



24TH INTERNATIONAL WORKSHOP OF
EUROPEAN VEGETATION SURVEY



BOOK OF EXCURSIONS



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UNIVERSITY OF RENNES 1, FRANCE

BOOK OF EXCURSIONS

24th EVS Workshop

Rennes, France

4 - 8 May 2015

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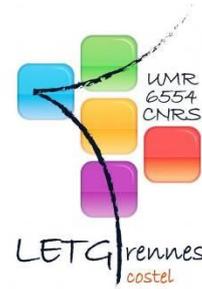
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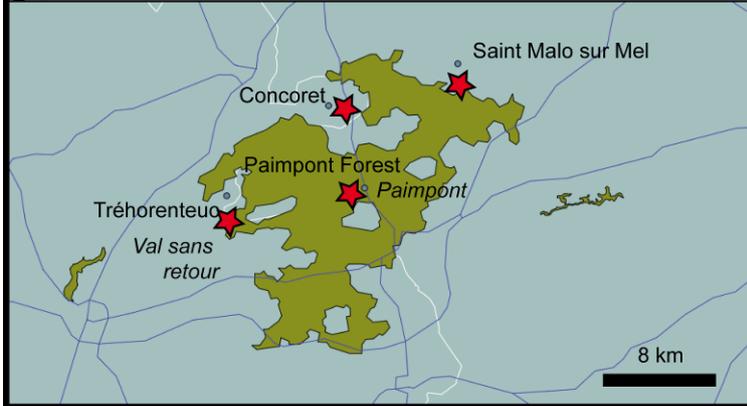
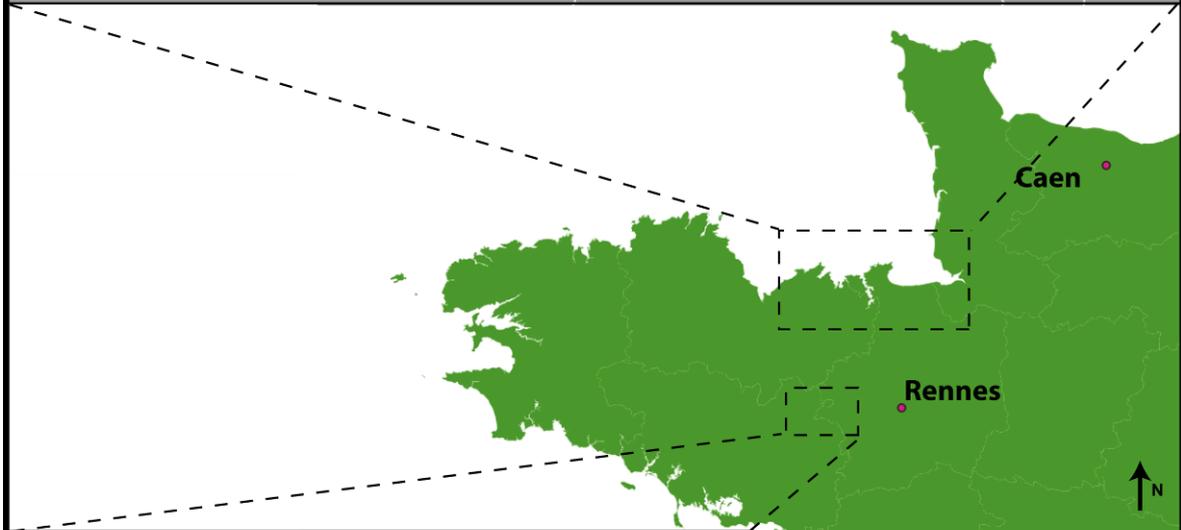
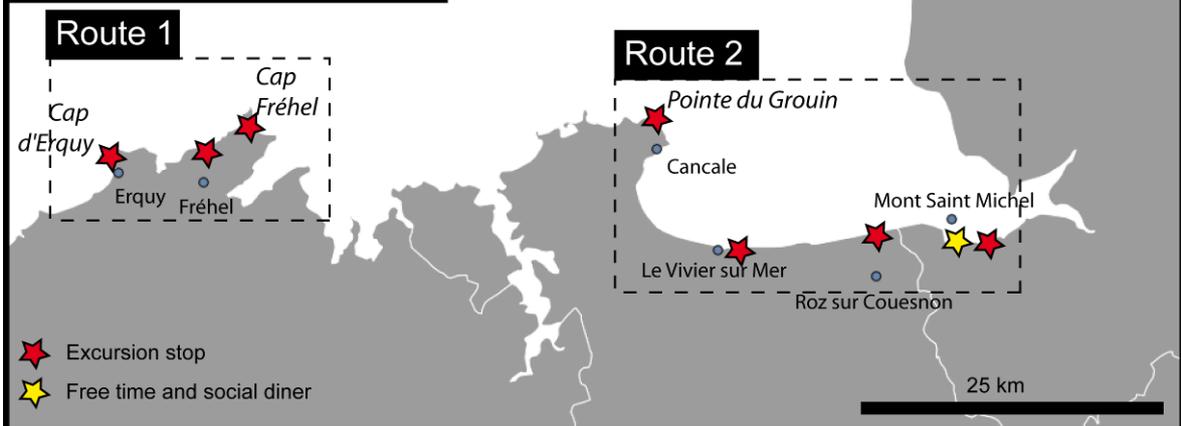
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Mid workshop excursions



Post workshop excursion

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2. Main vegetation types

Similar to most of the large American headlands, the coastal vegetation is structured in zones parallel to the coastline and whose spatial extension varies with the degree of exposure to climatic elements, particularly wind and salt spray (Tüxen 1976). Generally speaking, chasmohalophyte vegetation in rock crevices is followed by maritime grassland, at the upper limit of which develop maritime heathlands and then maritime thickets.

The two cape sites have exceptional geomorphological and ecological diversity, harbouring together the largest and most diversified maritime heath and grasslands of the American Massif (more than 400 ha at Cap Fréhel), as well as highly unique vegetation on fixed dunes (Géhu 1980).

Both sites have been the object of phytosociological studies, primarily focused on heath vegetation (Géhu 1963, J.-M. & J. Géhu 1975) or the coastal fringe vegetation (J.-M. & J. Géhu 1983, Géhu & Franck 1984). The first vegetation map was completed in 1980 for Cap Fréhel (Forgeard *et al.* 1980). Studies carried out for management plans or for documents of objectives with regard to natural protected areas furnished additional phytosociological information and habitat maps for Cap d'Erquy and Cap Fréhel (Gallet *et al.* 2000, Glemarec 2009). A synopsis and vegetation map were recently published (Bioret *et al.* 2014).

2.1. Maritime rock-crevice vegetation

Above the high spring-tide level, maritime rock-crevice vegetation is represented by two plant associations. Bare rock crevices or those with some debris on dry, sunny cliffs heavily exposed to wind and salt spray are colonised by the *Crithmum maritimum-Spergularia rupicola* community (cf. *Spergulario rupicolae-Crithmetum maritimi* (Roux & Lahondère 1960) Géhu 1962 *nom inv.*).

More sporadically and in more sheltered spots, deeper, cool, shady crevices or fissures are occupied by the *Armeria maritima-Asplenium marinum* association (cf. *Armerio maritimae-Asplenietum marini* Géhu & Géhu-Franck 1984).

Beyond the salt-spray deposition zone, the *Umbilicus rupestris-Asplenium billotii* association (cf. *Umbilico rupestris-Asplenietum billoti* de Foucault 1979) colonises fissures and crevices on sheltered, dry, sunny cliffs.

The area at the upper limit of the gravel beach in the western part of Cap d'Erquy is colonised by sea couch grass (*Agropyron pungens*), belonging to the *Beta vulgaris* subsp. *maritima-Agropyron pungens* association (cf. *Beto maritimae-Agropyretum pungentis* (Arènes 1933) Corillion 1953); the *Crithmum maritimum-Juncus acutus* association (cf. *Crithmo maritimi-Juncetum acuti* Bioret 2008) colonises rock fissures.

2.1.1. Maritime grasslands

On windy slopes, maritime grasslands on coastal rankers are made up of a *Festuca rubra* subsp. *pruinosa-Armeria maritima* association (cf. *Armerio maritimae-Festucetum pruinosa* Géhu 2008). In contrast to the rocky coasts of Finistère, where this maritime grassland is omnipresent and forms rather wide stands, this community only colonises berms or slope bottoms on small surface areas ranging from a few to some hundred square meters.

On steep ledges where organic matter has accumulated, mats of sea campion correspond to a *Spergularia rupicola-Silene maritime* association (cf. ***Spergulario rupicolae-Silenetum maritimae*** Bioret & Géhu 2000).

In lateral contact or seaward from the *Armeria maritima-Festuca rubra* subsp. *pruinosa* association, rocky berms are colonised by linear vegetation physiognomically dominated by thick cushions of *Armeria maritima*, corresponding to the *Spergularia rupicola-Armeria maritime* association (cf. ***Spergulario rupicolae-Armerietum maritimae*** Géhu 2008).

Some shady cliff walls with seepage are colonised by an *Osmunda regalis-Festuca rubra* subsp. *pruinosa* association (cf. ***Osmundo regalis-Festucetum pruinosa*** Géhu & Bioret 2000).

Two types of maritime grasslands develop in the median windy areas of the northern-exposed part of Cap Fréhel: *Heracleum sphondylium-Festuca rubra* subsp. *pruinosa* and *Silene dioica* subsp. *zetlandica-Festuca rubra* subsp. *pruinosa* (cf. ***Heracleo sphondylii-Festucetum pruinosa*** Bioret & Géhu 2008 and ***Sileno zetlandicae-Festucetum pruinosa*** Bioret & Géhu 2008).

On sunny clayey-cobbly slopes, there are *Dactylis glomerata-Daucus carota* subsp. *gummifer* grasslands (cf. ***Dactylo oceanicae-Daucetum gummiferi*** Géhu 2008).

On vertical exposed or semi-exposed rock cliff walls, curtains of ivy correspond to an *Orobancha hederiae-Hedera helix* association (cf. ***Orobancho hederiae-Hederetum helicis*** (Géhu 1961) 2006). It is characterised by an accumulation of organic litter and some shrub thicket species.

With higher exposure to salt due to salt spray, the ivy carpets of steep walls without organic debris between the ivy and the rock face correspond to *Armeria maritima-Hedera helix* associations (cf. ***Armerio maritimae-Hederetum helicis*** Géhu & Duquef 2009).

A third type of maritime, meso-xerophilous and mesotrophic ivy-based community (Géhu & Duquef, 2009), corresponding to a *Hedera helix-Silene maritime* association (cf. ***Hedero helicis-Silenetum maritimae*** Géhu 2008), is found sporadically on detritic soils on low sunny cliffs.

In continuation of the *Dactylo-Sedetum* association around rocky outcrops where some organic soil can accumulate, grows a low perennial maritime grassland based on *Festuca armoricana* and *Sedum anglicum* corresponding to ***Sedo anglici-Festucetum armoricanae*** Bioret *et al.* 2014.

2.2. Short-turf grassland and sparse grassland vegetation

Near rocky outcrops, superficial accumulations of detritus due to bedrock erosion are colonised by perennial grasses of the *Dactylis glomerata* subsp. *oceanica-Sedum anglicum* association (cf. ***Dactylo oceanicae-Sedetum anglici*** J.-M & J. Géhu & Caron 1978 corr. Géhu 2008).

Other grasslands dominated by therophytes sometimes develop in contact with the two preceding plant communities: a *Prospero autumnale* and *Romulea columnnae* assemblage found in soil-filled depressions on rocky berms and short-turf grassland dominated by *Aira praecox* and *Logfia minima* on thin organic soil on sandstone outcrops that is assigned to the *Filago minima-Aira praecox* association (***Filagini minima-Airetum praecocis*** Wattez, Géhu & de Foucault 1978).

Sparse grassland composed of *Armeria maritima* and *Plantago coronopus* located at the lower edge of the *Armeria maritima-Festuca rubra* association corresponds to the *Armeria maritima-Plantago*

coronopus association (cf. *Armerio maritimae-Plantaginetum coronopodis* (Van den Berghen 1979); Bioret & Géhu 2008). It develops in the primary conditions linked to wind deflation or in secondary conditions following trampling on perennial grasslands.

Therophyte grasslands are represented by three plant associations involving *Sagina maritima* (cf. *Sagineta maritimae* Westhoff *et al.* 1962). They develop in primary succession on bare substrate resulting from climatic erosion on seaward maritime grasslands or in depressions in these grasslands or in secondary succession following trampling of the vegetation. They correspond to different environmental conditions:

- In more maritime conditions: *Sagino maritimae-Catapodietum marini* R. Tx. 1963;
- In sheltered, more thermophilic conditions on free-draining substrate: *Trifolio scabri-Catapodietum marini* Géhu & de Foucault 1978;
- In nitrophilous conditions in conjunction with sea-bird populations: *Soncho oleracei-Cochlearietum danicae* Géhu & de Foucault 1978.

2.3. Maritime heaths and maritime scrub thickets

The Cap d'Erquy and Cap Fréhel sites have a diversity of coastal heaths that are unique within the Armorican Massif with respect to their plant assemblages and their ecological communities, as well as to their extent and state of conservation. The main coastal heath inventoried belong to the alliance *Dactylis glomerata subsp. oceanica-Ulex europaeus var. maritimus* (cf. *Dactylo oceanicae-Ulicion maritimi* Géhu 1975), that combines all of primary and sub-primary maritime heaths rich in coastal ecotypes (CORILLION 1965, J.-M. & J. GÉHU 1975, BIORET & GÉHU 1999). They are all low-lying due to the cushion-like aspect of *Ulex europaeus var. maritimus* and *Ulex gallii var. humilis*, associated with heather (*Calluna vulgaris* and *Erica* spp.).

Three dominant types of heathlands can be distinguished according to the nature of the soil and its hydromorphy (Figure 2) (Géhu 1963, J.-M. & J. Géhu 1975).

