class: <i>Calluno-Ulicetea</i> (<i>Nardetea</i> , *2), union: <i>Violion caninae</i> (<i>Nardo-Galion</i> , *2)]	B1.41 (P16.221) Northern fixed grey dunes B1.47 (P16.227) Dune fine grass annual communities (vegetations of both habitat units occur in same areas with slightly different soil characteristics. Almost same vegetation types, cannot be separated by aerial photographs)	2130 Fixed coastal dunes with herbaceous vegetation (grey dunes). Subtypes 2131, 2137.	10.03 Grey dune grassland.	3.10.3 (KDG)
6 Dune heath (b) Brown dunes/tertiary dunes. Coastal stable dunes with heath vegetation.	General: <i>Hieracio-Empetretum</i> = <i>Polypodio-Empetretum</i> (*2) (vegetation with <i>Empetrum nigrum</i> , and sometimes <i>Calluna vulgaris</i>) [class: <i>Calluno-Ulicetea</i> (<i>Nardo-Callunetea</i> , *3) union: <i>Empetrium nigri</i> (<i>Genistion pilosae</i> , *3)]	B1.51 (P16.23) (<i>Empetrum nigrum</i>) brown dunes B1.52 (P16.24) (<i>Calluna vulgaris</i>) brown dunes. Dominant habitat is B1.51: crawnberrry brown dunes. Common heather brown dunes occur in small patches in areas with crawnberrry as a result of former grazing.	2140 Decalcified fixed dunes with <i>Empetrum nigrum</i> . 2150 Atlantic decalcified fixed dunes (<i>Calluno-Ulicetea</i>).	10.04.01 Dunes with coastal heath with <i>Empetrum nigrum</i> . 10.04.02 Dune heath with <i>Calluna vulgaris</i> .	3.10.4 (KDH)
7 Open dune areas (c)	No vegetation. Dune moving due to strong airborne sand drift in the main wind direction. Usually develops after degradation of white-, grey- and brown dunes.	-	-	10.07 Natural shifting dunes.	3.10.9 (KDO)
8 Dune scrub (d) Older white dunes/secondary dunes Coastal dune scrub with <i>Hippophae rhamnoides</i> . Normally on the lee side of the older white dunes or on the beginning of younger grey dunes, typical for calcareous sand.	General: <i>Hippophae-Sambucetum nigrae</i> (<i>Salicis arenariae-Hippophaetum</i> , *3) (vegetation with <i>Hippophae rhamnoides</i> and mostly <i>Sambucus nigra</i>) [class: <i>Rhamno-Prunetea</i> , union: <i>Salicion arenariae</i> (<i>Berberidion vulgaris</i> , *2/3)]	B1.61 (P16.26) Coastal dune thickets.	2160 Dunes with <i>Hippophae rhamnoides</i> .	10.06 Dune scrub (natural).	3.10.6 (KDB)
9 Dune willow shrubbery Brown dunes/tertiary dunes and dune slacks (sometimes also: second or grey dunes). Coastal dune shrubbery with <i>Salix repens</i> agg. (<i>Pyralo-Salicetum</i> is rare, <i>Salix repens</i> agg. vegetation and <i>Salicetum cinereae</i> - <i>salicetosum repentis</i> are common).	General: Vegetation with <i>Salix repens</i> agg. a. <i>Pyralo-Salicetum</i> b. <i>Salix repens</i> agg. vegetation unit [class: <i>Rhamno-Prunetea</i> , (<i>Calluno-Ulicetea</i> , *2/5), union: <i>Salicion arenariae</i> (<i>Empetrium nigri</i> , *2/5)] c. <i>Salicetum cinereae-salicetosum repentis</i> , *2 [class: <i>Franguletea</i> , union: <i>Salicion cinereae</i>]	B1.62 (P16.26) (<i>Salix arenaria</i>) mats.	2170 Dunes with <i>Salix repens</i> agg. (<i>Salicion arenariae</i>).	10.06 Dune scrub (natural).	3.10.5 (KDN), 3.11.5 (KNB), 3.11.6 (KNS)

Description	Vegetation (*1/2/3/4/5)	EUNIS (6):	Habitat Directive	Red List (7)	Biotope type (8)
10 Dune area forest (e) Brown dunes/tertiary dunes and dune slacks. Dune bushes/forest, coastal stable dunes with woodland vegetation.	General: <i>Betula pubescens</i> unit = <i>Empetro-Betuletum carpaticae</i> (mostly vegetation with <i>Betula pubescens</i> , sometimes with <i>Populus tremula</i> , <i>Quercus robur</i> , <i>Pinus nigra</i>) [class: <i>Vaccinio-Piceetea</i> (<i>Vaccinio-Betuletea pubescentis</i> , *2) union: <i>Betulion pubescentis</i>]	B1.71 (H-03.04.06.01) Coastal brown dunes covered with natural or almost natural coniferous forest, e.g. <i>Pinus silvestris</i> (in the Wadden Sea area only artificial <i>Pinus</i> plantations). B1.72 (H-03.04.06.02) Coastal brown dunes covered with deciduous forest (<i>Fagus</i> , <i>Betula</i> , <i>Quercus</i>). B1.85 (H-03.04.07.02) Coastal dunes: wet dune slacks: dominated by shrubs or trees (Same vegetation as B1.72, difficult to differentiate on aerial photographs).	2180		3.10.7 (KDX), 3.11.5 (KNB)