Dry coastal heaths are the most common; they colonise the steepest inclines and cliff tops on free-draining rankers and humus-iron podzols: they correspond to a *Ulex europaeus var. maritimus-Erica cinerea* association (cf. *Ulici maritimi-Ericetum cinereae* (Géhu 1962) J.-M. & J. Géhu 1975) on colluvial soils on sandstone and in more exposed conditions, and *Ulex gallii var. humilis-Erica cinerea* (cf. *Ulici humilis-Ericetum cinereae* (Van den Berghen 1958) J.-M. & J. Géhu 1975) on thinner and loose ranker podzols, in more sheltered conditions. This very distinct distribution at the farthest end of Cap d'Erquy was described by Géhu & Géhu (1975).

The mixed or mesophytic *Erica ciliaris - Ulex gallii var. humilis* heathland corresponds to the syntaxon *Ulici humilis-Ericetum ciliaris* (Van den Berghen 1958) J.-M. & J. Géhu 1975 that develops on podzol rankers, rich in humus, deeper and moister than those of the dry heathlands.

In the lower part of the slopes near the base of shallow valleys, in contact with *Ulici humilis-Ericetum ciliaris*, a low-growing meso-hygrophilous heath develops on humic podzols with slightly marshy redox zones (Géhu 1963). When it grows directly on mineral beds, the heath often leaves bare spots. It is characterised by a unique floristic association of *Erica tetralix* and

Ulex gallii var. *humilis*. *Erica ciliaris* is also found, but at lower frequency. This heath corresponds to *Ulici humilis-Ericetum tetralicis* Bioret *et al.* 2014.

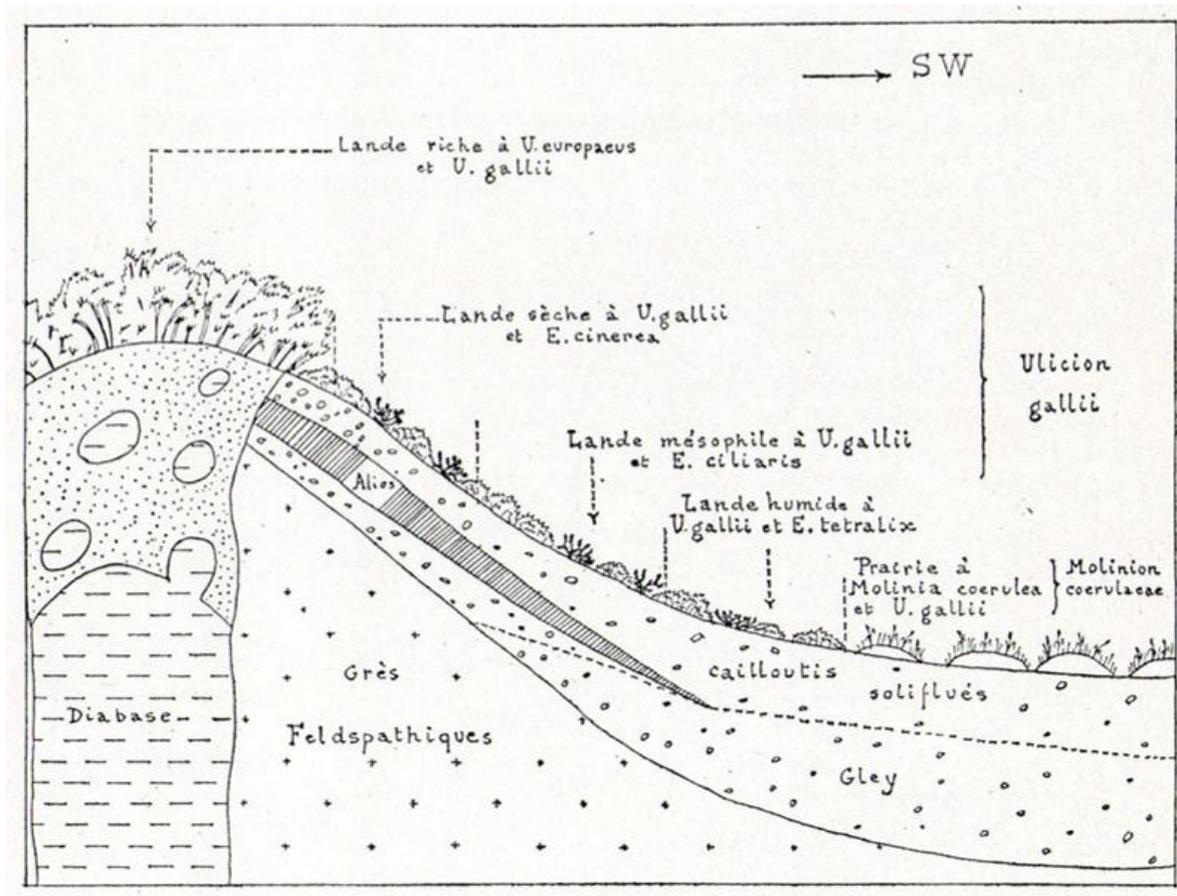


Figure 2. Phytosociological transect on the Fréhel plateau (Géhu 1963)

Lande: heathland ; prairie: grassland ; dolerite: dibase ; grès: sandstone

This diversity of plant communities in heathlands is further supplemented by the presence of other syntaxa (allied taxa) that occupy less surface area, in accordance with their community ecology.

Two particular chamaephyte plant assemblages physiognomically dominated by the round shrubs of European gorse and Western gorse have been identified on thin soils that dry out in the summer of cliff overhangs and rocky cliff ledges. They develop at the upper edge of maritime grasslands and in lateral contact with *Sileno maritimae-Festucenion pruinosae* or *Sedion anglici* turf. They correspond in part to a *Silene maritima-Ulex europaeus* var. *maritimus* association (cf. *Sileno maritimae-Ulicetum maritimae* Géhu 2008) in semi-sheltered areas and to a *Silene maritima-Ulex gallii* var. *humilis* association (cf. *Sileno maritimae-Ulicetum humilis* Rivas-Martínez 1979) on more exposed cliffs (i.e. Jas Point (Cap Fréhel), western Cap d'Erquy). Identified by Géhu (1963) as a “marginal assemblage of *Ulex gallii*, *Silene maritima*, *Erica cinerea*, *Erica portlandica*”, this association discontinuously occupies cliff overhangs and ledges on the middle to upper part of sandstone cliffs.

The syntaxonomic affiliation of these two plant assemblages deserves further discussion. They sometimes belong to the *Calluno-Ulicetea* (Rivas-Martínez, 1979, Géhu 2008a, Géhu &

Duquef 2009), or *Crataego-Prunetea* (Bioret 2008). Other than the dominance of *Ulex*, no other strictly characteristic species of *Calluno-Ulicetea* is present, with the exception of some surveys that include *Erica cinerea* and *Calluna vulgaris*. The thin organic soil set directly on the bedrock does not correspond to a veritable coastal ranker. Although the rounded shrubs of *Ulex* give the impression of a heath, these plants should be considered as low-lying shrubs, belonging to the phytosociological class of *Crataego-Prunetea spinosae*.

On the jagged ridges of the dolerite veins in the southern part of Cap Fréhel, a thicket associated with a fringe of *Brachypodium rupestre* contrasts starkly with *Ulici humilis-Ericetum cinereae*, with regard to the physiognomy exemplified by the rounded *Ulex europaeus* var. *maritimus* shrubs of 1.5 m to 2 m in height, and a deep, clay, non-podzolic, base-enriched soil due to the erosion of dolerite (Géhu 1963, Géhu 2008b). This fringe corresponds to a *Peucedanum officinale-Ulex europaeus* var. *maritimus* association (cf. *Peucedano officinalis-Ulicetum maritimi* Bioret *et al.* 2014).

On ancient sandy veneers rich in shell debris, unique low-lying thickets combine *Helianthemum nummularium* and *Ulex europaeus* var. *maritimus*, called *Helianthemo nummularii-Ulicetum maritimi* Bioret *et al.* 2014. Limited in space and observed in only two stations on Cap d'Erquy, in the north and in the south of the Lourtuais dune, this syntaxon is of major natural heritage interest.

2.4. Fringe vegetation

The diversity of the plant community in the fringe associated with maritime heath is directly linked to physiographic diversity as well as physico-chemical variability of substrates.

On cliffs under maritime influence, in semi-sheltered, cool situations, the stands of bracken on slopes correspond to the syntaxon *Melandrio zetlandici-Pteridium aquilini* Géhu & Géhu-Franck 1983, for which the geographic distribution is strictly limited to large Armorican headlands (Cap Fréhel, Ushant, the Crozon peninsula, Cap Sizun).

Low thickets of *Sileno maritimae-Ulicetum maritimae* and more rarely *Sileno maritimae-Ulicetum humilis* are preceded by a salt-tolerant fringe dominated by *Dactylis glomerata* and *Hyacinthoides non-scripta* often accompanied by *Silene vulgaris* subsp. *maritima* and corresponding to *Hyacintho non scriptae-Dactyletum glomeratae* (J.-M. & J. Géhu 1963) Bioret & Géhu 1996, on thin, rocky but moist soils.

On sandy veneers of cliff tops, the acidophilous fringe of a *Teucrium scorodonia-Brachypodium rupestre* association (cf. *Teucro scorodoniae-Brachypodietum rupestris* Bioret 2008) grows on a sandy-humic substrate; it accompanies the *Ulici maritimi-Ericetum cinereae* heath.

On shallow soils enriched in shell debris, the basophilous fringe of *Serratula tinctoria* subsp. *seoanei-Brachypodium rupestre* (cf. *Serratulo seoanei-Brachypodietum rupestris* Bioret & Glemarec *in* Bioret 2008) is associated with *Helianthemo nummularii-Ulicetum maritimi*.

At the summit of dolerite veins and associated with the *Peucedanum officinale* and *Ulex europaeus* var. *maritimus* thicket, a fringe dominated physiognomically and floristically by *Peucedanum officinale* and *Brachypodium rupestre* develops on deep clay soils that are base-rich due to erosion of the magmatic bedrock: *Brachypodium rupestre-Peucedanum officinale* Bioret *et al.* 2014.

2.5. Maritime scrub vegetation

The most frequently encountered maritime scrub is that which develops landward from the *Ulici maritimi-Ericetum cinereae* heath: dominated physiognomically and floristically by *Ulex europaeus* var. *maritimus* and *Prunus spinosa*, which can become dominant in mature phases, it is *Ulici maritimi-Prunetum spinosae* (Géhu & Géhu-Franck 1985) Bioret *et al.* 1991.

On the top of sandstone cliffs, in contact with the dry *Ulici humilis-Ericetum cinereae* heath, a blackthorn thicket, characterised by a floristic combination associating *Ulex galli* var. *humilis* and *Prunus spinosa* develops on shallow, organic, rocky soils: *Ulici humilis-Prunetum spinosae* Bioret *et al.* 2014.

2.6. Dune and backdune vegetation

Some rare dune slacks with limited spread are found on the eastern end of Cap d'Erquy (Lourtuais and Portuais dunes) and in the western part of Cap Fréhel. On the Lourtuais dune slack, the strong storms in the winter of 2013-2014 led to the temporary disappearance of the first pioneer zones of the *Beta vulgaris* subsp. *maritima-Atriplex laciniata* association (cf. *Beto maritimae-Atriplicetum laciniatae* R. Tx. (1950) 1967) and the *Euphorbia paralias-Elymus farctus* subsp. *boreo-atlanticus* embryo dunes (cf. *Euphorbio paraliae-Elymetum boreo-atlanticum* R. Tx. 1945 in Br.-Bl. & R. Tx. 1952), which were not observed in spring of 2014. However, the mobile dunes characterised by *Ammophila arenaria* that are part of the *Euphorbia paralias-Ammophila arenaria* complex (cf. *Euphorbio paraliae-Ammophiletum arenariae* R. Tx. 1945 in Br.-Bl. & R. Tx. 1952) remain in place.

At the upper margin of this zone, the short turf grassland of the fixed dune corresponding to *Hornungia petraea-Tortula ruralis* (cf. *Hornungio petraeae-Tortuletum ruraliformis* Géhu & de Foucault 1978 *corr.* Bioret *et al.* 2014) rapidly grades into a fringe dominated by *Geranium sanguineum*, called *Ulici maritimi-Geranium sanguinei* (Géhu 1963) J.-M. & J. Géhu 1983 that precedes a low undergrowth of *Rubia peregrina* and *Ligustrum vulgare*, *Rubio peregrinae-Ligustretum vulgare* Géhu 2007.

2.7. Meso-hygrophilous *Salix atrocinerea* willow grove

This is the only woody vegetation found on the headlands in Cap d'Erquy and Cap Fréhel. Preceded seaward by a bracken stand and a blackthorn thicket, this willow grove physiognomically and floristically dominated by *Salix atrocinerea* shows a relatively narrow, linear distribution restricted to the dolerite veins on the capes, either on mounds or in depressions with deep colluvium-enriched soils. This species-poor assemblage is the beginning of an edaphic-hygrophilous series of *Salix* formations that require further, more detailed description.

2.8. Natural heritage value

At the scale of the Armorican Massif and the French Atlantic coast, the coastal vegetation of Cap d'Erquy and Cap Fréhel is rich with respect to the diversity of the plant communities and their spatial extent. Their legal protected area status and conservation management help preserve this remarkable natural heritage. A large number of plant associations inventoried are of major heritage interest (Bensettiti *et al.* 2004, Bioret *et al.* 2011).

3. Syntaxonomic scheme of the main plant assemblages on Cap d'Erquy and Cap Fréhel

The syntaxonomic scheme proposed below follows for the most part that of Bardat *et al.* (2004) for higher classification levels.

EUPHORBIO PARALIAE-AMMOPHILETEA AUSTRALIS Géhu & Géhu-Franck 1988 *corr.* Géhu *in* Bardat *et al.* 2004

Ammophiletalia australis Braun-Blanq. 1933

Ammophilon arenariae (Tüxen *in* Braun-Blanq. & Tüxen 1952) Géhu 1988

Ammophilenion arenariae Géhu 1988

Euphorbio paraliae-Ammophiletum arenariae Tüxen 1945 *in* Br.-Bl. & Tüxen 1952

KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS Klika *in* Klika & V.Novak 1941

Artemisio lloydii-Koelerietalia albescentis G.Sissingh 1974

Koelerion albescentis Tüxen 1937

Hornungio petraeae-Tortuletum ruraliformis Géhu & de Foucault 1978 *corr.* Bioret *et al.* 2014

AGROPYRETEA PUNGENTIS Géhu 1968

Agropyretalia pungentis Géhu 1968

Agropyron pungentis Géhu 1968

Beto maritimae-Agropyretum pungentis (Arènes 1933) Corillion 1953

ASPLENIETEA TRICHOMANIS (Braun-Blanq. *in* H.Meier & Braun-Blanq. 1934) Oberd. 1977

Asplenienalia lanceolato-obovati Loisel 1970

Androsacetalia vandellii Braun-Blanq. *in* H.Meier & Braun-Blanq. 1934 *nom. corr.*

Asplenio billotii-Umbilicion rupestris B.Foucault 1988

Umbilico rupestris-Asplenietum billoti de Foucault 1979

ARMERIO MARITIMAE-FESTUCETEA PRUINOSAE Bioret & Géhu 2008

Crithmo maritimi-Armerietalia maritimae Géhu 1975

Crithmo maritimi-Armerion maritimae Géhu 1968

Armerio maritimae-Asplenienion marini Géhu 2008

Armerio maritimae-Asplenietum marini Géhu & Géhu-Franck 1984

Crithmo maritimi-Limonienion binervosi Géhu & Géhu-Franck 1984

Spergulario rupicolae-Crithmetum maritimi (Roux & Lahondère 1960) Géhu 1962 *nom inv.*

Crithmo maritimi-Juncetum acuti Bioret 2008

Armerio maritimae-Plantaginetum coronopodis (Van den Berghen 1979) Bioret & Géhu 2008

Sileno maritimae-Festucenion pruinosae (Géhu et Géhu-Franck 1984) Bioret & Géhu 2008

Armerio maritimae-Festucetum pruinosae Géhu 2008

Spergulario rupicolae-Silenetum maritimae Bioret & Géhu 2000

Spergulario rupicolae-Armerietum maritimae Géhu 2008
Festuco pruinosa-Osmundetum regalis Géhu & Bioret 2000
Heracleo sphondylii-Festucetum pruinosa Bioret & Géhu 2008
Sileno zetlandicae-Festucetum pruinosa Bioret & Géhu 2008
Dactylo oceanicae-Daucetum gummiferi Géhu 2008
Armerio maritimae-Hederetum helici Géhu & Duquet 2009
Orobancha bederea-Hederetum helici (Géhu 1961) 2006
Hedero helici-Silenetum maritimae Géhu 2008

Festucenion buonii Bioret *et al.* 2014

Sedo anglici-Festucetum armoricanae Bioret *et al.* 2014

SEDO ALBI-SCLERANTHETEA BIENNIS Braun-Blanq. 1955

Sedo albi-Scleranthetalia biennis Braun-Blanq. 1955

Sedion anglici Braun-Blanq. in Braun-Blanq. & Tüxen 1952

Dactylo oceanicae-Sedetum anglici J.-M & J. Géhu & Caron 1978 corr. Géhu 2008

HELIANTHEMATEA GUTTATI (Braun-Blanq. ex Rivas Goday 1958) Rivas Goday & Rivas Mart. 1963

Helianthemetalia guttati Braun-Blanq. in Braun-Blanq., Molin. & He.Wagner 1940

Thero-Airion Tüxen ex Oberd. 1957

Filagini minima - Airetum praecocis Wattez, Géhu & de Foucault 1978

Scilla autumnalis et *Romulea columnae* community

SAGINETEA MARITIMAE V.Westh., C.Leeuwen & Adriani 1962

Saginetalia maritimae V.Westh., C.Leeuwen & Adriani 1962

Saginion maritimae V.Westh., C.Leeuwen & Adriani 1962

Sagino maritimae-Catapodietum marini Tüxen in Tüxen & Westhoff 1963

Soncho oleracei-Cochlearietum danicae Géhu & de Foucault 1978

Catapodio marini-Trifolietum scabri Géhu & de Foucault 1978

CALLUNO VULGARIS-ULICETEA MINORIS Braun-Blanq. & Tüxen ex Klika in Klika & Hadak 1944

Ulicetalia minoris Quantin 1935

Dactylido oceanicae-Ulicion maritimi Géhu 1975

Ulici humilis-Ericetum cinerea (Vanden Berghen 1958) J.-M. & J. Géhu 1975

Ulici maritimi-Ericetum cinerea (Géhu 1962) J.-M. & J. Géhu 1975

Ulici humilis-Ericetum ciliaris (Vanden Berghen 1958) J.-M. & J. Géhu 1975

Ulici humilis-Ericetum tetralicis Bioret *et al.* 2014

TRIFOLIO MEDII-GERANIETEA SANGUINEI Th. Müll. 1962

Origanetalia vulgaris Th.Müll. 1962

Galio littoralis-Geranion sanguinei Géhu & Géhu-Franck 1983

Serratulo seoani-Brachypodietum rupestris Bioret & Glemarec *in* Bioret 2008
Ulici maritimi-Geranium sanguinei (Géhu 1963) Géhu & Géhu-Franck 1983
Galio littoralis-Brachypodietum rupestris Géhu & Géhu-Franck 1984 *emend.* Bioret 2008

MELAMPYRO PRATENSIS-HOLCETEA MOLLIS H.Passarge 1994

Melampyro pratensis-Holcetalia mollis H.Passarge 1979 *Conopodio majoris-Teucrion scorodoniae* Julve *ex* Boulet & Rameau *in* Bardat *et al.* 2004
Melandrio zelandici-Pteridietum aquilini Géhu & Géhu-Franck 1983
Brachypodio rupestris-Peucedanetum officinalis Bioret *et al.* 2014
Teucrio scorodoniae-Brachypodietum rupestris Bioret 2008
Hyacintho non scriptae-Dactyletum glomeratae (J.-M. & J. Géhu 1963) Bioret & Géhu 1996

CRATAEGO MONOGYNAE-PRUNETEA SPINOSAE Tüxen 1962

Prunetalia spinosae Tüxen 1952
Lonicerion periclymeni Géhu, B.Foucault & Delelis 1983
Ulici maritimi-Prunetum spinosae (Géhu & Géhu-Franck 1985) Bioret *et al.* 1991
Ulici humilis-Prunetum spinosae Bioret *et al.* 2014
Sileno maritimae-Ulicetum maritimi Géhu 2008
Sileno maritimae-Ulicetum humilis Rivas-Martínez 1979
Peucedano officinalis-Ulicetum europaei Bioret *et al.* 2014
Helianthemo nummulario-Ulicetum maritimi Bioret *et al.* 2014
Rubio peregrinae-Ligustretum vulgaris Géhu 2007

FRANGULETEA ALNI Doing *ex* V. Westh. *in* V. Westh. & den Held 1969

Salicetalia auritae Doing *ex* Krausch 1968
Saulaie méso-hygrophile à *Salix atrocinerea*

4. The symphytosociological and geosymphytosociological approach

The symphytosociological and geosymphytosociological approach was used to build a scheme based on the different integrative phytosociological units at Cap d'Erquy and Cap Fréhel. These units were used to construct in 2014 the maps of the vegetation series found on Cap Fréhel (Figure 3) and Cap d'Erquy (Figure 4).



Figure 3. Map of vegetation succession of Fréhel site. From Documents phytosociologiques (2014)

Légende

A. Curtaséries de landes sèches

-  A1. *Sileno maritimae-Ulco humilis curtosigmatum*
-  A2. *Sileno maritimae-Ulco maritimi curtosigmatum*
-  A3. *Ulici maritimi-Erico cinerea curtosigmatum*
-  A4. *Ulici humilis-Erico cinerea curtosigmatum*
-  A5. *Helianthemo nummularii-Ulco maritimi curtosigmatum*
-  A6. *Peucedano officinalis-Ulco maritimi curtosigmatum*

B. Curtaséries de landes mésophiles et hygrophiles

-  B1. *Ulici humilis-Erico ciliaris curtosigmatum*
-  B2. *Ulici humilis-Erico tetralicis curtosigmatum*
-  B3. *Ulici humilis-Erico ciliaris / Ulici humilis-Erico tetralicis curtosigmatum*

C. Curtaséries de fourrés littoraux

-  C1. *Ulici humilis-Pruno spinosae curtosigmatum*
-  C2. *Ulici maritimi-Pruno spinosae curtosigmatum*

D. Séries arrières dunaires

-  D1. *Rubio peregrini-Ligustro vulgaris curtosigmatum*

E. Séries temporelles hygrophiles

-  E1. Série de la Saulaie à *Salix atrocinerea*

F. Géopermaséries

-  F1. *Armerio maritimae-Festuco pruinosa geopermasigmatum*
-  F2. *Euphorbio paraliae-Ammophilo australis geopermasigmatum*
-  F3. Géopermasérie de l'*Oxycocco palustris-Ericion tetralicis*

G. Autres

-  G1. Urbanisation, routes, parking
-  G2. Cultures

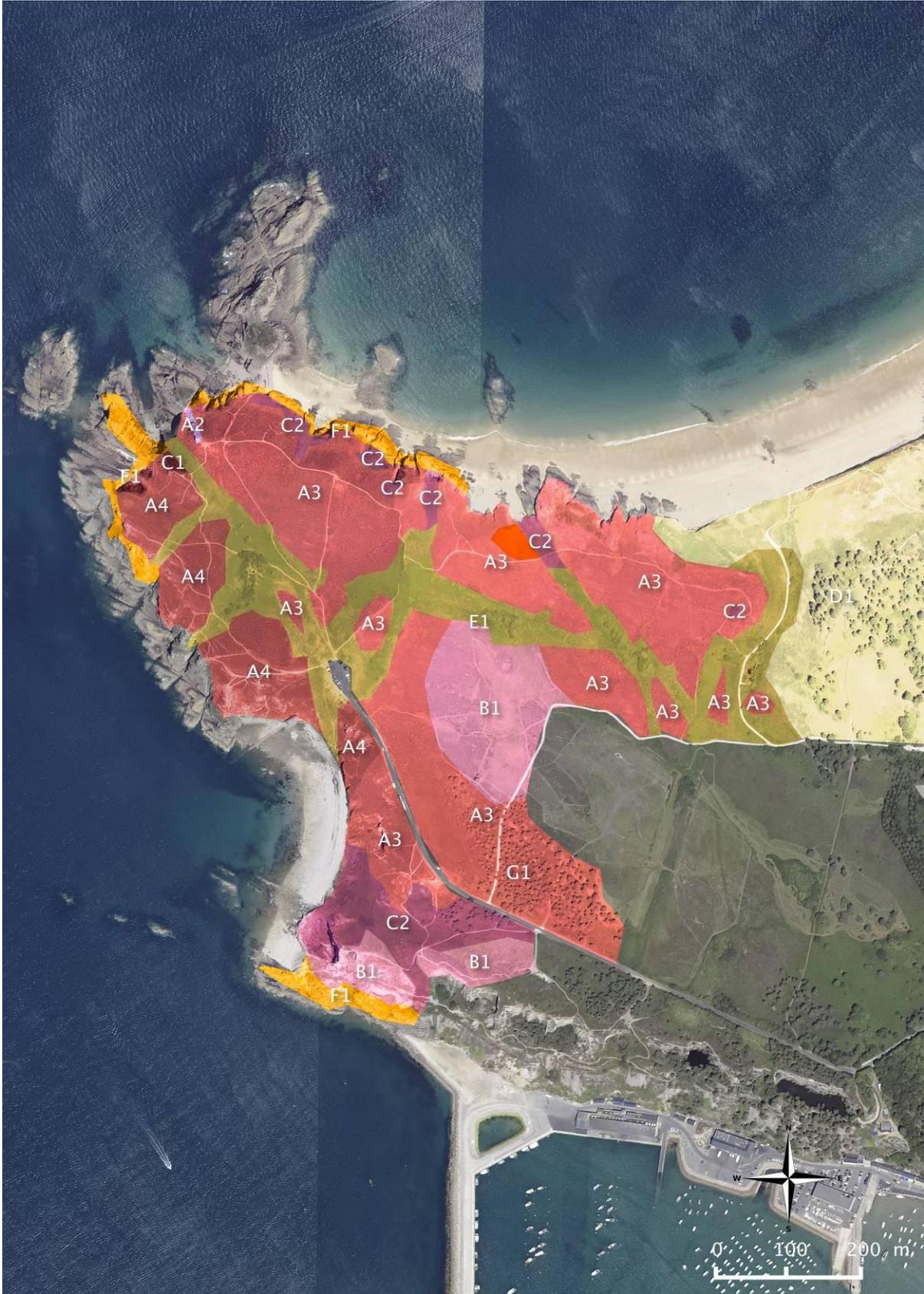


Figure 4. Map of vegetation succession of Erquy site. From Documents phytosociologiques (2014)

Légende

A. Curtaséries de landes sèches

-  A1. *Sileno maritimae-Ulico humilis curtosigmatum*
-  A2. *Sileno maritimae-Ulico maritimi curtosigmatum*
-  A3. *Ulici maritimi-Erico cinerea curtosigmatum*
-  A4. *Ulici humilis-Erico cinerea curtosigmatum*
-  A5. *Helianthemo nummularii-Ulico maritimi curtosigmatum*
-  A6. *Peucedano officinalis-Ulico maritimi curtosigmatum*

B. Curtaséries de landes mésophiles et hygrophiles

-  B1. *Ulici humilis-Erico ciliaris curtosigmatum*
-  B2. *Ulici humilis-Erico tetralicis curtosigmatum*
-  B3. *Ulici humilis-Erico ciliaris / Ulici humilis-Erico tetralicis curtosigmatum*

C. Curtaséries de fourrés littoraux

-  C1. *Ulici humilis-Pruno spinosae curtosigmatum*
-  C2. *Ulici maritimi-Pruno spinosae curtosigmatum*

D. Séries arrières dunaires

-  D1. *Rubio peregrini-Ligustro vulgaris curtosigmatum*

E. Séries temporihygrophiles

-  E1. Série de la Saulaie à *Salix atrocineria*

F. Géopermaséries

-  F1. *Armerio maritimae-Festuco pruinosa geopermasigmatum*
-  F2. *Euphorbio paraliae-Ammophilo australis geopermasigmatum*
-  F3. Géopermasérie de l'*Oxycocco palustris-Ericion tetralicis*