11 Pioneer dune slacks Pioneer vegetation in open mostly younger dune slacks with high dynamic	General: a. <i>Centauro-Saginetum</i> [class: <i>Saginetum matitimae</i> union: <i>Saginion maritimae</i>] (vegetation with <i>Centaurium littorale</i> and <i>Sagina nodosa</i>) b. <i>Cicendietum filiformis</i> [class: <i>Isoeto-Nanojuncetea</i> , union: <i>Radiolion (Nanocyperion, *2)</i>], (vegetation with <i>Radiola linoides</i> , <i>Anagalis minima</i> , <i>Cicendia filiformis</i> , and <i>Juncus pygmaeus</i>) c. <i>Samolo-Littorelletum</i> , <i>Eleocharitetum multicaulis</i> , [class: <i>Littorelletea uniflorae</i> union: <i>Hydrocotylo-Baldellion</i>], (vegetation with <i>Littorella uniflora</i> , <i>Samolus valerandi</i> , <i>Eleocharis multicaulis</i>) d. <i>Sphagno-Rhynchosporietum (Lycopodio-Rhynchosporietum *2)</i> [class: <i>Scheuchzerio-Caricetea nigrae (Oxycocco-Sphagnetea *2)</i>], union: <i>Rhynchosporion (Ericion tetralicis *2)</i> , (vegetation with <i>Rhynchospora alba</i> and <i>fusca</i>)	B1.81 (P16.32) Dune slack pioneer swards.	2190 Humid dune slacks. Subtype 2192: Dune slack pioneer swards.	10.05 Wet dune slacks (incl. coastal fens).	3.11.1 (KNH)
12 Dune slack fens Fens with grass and small sedges vegetation in mostly older dune slacks	General: a. <i>Junco baltici-Schoenetum nigricantis</i> [class: <i>Scheuchzerio-Caricetea nigrae (Parvocaricetea, *2)</i> , union: <i>Caricion davallinae</i>], (vegetation with <i>Schoenus nigricans</i> , <i>Liparis loeselii</i> , <i>Epipactis palustris</i>) b. <i>Caricetum trinervi-nigrae</i> [class: <i>Scheuchzerio-Caricetea nigrae (Parvocaricetea, *2)</i> , union: <i>Caricion nigrae</i>], (vegetation with <i>Carex trinervis</i> , <i>Carex nigra</i> , <i>Potentilla palustris</i>)	B1.82 (P16.33) Dune slack fens.	2190 Humid dune slacks. Subtype 2193: Dune slack fens.	10.05 Wet dune slacks (incl. coastal fens).	3.11.2 (KNK), 3.11.3 (KNA)
13 Dune slack heath Moist/wet heath vegetation in older dunes.	General: <i>Empetro-Ericetum</i> [class: <i>Oxycocco-Sphagnetea</i> , union: <i>Ericion tetralicis</i>] (vegetation with <i>Erica tetralix</i>)	B1.83 (P16.34) Dune slack grassland and heaths.	2190 Humid dune slacks. Subtype 2194: Dune slack grassland.	10.05 Wet dune slacks (incl. coastal fens).	3.11.3 (KNA)
14 Dune slack reedbed (f) Dune slack vegetation - beds - with big sedges and/or reed.	General: <i>Scirpo-Phragmitetum (Schoenoplecto-Phragmitetum *3, Typho-Phragmitetum *2)</i> and <i>Magnocaricion</i> -units, [class: <i>Phragmitetea</i> , union: <i>Phragmition</i> and (<i>Magno-</i>) <i>Caricion</i>], (vegetation with <i>Phragmites australis</i> and/or big sedges)	B1.84 (P16.35) Dune slack reedbeds, sedgebeds and canebeds.	2190 Humid dune slacks. Subtype 2195: Dune slack reedbeds and sedgebeds.	10.05 Wet dune slacks (incl. coastal fens).	3.11.4 (KNR)

- (a) In the Wadden Sea, habitat units B1.41 and B1.47 have almost the same vegetation and differ only slightly concerning their soil characteristics. Because they occur on the same areas in mosaik-like patterns they can not be differentiated on aerial photographs. Therefore, for practical reasons, they are treated as one habitat unit.
- (b) The characteristic heath vegetation is dominated by cranberries (*Empetrum*). In some small patches, common heather (*Calluna*) occurs as a result of former grazing management and cannot therefore not distinguished as a separate habitat unit on aerial photographs.
- (c) This type has been added to the EUNIS list as a new habitat type. It is a characteristic habitat unit of the dune area and concerns the open unvegetated dune areas in older dunes (wind blown out) or shifting dunes (e.g. on Sylt)
- (d) This type is distinguished from the very generally dune willow shrubbery with *Salix* species because it is very typical for calcareous dunes between older white dunes and grey dunes.
- (e) The main coastal dune woods can be characterized as B1.72. In some areas, e.g. on the Danish islands, pines have been planted and form larger pine forests. For practical reasons, all tree dominated habitat units have been combined. This concerns also the shrub and tree habitats in moist and wet dune slacks (B1.85).
- (f) On aerial photographs, dune slacks dominated by shrubs and trees can hardly be distinguished from other forest areas adjacent to the dune slacks. For practical reasons, these habitat is treated in combination with B1.7.