G. Autres

-  G1. Urbanisation, routes, parking
-  G2. Cultures

5. Botanical partial inventory of the Cap d'Erquy and Cap Fréhel (2014).

Trachéophytes (nomenclature TAXREF 7)

- Acer pseudoplatanus* L. 1753
Achillea millefolium L. 1753
Agrostis capillaris L. 1753
Agrostis stolonifera var. *maritima*
Agrostis stolonifera subsp. *maritima* (Lam.) Vasc. 1974
Aira caryophyllea L. 1753
Aira praecox L. 1753
Allium sphaerocephalon L. 1753
Ammophila arenaria (L.) Link 1827
Anacamptis morio (L.) R.M.Bateman, Pridgeon & M.W.Chase 1997
Anisantha diandra (Roth) Tutin ex Tzvelev 1963
Anisantha sterilis (L.) Nevski 1934
Anthoxanthum odoratum L. 1753
Anthyllis vulneraria L. 1753
Aphanes microcarpa (Boiss. & Reut.) Rothm. 1937
Arenaria serpyllifolia L. 1753
Armeria maritima Willd. 1809
Arum italicum Mill. 1768
Asplenium marinum L. 1753
Asplenium obovatum subsp. *billotii* (F.W.Schultz) O.Bolòs, Vigo, Massales & Ninot 1990
Beta vulgaris subsp. *maritima* (L.) Arcang. 1882
Betonica officinalis L. 1753
Blackstonia perfoliata (L.) Huds. 1762
Brachypodium rupestre (Host) Roem. & Schult. 1817
Briqua media L. 1753
Briqua minor L. 1753
Bromopsis erecta (Huds.) Fourr. 1869
Bromus hordeaceus subsp. *feronii* (Mabille) P.Sm. 1968
Bupleurum baldense Turra 1764
Calluna vulgaris (L.) Hull 1808
Cardamine hirsuta L. 1753
Carduus tenuiflorus Curtis 1793
Carex arenaria L. 1753
Carex binervis Sm., 1800
Carex distans L. 1759
Carex extensa Gooden. 1794
Carex flacca Schreb. 1771
Carex nigra (L.) Reichard 1778
Carex panicea L. 1753
Carex pilulifera L. 1753
Carlina vulgaris L. 1753
Catapodium marinum (L.) C.E.Hubb. 1955
Catapodium rigidum (L.) C.E.Hubb. 1953
Centaurea nigra L. 1753
Centaureum erythraea var. *capitatum* (Willd.) Melderis 1972
Cerastium diffusum Pers. 1805
Cerastium glomeratum Thuill. 1799
Cerastium semidecandrum L. 1753
Cirsium acaule (L.) Scop. 1769
Cirsium arvense (L.) Scop. 1772
Cirsium filipendulum Lange 1861
Cochlearia danica L. 1753
Convolvulus arvensis L. 1753
Convolvulus soldanella L. 1753
Crassula tillaea Lest.-GarL. 1903
Crithmum maritimum L. 1753
Cuscuta epithymum (L.) L. 1774
Cynosurus echinatus L. 1753
Dactylis glomerata L. 1753
Dactylis glomerata subsp. *oceanica* G.Guignard 1986
Dactylorhiza maculata subsp. *ericetorum* E. F. Linton) P. H. & Summerth 1965
Danthonia decumbens (L.) DC. 1805
Daucus carota L. subsp. *carota*
Daucus carota subsp. *gummifer* (Syme) Hook.f. 1884
Digitalis purpurea L. 1753
Dryopteris dilatata (Hoffm.) A.Gray 1848
Dryopteris filix-mas (L.) Schott 1834
Elytrigia acuta (DC.) Tzvelev 1973
Epilobium angustifolium L. 1753
Epilobium tetragonum L. 1753
Equisetum arvense L. 1753
Equisetum × *litorale* Kuhlew. ex Rupr.
Erica ciliaris Loefl. ex L. 1753
Erica cinerea L. 1753
Erica tetralix L. 1753
Eupatorium cannabinum L. 1753
Euphorbia segetalis subsp. *portlandica* (L.) Litard. 1936
Festuca armoricana Kerguelén, 1975
Festuca juncifolia Chaud. 1821
Festuca rubra subsp. *pruinosa* (Hack.) Piper 1906
Fumaria capreolata L. 1753
Galium aparine L. 1753
Galium verum var. *maritimum* DC. 1805
Gentiana pneumonanthe L. 1753
Geranium molle L. 1753
Geranium purpureum Vill. 1786
Geranium robertianum L. 1753
Geranium sanguineum L. 1753
Hedera helix L. 1753
Helianthemum nummularium (L.) Mill. 1768
Heracleum sphondylium L. 1753
Heracleum sphondylium var. *trifoliatum* (Blanch.) Reduron 2007
Hieracium umbellatum L. 1753
Holcus lanatus L. 1753
Holcus mollis L. 1759
Hornungia petraea (L.) Rchb. 1838
Hyacinthoides non-scripta (L.) Chouard ex Rothm. 1944
Hypochoeris glabra L. 1753
Hypochoeris radicata L. 1753
Iris foetidissima L. 1753
Jacobaea erucifolia (L.) P.Gaertn., B.Mey. & Scherb. 1801
Jacobaea maritima (L.) Pelsler & Meijer 2005
Jacobaea vulgaris Gaertn. 1791
Jasione maritima (Duby) Merino 1906
Jasione montana L. 1753
Juncus acutiflorus Ehrh. ex Hoffm. 1791
Juncus acutus L. 1753
Juncus bufonius L. 1753
Juncus maritimus Lam. 1794
Kindbergia praelonga (Hedw.)
Knautia arvensis (L.) Coult 1828
Koeleria albescens DC. 1813
Leucanthemum vulgare Lam. 1779
Ligustrum vulgare L. 1753
Limbaria crithmoides (L.) Dumort. 1827
Linum usitatissimum subsp. *angustifolium* (Huds.) Thell. 1912
Linum catharticum L. 1753
Logfia minima (Sm.) Dumort. 1827
Lagurus ovatus L. 1753
Lonicera periclymenum L. 1753
Lotus corniculatus L. 1753
Lysimachia arvensis (L.) U.Manns & Anderb. 2009
Lysimachia arvensis subsp. *parviflora* (Hoffmanns & Link) Peruzzi 2010
Lysimachia tenella L. 1753
Mibora minima (L.) Desv. 1818
Minuartia hybrida (Vill.) Schischk. 1936

- Molinia caerulea* (L.) Moench 1794
Myosotis discolor Pers. 1797
Myosotis ramosissima Rochel. 1814
Narcissus pseudonarcissus L. 1753
Ononis spinosa subsp. *procurrens* (Wallr.) Briq. 1913
Osmunda regalis L. 1753
Parentucellia latifolia (L.) Caruel 1885
Pedicularis sylvatica L. 1753
Peucedanum officinale L. 1753
Phleum arenarium L. 1753
Pilosella officinarum F.W.Schultz & Sch.Bip. 1862
Pilosella peleteriana (Mérat.) F. W. Schult & Sch. Bip. 1862
Pimpinella saxifraga L. 1753
Pinguicula lusitanica L. 1753
Plantago coronopus L. 1753
Plantago lanceolata L. 1753
Plantago lanceolata var. *lanuginosa* Bluff. & Fingerh. 1825
Plantago maritima L. 1753
Poa annua L. 1753
Poa bulbosa L. 1753
Poa trivialis L. 1753
Polygala serpyllifolia Hose 1797
Polygonatum odoratum (Mill.) Druce 1906
Polypodium interjectum Shivas 1961
Potentilla erecta (L.) Räusch. 1797
Poterium sanguisorba L. 1753
Primula veris L. 1753
Primula vulgaris Huds. 1762
Prospero autumnale (L.) Speta 1982
Prunus spinosa L. 1753
Pseudarrhenatherum longifolium (Thore) Rouy 1922
Pseudognaphalium undulatum (L.) Hilliard & Burt 1981
Pteridium aquilinum (L.) Kuhn 1879
Pulmonaria longifolia (Bastard) Boreau 1857
Romulea columnae Sebast. & Mauri 1818
Rosa canina L. 1753
Rosa spinosissima L. 1753
Rubia peregrina L. 1753
Rubus sp.
Rumex acetosa L. 1753
Rumex acetosa subsp. *biformis* (Lange) Castrov. & Valdés Berm. 1976
Rumex acetosa L. 1753
Ruscus aculeatus L. 1753
Sagina maritima G.Don 1810
Salix atrocinerea Brot. 1804
Salix repens L. 1753
Sambucus nigra L. 1753
Samolus valerandi L. 1753
Saxifraga tridactylites L. 1753
Schoenus nigricans L. 1753
Scorzonera humilis L. 1753
Scrophularia scorodonia L. 1753
Sedum acre L. 1753
Sedum anglicum Huds. 1778
Senecio sylvaticus L. 1753
Senecio vulgaris L. 1953
Serratula tinctoria subsp. *seoanei* (Willk.) Laínz 1971
Silene dioica var. *zetlandica* (Compton) Kerguelén 1998
Silene latifolia subsp. *alba* (Mill.) Greuter & Burdet 1982
Silene nutans L. 1753
Silene uniflora Roth 1794 subsp. *uniflora* (= *Silene vulgaris* subsp. *maritima* (With.) A Löve & D Löve)
Simethis mattiazzi (Vand.) G.López & Jarvis 1984
Solidago virgaurea subsp. *rupicola* (Rouy) Lambinon 1962
Sonchus arvensis L. 1753
Sonchus oleraceus L. 1753
Spergula rupicola (Lebel ex Le Jol.) G.López 2010
Stellaria holostea L. 1753
Stellaria media (L.) Vill. 1789
Teesdalia nudicaulis (L.) R.Br., 1812
Teucrium scorodonia L. 1753
Thymus praecox subsp. *britannicus* (Ronniger) Holub 1973
Trifolium arvense L. 1753
Trifolium scabrum L. 1753
Trisetum flavescens (L.) P. Beauv.
Ulex gallii var. *humilis* Planch. 1849
Ulex europaeus var. *maritimus* auct.
Ulmus minor Mill. 1768
Umbilicus rupestris (Salisb.) Dandy 1948
Urtica dioica L. 1753
Vicia angustifolia L. 1759
Vicia sativa L. 1753
Viola riviniana Rchb. 1823
Vulpia bromoides (L.) Gray 1821

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7. Description of the Sensitive Natural Area of Cap d'Erquy and an overview of the actions implemented by the departmental council

Text O. Le Bihan, ENS Côtes d'Armor department council

Cap d'Erquy was acquired by the Côtes d'Armor *département* between 1980 and 1986 as part of its Sensitive Natural Areas plan. Today, the area covers 170 ha and represents 85% of the Sensitive Natural Area land that can potentially be acquired in this sector.

7.1. Protected area status

- The total protected area (Act of May 1930) was created by the decree of 16 October 1978;
- The whole area was declared a Natural Area in the local Erquy land planning document (*PLU*) and parts were declared as a Protected Wooded Area;
- The whole area was declared a Remarkable Site in accordance with the Coastal Act;
- The whole area is included, along with the Remarkable Sites, within the contours of the Natura 2000 site no. 11 (5300011) "Capd'Erquy – Cap Fréhel"

7.2. The value of the natural area

The Cap d'Erquy site is a designated Remarkable Site, with high natural heritage value in consideration of the following features:

- Cliff vegetation and maritime grasslands;
- Dune environments, sand veneers and alkaline low marshes;
- Heathland habitats (dry, mixed and wet heaths);
- Plant species (high species richness, high number of rare or vulnerable taxa);
- Animal species, particularly bird and insect species (alcon blue butterfly, scaly cricket).

The varied mesological situations, ranging from sandstone cliffs to cliff tops dominated by dry or mixed heath, sand veneers, depressions containing alkaline low marshes and wet heath all contribute to the diversity of plant assemblages found there.

In addition, certain agricultural practices in particular (mowing/removal and grazing on heathlands and sand veneer formations) help maintain these habitats in good conservation status. The diversity of management methods also leads to the different remarkable plant formations.

The site also harbours a historical record of the changes in landscape and human activities:

- Occupation during the Gallo-Roman era;
- Past and present agricultural practices (mowing and grazing on heathlands and grasslands, etc.);
- Forestry practices (plantation of resinous species);
- Former economic activities involving sandstone quarries.

7.3. The value of studying the natural heritage and of scientific environmental monitoring

The Cap d'Erquy site is a Sensitive Natural Area of prime importance for biodiversity in the Côtes d'Armor *département* and also on a regional level. The rare natural habitats, of interest for the European community, unique or diversified must be preserved in consideration of their remarkable natural heritage. Knowledge of the natural habitats (their structure, composition, functional ecology, links with human activities) and species constitute a first preliminary step for

- Establishing a diagnosis at a given point in time of the natural environment and formulating appropriate conservation measures;
- Understanding ecosystem function;
- Promoting environmental education and awareness of natural environment;
- Assessing the conservation status of a site by surveying and comparing stations at regular intervals.

8. Cap Fréhel: ecosystem restoration

8.1. Background

The Cap Fréhel site is highly frequented by tourists, with 1.0 to 1.3 M visitors per year, particularly in the summer. Of these visitors, 80% visit the cliff top beyond the lighthouse. Until 1998, trampling affected maritime grasslands and heathlands alike, and created multiple tracks. Trampling, combined with wind and rain erosion, led to ever deeper and wider paths.

Declared a protected area in 1967, degradation was halted and restoration of the site was undertaken as of 1999.

8.2. Restoration of the site

The chosen plan included

- 1 – Keeping visitors on marked footpaths and preventing trampling of other areas by roping them off;
- 2 – Restoring damaged grasslands and heathlands and preserving those that survived, with installation of information panels. The selected restoration plan aimed to induce recovery of the ecological communities from the diaspore bank found in the soil or nearby. This passive restoration process preserves the oligotrophic nature of these ecosystems, a key element in the resilience process. On some slopes, geotextiles (coconut fibre mats) were installed.

8.3. Assessment of restoration actions

- 1 – Visitors by and large stay on the trails and respect the roped-off areas; the high number of visitors inspires environmentally respectful conduct.

2 – Grasslands and heathlands show relatively good resilience on oligotrophic ranker soils.

- Winter-spring bryophyte communities: *Ceratodon purpureus*, *Campylopus introflexus*, *Polytrichum juniperinum*, etc.
- The winter therophyte communities: *Aira praecox*, *Vulpia bromoides*, *Arenaria serpyllifolia*, *Poa annua*, etc.
- The *Plantago coronopus*, *Hypochaeris radicata*, *Dactylis glomerata*, etc. communities
- The *Sedum anglicum* and *Filago minima* communities
- The heath communities made up of *Erica cinerea*, *Calluna vulgaris*, *Danthonia decumbens*, etc.

3 – On slopes for which a geotextile was installed, the mat trapped seeds, primarily grass caryopses, as well as minerals, leading to eutrophication. The resulting grasslands were composed of *Holcus lanatus*, *Anthoxanthum odoratum*, *Agrostis capillaris* and other common species that colonise these biotopes. On these slopes, recovery of the heathland is likely impossible.

Thus, after 15 years, the assessment shows a generally positive response, although the authorised tracks have continued to erode and deepen. Bare rocks are perhaps not, for these cliffs, a detriment to the environment of the site.

8.4. References

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Perrin G. 2002 – Evaluation des méthodes de restauration et de réhabilitation des sentiers de Cap d'Erquy et du Cap Fréhel. Mémoire stage Univ Rennes1 – C.G. 22, 67p.

Rozé F. Forgeard F. & Gallet S. 1999 – Identification, cartographie des habitats botaniques. Rapport DIREN / Univ Rennes 1, 14p.

9. Lancieux Bay

The entire Lancieux Bay represents one of the richest sites with respect to species diversity and plant communities for the entire coast. From Géhu (1979). Global study and analysis of the mud banks and salt and brackish marshes of the French Atlantic seaboard, Final report, Ministry in charge of the environment.

en 34 bis = 35 espèces végétales phanérogamiques

Agropyron junceum, *pungens*, *repens* (marit.) ; *Althaea officinalis* ;
Apium graveolens ; *Armeria maritima* ; *Arthrocnemum perenne* ;
Aster tripolium ; *Atriplex hastata* (salina) ; *Beta maritima* ;
Cakile maritima ; *Carex extensa*, *otrubae* ; *Festuca littoralis* ;
Glaux maritima ; *Halimione portulacoides* ; *Juncus gerardii*, *ma-*
ritimus ; *Limonium vulgare* ; *Lotus tenuis* ; *Oenanthe lachenalii* ;
Parapholis strigosa ; *Phragmites australis* ; *Plantago maritima* ;
Puccinellia maritima ; *Rumex crispus* ; *Ruppia maritima* ; *Salicor-*
nia disarticulata, *ramosissima* ; *Samolus valerandi* ; *Scirpus ma-*
ritimus (compact.) ; *Spartina townsendii* ; *Spergularia media* ;
Suaeda maritima (vulg.) ; *Triglochin maritima*.

et les algues suivantes :

Bostrychia scorpioides ; *Vaucheria* div. sp.

en 34 bis = 19 phytocoenoses

/ + *Agropyretum acuti* ; / 1 *Agropyro-Althaeetum* ; / + *Atriplici-*
Betetum ; / 1 *Atriplici-Agropyretum pungentis* ; / 1 *Atriplici-*
Agropyretum repentis ; / + *Beto-Atriplicetum* ; 0/4 *Bostrychio-*
Halimionetum ; 0/3 *Festucetum littoralis* ; 0 3 *Halimiono-Puccinel-*
lietum maritimae ; / 1 *Juncetum gerardii* ; /03 *Junco-Caricetum*
extensae ; 0 3 *Plantagini-Limonietum* ; /0 2,3 *Phragmitetum*
 (saumâtre) ; . 2 *Fuccinellio-Arthrocnemetum perennis* ; . + *Rup-*
pietum maritimae ; 0 2 *Salicornietum obscurae* ; . + *Salicornietum*
pusillo-ramosissimae ; . + *Scirpetum maritimi* ; 0 3,4 *Spartinetum*
townsendii.

ROUTE 2 - CLIFF, SALTMARSH: CANCALE AND MONT-SAINT-MICHEL BAY

1. Cancale

Located between the Mont-Saint-Michel Bay and the Emerald Coast, Grouin Point, a Sensitive Natural Area of the Ille-et-Vilaine *département* benefits from the measures deployed to study and protect two large natural entities: protected area and registered as part of Mont-Saint-Michel Bay, the European Natura 2000 sites of Mont-Saint-Michel Bay and the rocky coast from Cancale to Param. The Ille-et-Vilaine *département* published a discovery guide for this protected natural area.

A little history



A semaphore signal.

➔ **On the top of the point there is a semaphore signal built in 1861.**

It was used to monitor the passing of boats off the point, to alert them using signals if there was any danger and to provide rescue services if necessary. Meteorological observations were taken there and then used to help both the vessels at sea and the national Meteorology department.

The General Council purchased this semaphore system in 2000 with the aim of opening it to the public and ensuring that the Pointe du Grouin natural site was preserved. During the summer there is

an exhibition showing off all the riches of the natural spaces to be found along the coast.

Thanks to a partnership between the State, the Department and Cancale town council, the semaphore system is once again playing its coastal surveillance role and ensuring the safety of sailors during the summer months.

Due to its strategic position, the Germans built a large network of blockhouses on the Pointe du Grouin during the Second World War.

Flora

The plant landscape of the Pointe du Grouin is highly characteristic of the region's rocky coastline.



Bell Heather.

The vegetation is spread out into a mosaic of plants which are subtly conditioned by the wind, the nature of the soil and the topography.

The edges of the cliffs are covered here and there by the coastal grassy areas characterised by pads 4 to 8 inches high armeria maritima, sea campion, English stonecrop, sheep's bit, musk thistle and Queen

Anne's lace. As for the pennywort, it will take up any space - no matter how small - which happens to be available.

The point is dominated by the common gorse and by the western gorse, the blackthorn, the Burnet rose, bracken, ivy and brambles.

This coastal moor area is 20 inches high and is interspersed with low-lying plant formations made up of bell heather and calluna. These latter give some idea of just how poor the soil is in these places. To the east, where the soil gets thicker and the slope becomes gentler, there are meadows which are full of cocksfoot grass, tansy ragwort, mouse barley, common yarrow, mallow, scabiosa and hedge bindweed.

Further south, enjoying rather more clement living conditions, blackthorn, hawthorns and common gorse represent the highest stage of the moor reaching almost 2 yards.

English Stonecrop.



Fauna



The great black-backed gull.

|| The Île des Landes is the largest nesting site for coastal birds in the Ille-and-Vilaine area.

- It has been a natural reserve since 1961 and is managed by Brittany-Vivante-SEPNB; amongst other things it is home to the largest colony of great cormorants in Brittany. There are four other species all sharing the space.
- The shag is smaller than the great cormorant and spends all his time on the coast. The herring gull, which is to be found all along the French coast, will not think twice about flying inland to the towns to find food. The lesser black-headed gull is a migrating bird and returns to North Africa every winter. Finally the great black-backed gull is the largest member of the family and is a predator much feared by other birds.

easily see puffins, skuas, northern gannets and other seabirds.

The coastal moor area of the Pointe du Grouin is home to numerous members of the Passeriformes family such as the Dartford warbler, the linnet and the stonechat.

Finally, the blockhouses provide housing for a bat which appears in the red book of endangered species in France: the greater horseshoe bat.



European shag.

Words underscored indicate protected species.

The work of the General Council

The General Council is working to preserve sensitive natural areas. It aims to reconcile the conservation of natural environments and biodiversity with keeping areas open to the public.

Almost all of the Pointe du Grouin - in other words almost 58 acres - belongs to the Department. To start with the General Council worked hard to organise the way that tourists visit the area. But the point became a victim of its own success and suffered serious damage (soil erosion, disappearance of coastal grassy areas, protected plant species trampled upon). So areas of plant recolonisation and a route along which people

could walk were marked out. As visitors are very keen to preserve such a high quality environment they have followed this, so the restoration plan has been a success. Even so, we cannot take our eye off the ball and must keep up the good work.

Parking areas integrated into the landscape have been made available to the public at the entrance to the Pointe du Grouin.

Ile des Landes.



1.1. Overview of the visit of the 'Pointe du Grouin'



Figure 5. Global view of the Pointe du Grouin and excursion stops. Photo MRW Zeppeline

1.2. Phytosociological overview of the vegetation found on the cliffs at 'la Pointe du Grouin' (Cancale, Ille-et-Vilaine)

The terrestrial vegetation on maritime cliffs is adapted to specific ecological conditions on wind-exposed coasts (Tüxen, 1976). Plant communities that are exposed to frequent winds and more or less direct salt spray must tolerate summer drought that can sometimes be severe, further aggravated by the drying effects of wind and salt and the absence of real soil. Exposure to these ecological constraints gave rise to the development of an array of morphological and physiological adaptations, exemplified by the presence of many 'microtaxa' (Bioret & Géhu 1999).

Above the extreme high spring-tide water mark, cliff vegetation is organised in zones parallel to the seafront, in response to decreasing maritime influence.

The splash-zone lichens (supralittoral fringe): at upper levels, these zones increase in species richness. The hydrohaline/upper splash zone is characterised in exposed conditions by *Lichina pygmaea* and in sheltered conditions by *Lichina confinis*. The hygrohaline zone is colonised by *Verrucaria maura*, *Caloplaca marina* and more landward by *Xanthoria parietina*. At the aerohaline sub-zone, *Lecanora atra* appears.

Rock crevices and sandy silt veneers show discontinuous linear vegetation dominated by chasmo-halophilous plants and chomo-halophilous plants belonging to the sub-alliances *Armeria maritima-Asplenium marinum* (cf. *Armerio maritimae-Asplenienion marini*) and *Crithmum maritimum-Limonium binervosum* (cf. *Crithmo maritimi-Limonienion binervosi*).

1.2.1. Rock-crevice vegetation

Above the high spring-tide water mark, maritime cliff vegetation (chasmo-halophilous plants) colonise rock crevices and fissures that are more or less infilled with fine deposits.

At Moulière Point, the *Armeria maritima-Asplenium marinum* association (cf. ***Armerio maritimae-Asplenietum marini*** Géhu & Géhu-Franck 1984) colonises the deepest cool, shady crevices or fissures in semi-sheltered conditions.

At Grouin Point, beyond the salt spray deposition zone, the *Umbilicus rupestris-Asplenium billotii* association (cf. ***Umbilico rupestris-Asplenietum billoti*** de Foucault 1979) colonises sheltered, dry, sunny fissures.

1.2.2. Maritime grasslands

On windy slopes, maritime grasslands on coastal rankers are composed of an *Armeria maritima-Festuca rubra* subsp. *pruinosa* association (cf. ***Armerio maritimae-Festucetum pruinosa*** Géhu 2008).

On steep ledges with minimal organic deposits, mats of sea campion are part of a *Spergularia rupicola-Silene maritima* association (cf. ***Spergulario rupicolae-Silenetum maritimae*** Bioret & Géhu 2000).

In lateral contact or seaward from the *Armeria maritima-Festuca rubra* subsp. *pruinosa* association, rocky berms are colonised by linear vegetation dominated physiognomically by thick cushions of *Armeria maritima*, corresponding to the *Spergularia rupicola-Armeria maritima* association (cf. ***Spergulario rupicolae-Armerietum maritimae*** Géhu 2008).

In very windy situations with extensive salt spray producing salinity levels close to that of salt marshes, unusual vegetation dominated by *Halimione portulacoides* characterises *Spergulario rupicolae-Halimionetum portulacoidis* Bioret & Géhu 2008.

On vertical exposed or semi-exposed rock cliff walls, curtains of ivy correspond to an *Orobanch hederae-Hedera helix* association (cf. ***Orobancho hederae-Hederetum helicis*** (Géhu 1961) 2006). It is characterised by an accumulation of organic litter and some shrub thicket species.

1.2.3. Short turf grassland and sparse grassland vegetation

Near rocky outcrops, superficial accumulations of detritus from eroded bedrock are colonised by perennial grasses of the *Dactylis glomerata-Sedum anglicum* community (cf. ***Dactylo oceanicae-Sedetum anglici*** Géhu, Géhu & Caron 1978 corr. Géhu 2008).

The open *Armeria maritima* and *Plantago coronopus* grassland located at the lower edge of the *Armerio maritimae-Festucetum pruinosa* association corresponds to ***Armerio maritimae-Plantaginietum coronopodis*** (Van den Berghen 1979) Bioret & Géhu 2008. It develops in the

primary succession conditions related to wind deflation or secondary succession due to trampling of perennial grasslands.

A sparse therophyte *Sagina maritima* grassland (cf. *Saginetea maritimae* Westhoff *et al.* 1962) develops on bare substrate created by climatic erosion at the lower edge of maritime grasslands or in depressions in these grasslands, or even in secondary succession following frequent trampling that wears the vegetation down to bare ground. This is a *Sagina maritima-Catapodium marinum* community (cf. *Sagino maritimae-Catapodium marini* R. Tx. 1963).

At the foot of boulders in nitrogen-rich conditions, a *Sonchus oleraceus-Cochlearia danica* association develops (cf. *Soncho oleracei-Cochlearietum danicae* Géhu & de Foucault *ex de* Foucault & Bioret 2010).

1.2.4. Maritime scrub vegetation

Two chamaephyte assemblages dominated physiognomically by rounded *Ulex europaeus* var. *maritimus* cushions and shrubs colonise the summits of the cliffs on Grouin Point.

In exposed to semi-sheltered conditions, a *Silene maritima-Sileno maritimae-Ulicetum maritimi* Géhu 2008

The . *Ulici maritimi-Prunetum spinosae* (Géhu & Géhu-Franck 1985) Bioret *et al.* 1991) is the most frequent maritime scrub formation. It develops at the upper edge of *Sileno-Ulicetum maritimi* or directly at the upper edge of the *Armerio-Festucetum pruinosae* grassland. It is dominated physiognomically and floristically by *Ulex europaeus* var. *maritimus* and *Prunus spinosa*, which can become dominant in mature phases of the formation.

1.2.5. Fringe vegetation

Locally, the acidophilous *Teucrium scorodonia-Brachypodium rupestre* fringe (cf. **Teucro scorodoniae-Brachypodietum rupestris** Bioret 2008) precedes that of *Ulici maritimi-Prunetum spinosae*.

1.3. Syntaxonomic scheme of the main plant assemblages at Grouin Point

The syntaxonomic scheme proposed below follows for the most part that of Bardat *et al.* (2004) for higher level classifications.

ASPLENIETEA TRICHOMANIS (Braun-Blanq. *in* H. Meier & Braun-Blanq. 1934) Oberd. 1977

Asplenienalia lanceolato-obovati Loisel 1970

Androsacetalia vandellii Braun-Blanq. *in* H. Meier & Braun-Blanq. 1934 *nom. corr.*

Asplenio billotii-Umbilicion rupestris B.Foucault 1988

Umbilico rupestris-Asplenietum billoti de Foucault 1979

ARMERIO MARITIMAE-FESTUCETEA PRUINOSAE Bioret & Géhu 2008

Crithmo maritimi-Armerietalia maritimae Géhu 1975

Crithmo maritimi-Armerion maritimae Géhu 1968

Armerio maritimae-Asplenienion marini Géhu 2008

Armerio maritimae-Asplenietum marini Géhu & Géhu-Franck 1984

Crithmo maritimi-Limonienion binervosi Géhu & Géhu-Franck 1984

Spergulario rupicolae-Crithmetum maritimi (Roux & Lahondère 1960) Géhu 1962 *nom inv.*

Armerio maritimae-Plantaginetum coronopodis (Van den Berghen 1979) Bioret & Géhu 2008

Sileno maritimae-Festucenion pruinosae (Géhu & Géhu-Franck 1984) Bioret & Géhu 2008

Armerio maritimae-Festucetum pruinosae Géhu 2008

Spergulario rupicolae-Silenetum maritimae Bioret & Géhu 2000

Spergulario rupicolae-Armerietum maritimae Géhu 2008

Orobancha hederae-Hederetum belicis (Géhu 1961) 2006

Spergulario rupicolae-Halimionetum portulacoidis Bioret & Géhu 2008

SEDO ALBI-SCLERANTHETEA BIENNIS Braun-Blanq. 1955

Sedo albi-Scleranthetalia biennis Braun-Blanq. 1955

Sedion anglici Braun-Blanq. *in* Braun-Blanq. & Tüxen 1952

Dactylo oceanicae-Sedetum anglici J.-M & J. Géhu & Caron 1978 *corr.* Géhu 2008

SAGINETEA MARITIMAE V.Westh., C. Leeuwen & Adriani 1962

Saginetalia maritimae V.Westh., C. Leeuwen & Adriani 1962

Saginion maritimae V.Westh., C. Leeuwen & Adriani 1962

Sagino maritimae-Catapodietum marini Tüxen *in* Tüxen & Westhoff 1963

Soncho oleracei-Cochlearietum danicae Géhu & de Foucault *ex* de Foucault & Bioret 2010

CRATAEGO MONOGYNAE-PRUNETEA SPINOSAE Tüxen 1962

Prunetalia spinosae Tüxen 1952

Lonicerion periclymeni Géhu, B. Foucault & Delelis 1983

Ulici maritimi-Prunetum spinosae (Géhu & Géhu-Franck 1985) Bioret *et al.* 1991

Sileno maritimae-Ulicetum maritimi Géhu 2008

1.4. References

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1.5. Vegetation map of 'la Pointe du Grouin'

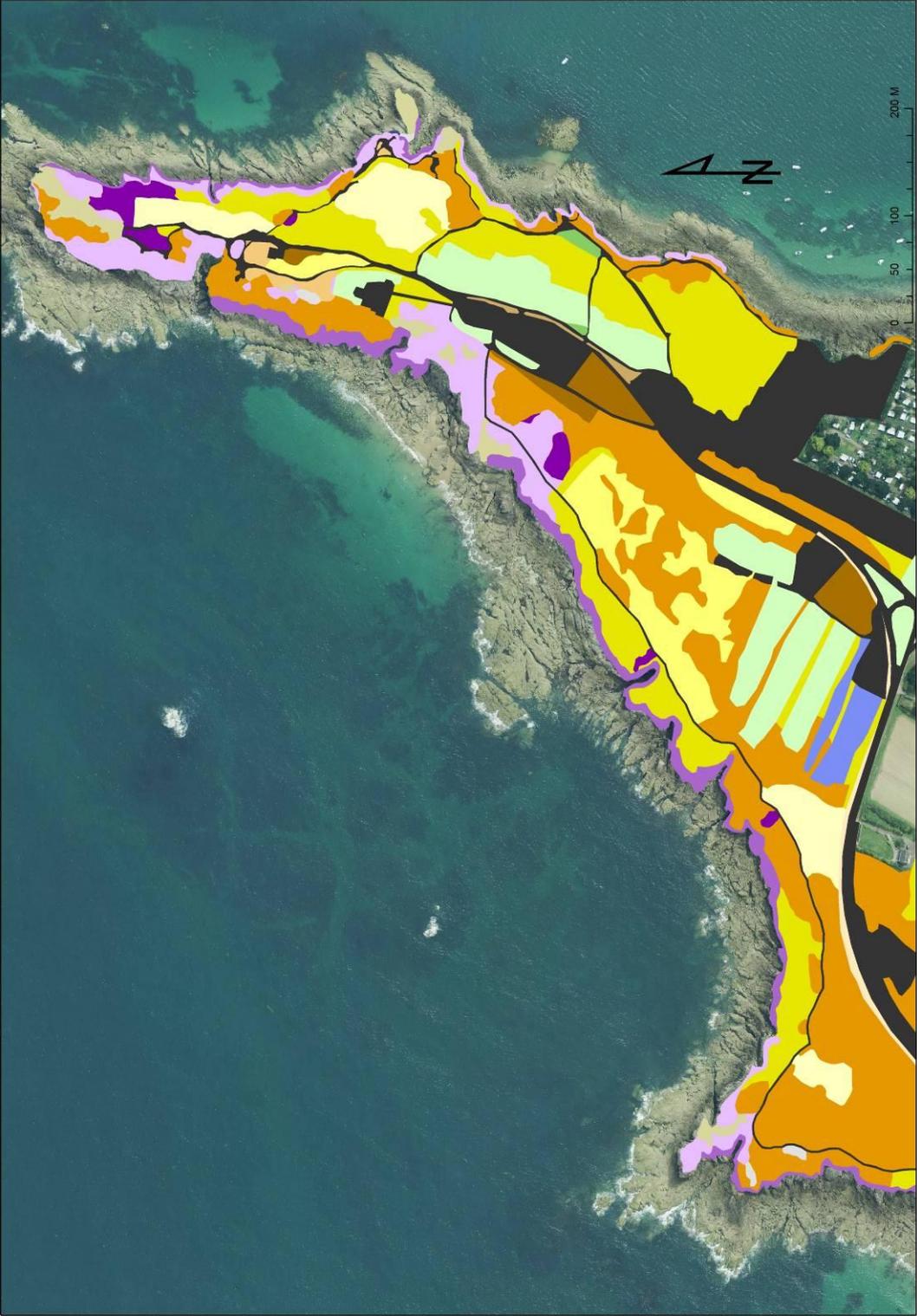


Figure 6. Vegetation map of the Grouin cap. Conseil Général 35, Dervenn, 2014

-  *Polygono arenastri-Poetalia annuae* Tüxen in Géhu, J.L. Rich & Tüxen 1972
corr Rivas-Martínez, Báscones, T.E. Díaz, Fernández González & Loidi 1991
-  *Sisymbrietea officinalis* Korneck 1974
-  *Hordeetum murinum* Allorge 1922
-  *Lonicerion periclymeni* Géhu, de Foucault & Delelis 1983
-  *Franguletea alni* Doing ex V. Westhoff in V. Westhoff & Den Held 1969 /
Crataego monogynae - *Prunetea spinosae* Tüxen 1962
-  *Armerio maritimae* - *Hederetum helici*s Géhu & Duquet 2009
-  *Ulici maritimi* - *Ericetum cinereae* (Géhu & Géhu-Franck 1962) Géhu & Géhu-Franck 1975
-  *Conopodio majoris* - *Teucrion scorodoniae* Julve ex Boulet & Rameau in Bardat et al. 2004
-  *Melampyro pratensis* - *Holcetea mollis* Passarge 1994
-  *Holco mollis-Pteridion aquilini* (Passarge 1994) Rameau all. prov. et stat. prov.
-  *Armerio maritimae* - *Festucetum pruinosa*e Géhu 2008
-  *Dactylo oceanicae-Sedetum anglici* (Lemée 1938) Géhu & Géhu-Franck & B. Caron 1978
-  *Armerio maritimae* - *Plantaginetum coronopodis* (Vanden Berghen 1965) Bioret & Géhu 2008
-  *Arrhenatheretea elatioris* Br.-Bl. 1949 nom. nud.
-  *Lolio perennis* - *Plantaginion majoris* Sissingh 1969
-  *Arrhenatherion elatioris* Koch 1926
-  *Spergulario rupicola*e - *Crithmetum maritimi* (Roux & Lahondère 1960) Géhu 1962 nom. inv. prop.
-  *Crithmo maritimi-Limonietum ovalifolii* (Kuhnholz-Lordat 1926) Lahondère, Bioret & Botineau 1991
-  Milieux naturels sans végétation phanérogame
-  Milieux anthropisés

Species list from 'la pointe du Grouin'

- Achillea millefolium* L. subsp. *millefolium*
Aira praecox L.
Anagallis arvensis L.
Anagallis arvensis L.
Anchusa arvensis (L.) M.Bieb. subsp. *arvensis*
Anthoxanthum odoratum L.
Anthyllis vulneraria L.
Armeria maritima (Mill.) Willd. subsp. *maritima*
Beta vulgaris L. subsp. *maritima* (L.) Arcang.
Bromus diandrus Roth
Bromus hordeaceus L.
Bromus hordeaceus L. subsp. *thominei* (Hardouin)
Braun-Blanq.
Bromus sterilis L.
Bryonia dioica Jacq.
Capsella bursa-pastoris (L.) Medik. subsp. *bursa-pastoris*
Carduus tenuiflorus Curtis
Carex pilulifera L. subsp. *pilulifera*
Catapodium marinum (L.) C.E.Hubb.
Catapodium rigidum (L.) C.E.Hubb.
Centaurea gr. pratensis / *gr. nigra*
Cerastium diffusum Pers. subsp. *diffusum*
Cerastium fontanum Baumg.
Cerastium glomeratum Thuill.
Cerastium semidecandrum L. subsp. *semidecandrum*
cf Romulea columnae
Chenopodium album L.
Chrysanthemum segetum L.
Cochlearia danica L.
Crassula tillaea Lest.-Garl.
Crepis capillaris (L.) Wallr.
Crepis vesicaria L. subsp. *vesicaria*
Crithmum maritimum L.
Dactylis glomerata L.
Daucus carota L. subsp. *gummifer* (Syme) Hook.f.
Erodium moschatum (L.) L'Hér.
Erophila verna (L.) Chevall.
Euphorbia portlandica L.
Festuca gr. rubra
Festuca rubra L. subsp. *pruinosa* (Hack.) Piper
Foeniculum vulgare Mill. subsp. *vulgare*
Fumaria muralis Sond. ex W.D.J.Koch subsp. *muralis*
Fumaria officinalis L.
Galium aparine L.
Galium mollugo L.
Geranium dissectum L.
Geranium robertianum L.
Hedera helix L.
Heracleum sphondylium L.
Hirschfeldia incana (L.) Lagr.-Foss.
Holcus lanatus L.
Hordeum murinum L.
Hyacinthoides non-scripta (L.) Chouard ex Rothm.
Hypericum humifusum L.
Hypochaeris radicata L.
Inula crithmoides L.
Iris foetidissima L.
Jasione crispa (Pourr.) Samp. subsp. *maritima* (Duby)
Tutin
Juncus capitatus Weigel
Lagurus ovatus L.
Leontodon saxatilis Lam.
Leucanthemum vulgare Lam.
Limonium ovalifolium (Poir.) Kuntze
Logfia minima (Sm.) Dumort.
Lolium perenne L.
Lonicera periclymenum L.
Lotus angustissimus L.
Lotus corniculatus L.
Malva moschata L.
Malva sylvestris L.
Matricaria perforata Mérat
Matthiola sinuata (L.) R.Br.
Medicago arabica (L.) Huds.
Medicago polymorpha L.
Mercurialis annua L.
Ononis repens L.
Ornithopus perpusillus L.
Picris echioides L.
Plantago coronopus L. subsp. *coronopus*
Plantago lanceolata L.
Prunus spinosa L.
Prunus spinosa L.
Pteridium aquilinum (L.) Kubn
Ranunculus bulbosus L. subsp. *bulbosus*
Ranunculus repens L.
Rubus sp.
Rumex acetosa L. subsp. *acetosa*
Rumex crispus L.
Ruscus aculeatus L.
Sagina maritima G.Don
Sedum anglicum Huds. subsp. *anglicum*
Senecio jacobaea L.
Senecio sylvaticus L.
Senecio vulgaris L.
Silene latifolia Poir. subsp. *alba* (Mill.) Greuter & Burdet
Silene vulgaris (Moench) Garcke subsp. *maritima* (With.) A.Löve & D.Löve
Sinapis arvensis L.
Sonchus arvensis L. subsp. *arvensis*
Sonchus oleraceus L.
Spergularia rupicola Lebel ex Le Jol.
Torilis nodosa (L.) Gaertn.
Trifolium campestre Schreb. subsp. *campestre*
Trifolium dubium Sibth.
Trifolium glomeratum L.

Trifolium pratense L.
Trifolium repens L.
Trifolium scabrum L.
Trifolium subterraneum L.
Trifolium suffocatum L.
Ulex europaeus L.
Ulex europaeus L. subsp. *europaeus* var. *maritimus* auct.
Ulex gallii Planch.
Umbilicus rupestris (Salisb.) Dandy
Urtica urens L.
Vicia hirsuta (L.) S.F.Gray
Vicia lutea L. subsp. *lutea*
Vicia sativa L.
Viola riviniana Rchb.
Vulpia bromoides (L.) S.F.Gray

1.6. Restoration Experiment at 'the Grouin cap'

The Ille-et-Vilaine departmental council set up experiments to analyse the potential for restoration of maritime grasslands degraded by high visitor rates and associated trampling. A series of permanent plots isolated from human trampling was initiated and the vegetation dynamics has been monitored since 2010 (see below the results for two permanent plots). After four years of protection, recovery is spectacular, in terms of species richness and diversity as well as in terms of plant cover.

Permanent plot 1

Species	Frequency (%)				
	2010	2011	2012	2013	2014
<i>Aira praecox</i>				61	81
<i>Armeria maritima</i>		4		10	23
<i>Bromus ferroni</i>					3
<i>Bromus sp.</i>				2	
<i>Cerastium fontanum</i>					47
<i>Dactylis glomerata</i>				1	3
<i>Desmazeria rigida</i>				8	12
<i>Festuca rubra subsp pruinosa</i>					
<i>Hieracium pilosella</i>					1
<i>Hypochaeris radicata</i>				32	35
<i>Jasione montana</i>				4	4
<i>Poa annua</i>	7			8	
<i>Plantago coronopus</i>	40	83		100	99
<i>Plantago lanceolata</i>	7			1	
<i>Sagina apetala sp. Erecta</i>		7		66	70
<i>Sedum anglicum</i>					3
<i>Spergularia rupicola</i>		3			

Permanent plot 2

Species	Frequency (%)				
	2010	2011	2012	2013	2014
<i>Aira praecox</i>				75	73
<i>Anthoxanthum odoratum</i>					2
<i>Anthylis vulneraria</i>					1
<i>Aphanes microcarpa</i>					12
<i>Armeria maritima</i>					14
<i>Bromus ferroni</i>					87
<i>Bromus hordeaceus</i>				6	26
<i>Bromus hordeaceus ssp. Tomini</i>					5
<i>Bromus sp.</i>					46
<i>Cerastium fontanum</i>					9
<i>Dactylis glomerata</i>		1		18	43
<i>Daucus carota</i>				66	71
<i>Desmazeria rigida</i>					2
<i>Festuca rubra subsp pruinosa</i>					0
<i>Hieracium pilosella</i>					1
<i>Hypericum humifusum</i>					1
<i>Hypochaeris radicata</i>				66	67
<i>Jasione montana</i>					50
<i>Plantago coronopus</i>	64	96		100	91
<i>Plantago lanceolata</i>		2		15	36
<i>Poa annua</i>				2	8
<i>Rumex acetosella</i>					1
<i>Sagina apetala</i>		4		51	97
<i>Sedum anglicum</i>	2	31		99	96
<i>Taraxacoides</i>					1
<i>Ulex Europaeus</i>					2

2. Mont-Saint-Michel Bay

2.1. Dynamics of plant assemblages in the eastern Mont-Saint-Michel Bay (1984-1994)

The Mont-Saint-Michel Bay was formed in the Quaternary during the Flandrian transgression. Its natural evolution has been disturbed many times by important works between 1856 and 1934, a period during which 2800 ha of polders were reclaimed, 50 km of dikes were constructed, the Couesnon Canal was dug, and the submersible Roche-Torin sea wall was built. These structures dramatically compromised the dynamic equilibrium of the bay by accelerating its silting-up and preventing sediments from being flushed out by rivers or tides. In an attempt to recover the insularity of Mont-Saint-Michel, the submersible Roche-Torin sea wall was partially levelled between 1983 and 1984.

Mapping studies carried out in 1984 and again in 1994 (Figure 7) revealed changes in plant assemblages and the shoreline (Figure 8). The main observation is that the salt marshes have continued to develop seaward.

Typically, the shore is first colonised by annual species, primarily *Salicornia dolichostachya*, *Salicornia fragilis* and *Suaeda maritima*. In 1994, these assemblages showed dramatic progression and indicated extensive silting up.

These pioneer assemblages are supplanted by vegetation units characterised by *Puccinellia maritima* accompanied by various other species, annual saltworts, *Suaeda maritima* and *Halimione portulacoides*. At a distance from these zones, there are monospecific stands of *Halimione portulacoides*.

In areas where sheep graze, this dynamic *Puccinellia-Halimione* succession does not occur. *Halimione portulacoides* does not tolerate trampling by sheep and is replaced by *Puccinellia* that takes over and forms vast grasslands.

In upper salt marshes, less influenced by the tide, several species — namely *Festuca rubra*, *Agrostis stolonifera*, *Juncus gerardii* and *Elymus athericus* — participate in mixed assemblages, spatially organised in patches. Although the destruction of the sea wall was intended to lead to a more pronounced marine-influenced environment, the observations made in 1994 show that, in contrast, plant communities have continued to develop in the upper salt marshes.

Route 2 - Cliff, saltmarsh: Cancale and Mont-Saint-Michel bay

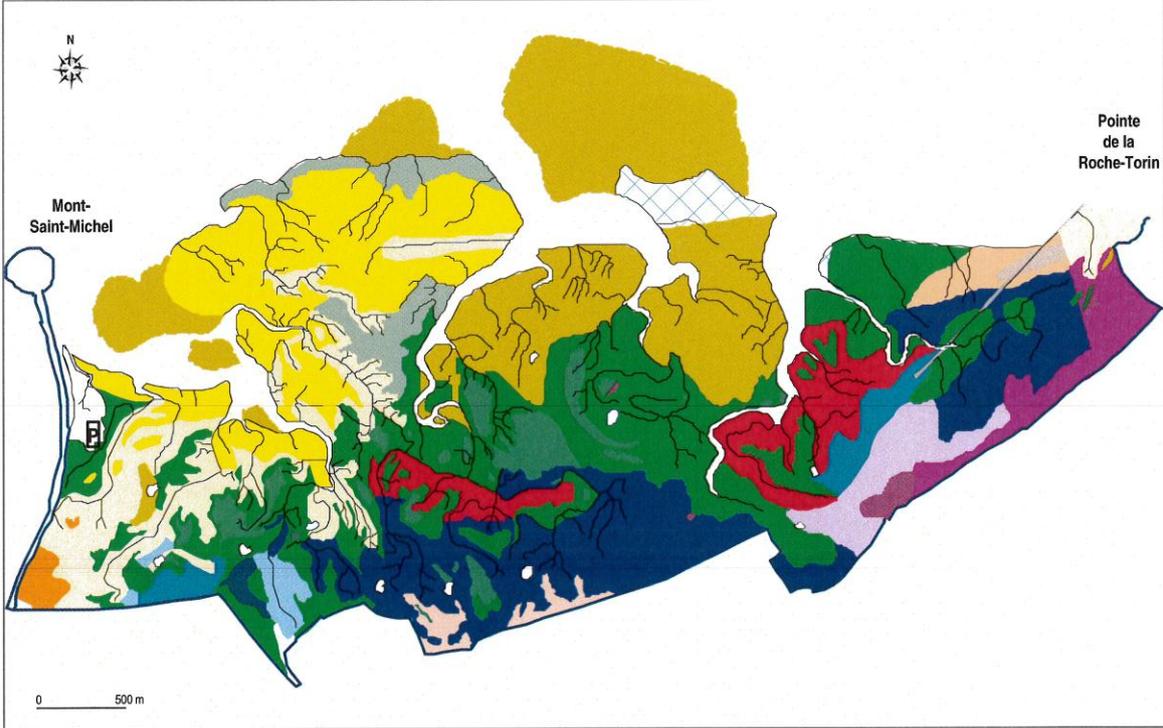
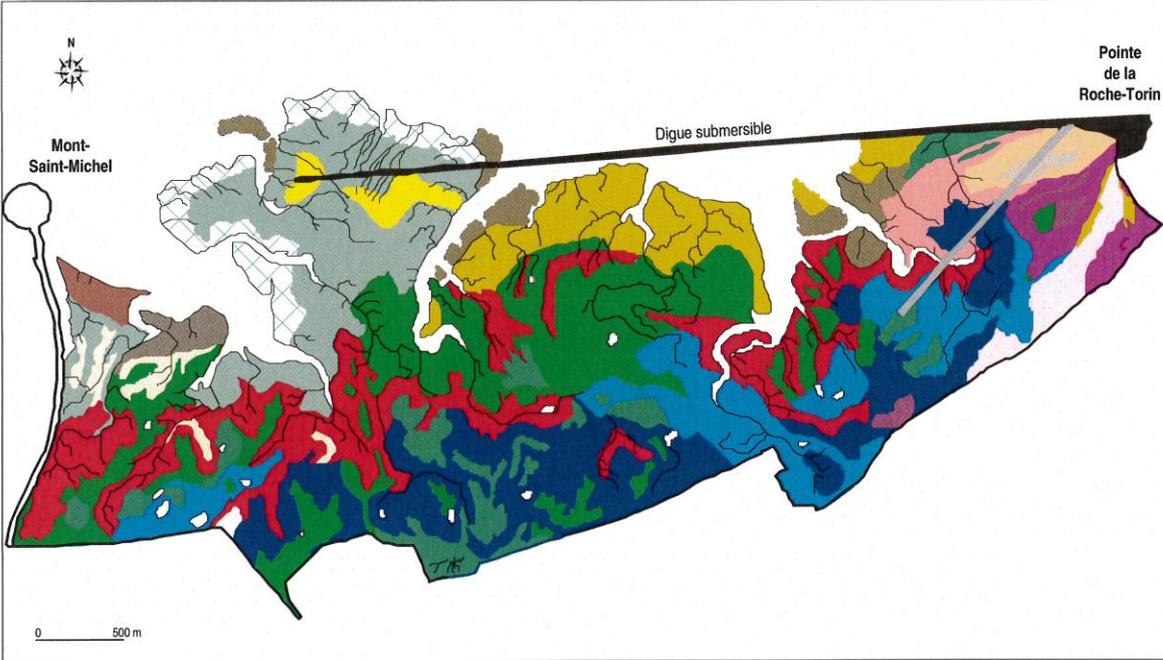


Figure 7. Vegetation maps in 1984 (above) and 1994 (below). From Bouchard *et al.*, 1995

VÉGÉTATION PIONNIÈRE

-  Groupement pionnier à Salicornes annuelles tétraploïdes

VÉGÉTATION DES MARAIS SALÉS

Végétation en cours de stabilisation

-  Pelouse ouverte à *Puccinellia maritima* et annuelles pionnières
-  Pelouse ouverte à *Puccinellia maritima* et *Salicornia ramosissima* en espèces pionnières
-  Pelouse ouverte à *Puccinellia maritima*, *Halimione portulacoides* et espèces pionnières

Pelouse à dominante vivace à *Puccinellia maritima*

-  Pelouse rase et dense à *Puccinellia maritima*
-  Pelouse ouverte à *Puccinellia maritima* avec dominance estivale de *Salicornia ramosissima*
-  Pelouse à *Puccinellia maritima* avec dominance estivale de *Suaeda maritima* en strate supérieure
-  Pelouse à *Puccinellia maritima* parsemée de buissons nains de *Halimione portulacoides*

Prairie dense de hautes herbes à *Agropyrum pungens*

-  Prairie à *Agropyrum pungens*

Jonçaies

-  Pelouse à *Juncus gerardii*

Pelouse à dominante vivace à *Agrostis stolonifera*

-  Pelouse à *Agrostis stolonifera*

Végétation des milieux de contact supérieur

-  Groupement de la dune fixée avec *Tortula ruraliformis* et *Limonium lychnidifolium*

Pelouse à dominante vivace à *Festuca rubra*

-  Pelouse dense à *Festuca rubra*
-  Pelouse à *Festuca rubra* parsemée de touffes hautes d'*Agropyrum pungens*
-  Pelouse à *Festuca rubra* avec apparition estivale de *Parapholis strigosa*
-  Pelouse à *Festuca rubra* accompagnée de *Limonium lychnidifolium* et *Parapholis strigosa* et parsemée de touffes d'*Agropyrum pungens*

Formation semi-ligneuse naine à *Halimione portulacoides*

-  Fourrés ras, monospécifiques, à *Halimione portulacoides*
-  Fourrés ras à *Halimione portulacoides* avec faciès estival d'*Aster tripolium*
-  Fourrés à *Halimione portulacoides* avec faciès estival d'*Aster tripolium* de *Suaeda maritima*

Groupements mixtes

-  Pelouse à *Festuca rubra* et *Agrostis stolonifera* avec tâches estivales de *Trifolium fragiferum*
-  Pelouse à *Puccinellia maritima* et *Agrostis stolonifera*
-  Pelouse à *Juncus gerardii* et *Festuca rubra* accompagnés d'un voile annuel d'*Hordeum maritimum*
-  Pelouse à *Agrostis stolonifera* et *Juncus gerardii*
-  Pelouse à *Agrostis stolonifera* et *Juncus gerardii* accompagnés de nombreuses espèces
-  Pelouse à *Agrostis stolonifera*, *Festuca rubra* et *Juncus gerardii*
-  Pelouse à *Festuca rubra* et *Agrostis stolonifera*

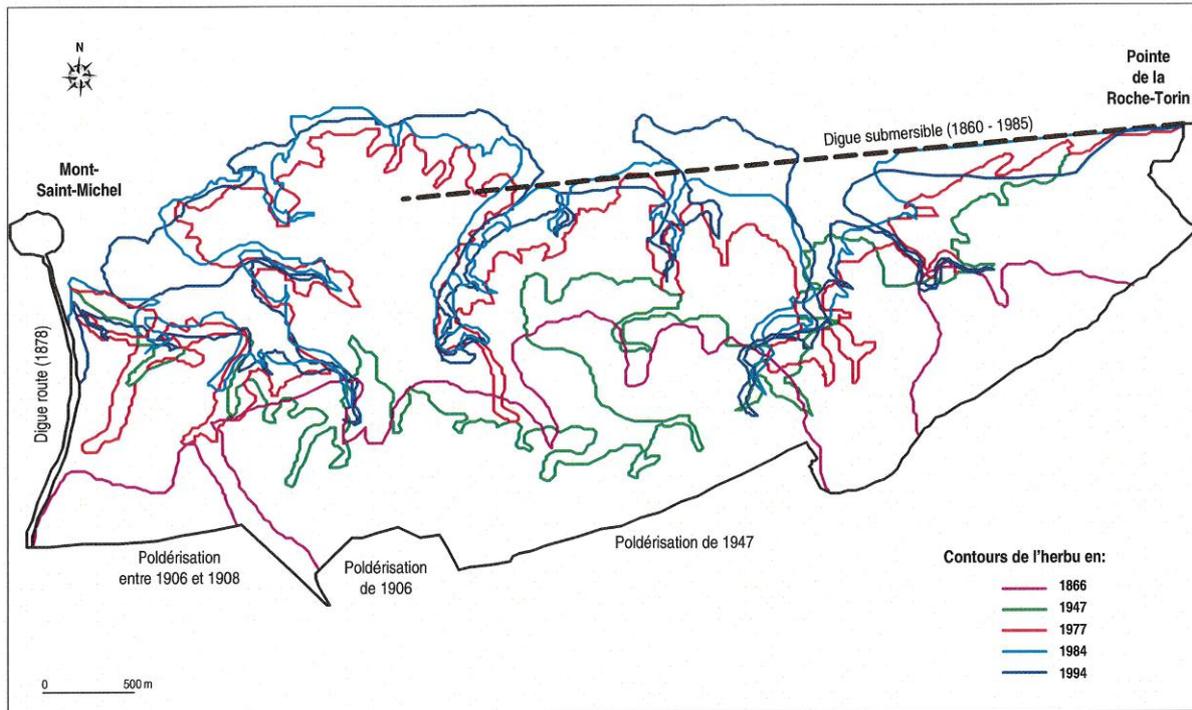


Figure 8. Evolution of the limit of the vegetation between 1886 and 1994. From Bouchard *et al.*, 1995

2.2. Dynamics of plant assemblages in the western part of Mont-Saint-Michel Bay (1991-2001)

Since the 2000s, in certain non-grazed zones of the saltmarsh, *Elymus athericus* has developed extensively at the expense of *Halimione portulacoides* and upper salt marsh assemblages (Figure 9).

The spread of the native clonal grass *Elymus athericus* (Link) is one of the most significant changes that have affected the plant communities of European salt marshes in the last decade (Bockelmann 2002).

From 1991 to 2001, *Elymus athericus* has spread at a rate of 4 ha yr⁻¹ (i.e., about 55 m yr⁻¹), while the overall area of the salt marsh only increased by 1.5 ha yr⁻¹ (i.e., about 22 m yr⁻¹). The percent of the marsh occupied by this species increased from 37% to 73% between 1991 and 2001. This trend has been continued from 2001 onward while there was no regular monitoring.

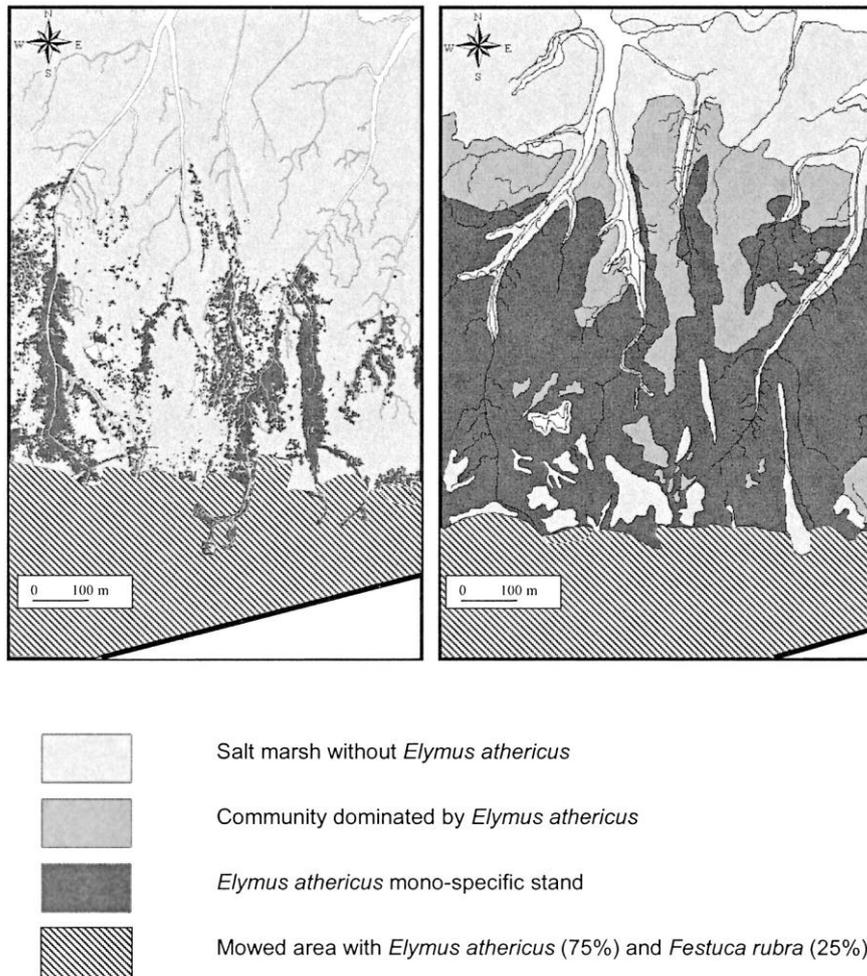


Figure 9. *Elymus athericus* spread in the last decade: comparison of areas covered with this species between 1991 (left) and 2001 (right). From Valery *et al.*, 2004

The increase of salt marsh area occupied by *Elymus athericus* occurred to the detriment of *Hamillione portulacoides*, which was covering nearly 1/3 of the marsh in 1991–92 (Bouchard 1996) but only 1/8 of the marsh in 2001 (Valery 2001). In 1991, *Elymus athericus* was present almost exclusively along the banks of the drainage creeks where the pore-water concentration of NO₃ is known to be significantly higher than in others areas of the marsh (Troccaz 1996). Formerly confined to the high marsh, this native species is progressively invading the middle and low salt marshes where it often forms a dense monospecific stand.

2.3. Plant community dynamics in the salt marsh pioneer zone

One of the limiting factors for vegetation colonization in pionner zone is sediment instability. While *Spartina maritima* or *Spartina anglica* as generally considered as efficient seceis for positive sedimentation and substrate stabilization it was shown by Langlois *et al.* (2003) in the Mont St Michel bay that *Puccinellia maritima* plays a much more efficient role (Figure 10).

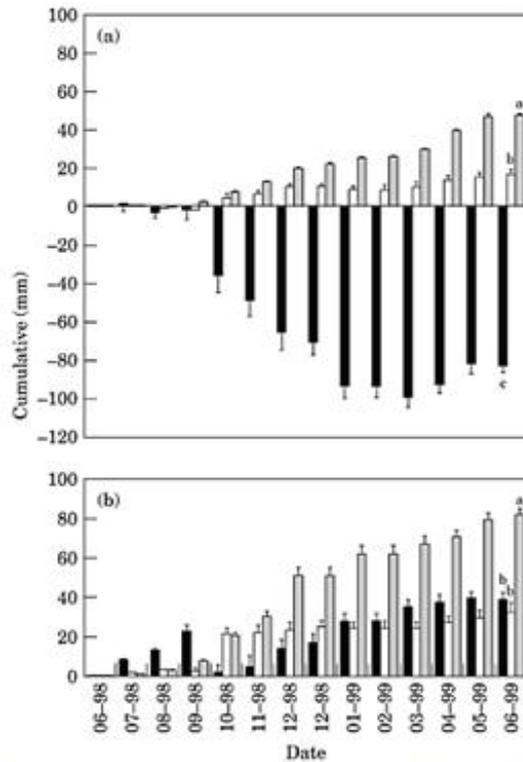


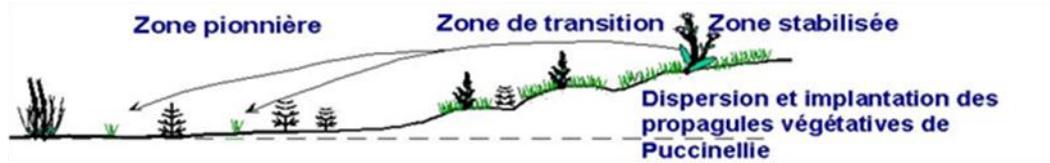
Fig. 3. Soil level change (mm) during one year (June 1998-June 1999), on mudflats (a) and in areas covered by *Puccinellia maritima* (b) in the three pioneer zones. Different letters indicate a significant difference in annual change between sites. ■, Site 1; □, Site 2; ▨, Site 3.

Figure 10. Soil level change (mm) during one year from Langlois *et al.* 2003

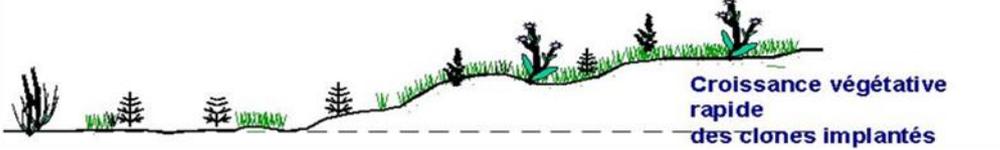
This clonal *poacea* is indeed able to stabilize the sediment deposits even in the local macrotidal regime. This ability together with its tolerance to burial (Langlois *et al.* 2001) explain that the soil elevation increase steadily where *Puccinellia maritima* is covering the substrate in pionner zone while bare mud flats are frequently submitted to erosion events in exposed site (a) showed a reduced elevation increae along years in protected site (b).

Based on *Puccinellia* demographic functioning and due to its strong clonal growth ability once settled, even in pionner zone of the salt marsh, this species is suggested to play a key role in the vegetation dynamics of the salt marshes (Figure 11). It was found to speed up the process of succession as suggested by the schemes below whih are based to monitoring results from Langlois (2000).

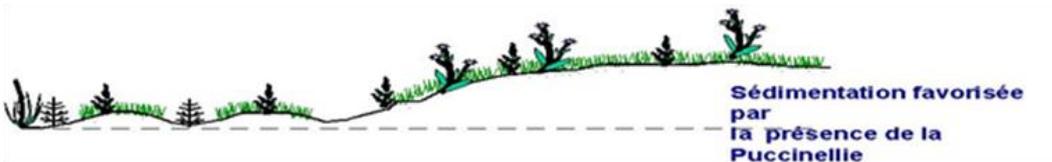
1- Vegetative propagules of Puccinellia are dispersed from high to low saltmarsh



2- Rapid growth of puccinellia clones which colonized the low saltmarsh



3- The establishment of Puccinellia is favorable to sediment deposit and soil elevation increase



4- In mild site, protected from the harsher hydrodynamic effects, only two to three years after the establishment of Puccinellia on pionner zone, the vegetation resembles a stabilized plant community, species diverse. The succession is less straightforward and slower in more exposed site in the bay.



Figure 11. The vegetation dynamics of the salt marshes (From Langlois 2000)

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POST-WORKSHOP EXCURSION - INLAND FOREST AND BOG

1. What does Brocéliande mean?

The world Brocéliande leaves a great resonance in us. But where does it come from? We all know this word from somewhere. But what does it exactly mean? There are two possibilities and both are based on the Breton language. One is based on the word *brec'h* which means hill and the other one *bro* which means land and homeland. Summarized the first possibility would mean the "hilly moorland" related also to its topography and the second possibility would mean "the land of the other world" based on the popular belief.

The forest of Brocéliande was often compared with the forest of Paimpont located in the heart of Brittany. This forest once dominated the entire landscape of Brittany. Now it is up to you enter into the world of Brocéliande and to let yourself be enchanted by the trees, the landscape, the old stones and the legends.

Today Brocéliande remains the biggest forest of Brittany but its area consists of only 7500 hectares. The forest was deforested mainly due to cultivation, the development of the forge and its production of coal.

1.1. The abbey of Paimpont

This abbey of the 13th century was built on the same place as a priory of King Judicael which dated of the year 645. Originally being a Benedictine convent which was inhabited by monks up the 13th century till the revolution. Following architecture bases on the gothic style of the middle age: the walls, the openings, the baptismal font, and the vault.



1.2. The valley without return and the golden tree

The legend tells us of the mysterious valley close to the village of Tréhorenteuc, which is supposed to be the domain of the fairy Morgan, sister of King Arthur. Morgan was betrayed by her lover, that's why she put a terrible spell on this valley, that all unfaithful lovers would be imprisoned in the valley forever.



A long time ago the fairies decided to hide from the eyes of humans by making a pact between them. They chose hideouts of water. Seven of these fairies hid themselves at the end of the lake and only came after nightfall so as to admire their beauty in the lake. That's why it is called "The mirror lake of the fairies". They lived in peace until the youngest amongst them fell deeply in love with a handsome knight.

She broke the pact and angered her sisters extremely: a great battle broke out, so hard that the blood of the fairies spread all over the forest colouring the earth purple, which is still visible till this day.

1.3. The chapel of the Grail

This church of the 7th century suffered much destruction during time. The abbot Gillard decided in 1942 to renovate the church. He wanted to mix 3 beliefs with each other: Christianity, the legends of King Arthur and the Celtic aspect. He connected symbolically the personalities such as Merlin the great wizard, the fairy Morgan and Yvain the Knight of lion with Christianity and Celts. These are evident in the symbols of the church window, and the collection of paintings and mosaics.



1.4. The Merlin's Tomb

Originally Merlin's Tomb was a 12 m long Neolithic Dolmen alley. The monument got destroyed in the 19th century by some scavengers looking for gold. Unfortunately today, only two red schist rocks remained of it. That's the reason why some visitors disbelieve that this could be Merlin's Tomb. Others even doubt that a

magician like Merlin could be satisfied with such a moderate tomb. But did he really need a pompous tomb at all? Some even believe Merlin isn't dead. Indeed this was the place where Vivian his dearest captured Merlin in a castle of air in order that they could live side by side forever in the forest of Brocéliande.

In the legend Merlin is the son of a religious beauty and the devil. Therefore likewise positive and negative forces slumber in Merlin. He foresees the future and knows the past. In his youth he became aware of this power. His spirit lives in the forest. Sometimes Merlin sits down on his tomb and listens to the wishes of the humans. Thereby the legend stays alive...



1.5. The fountain of Youth

The clearing by the fountain was a meeting place for the druids on solstice, equinox and other Celtic feasts. Each summer solstice the newborns were taken to this fountain in order to count and bless them. The ones that could not attend to this ceremony would be counted by the following summer solstice. Even though being one year old they were counted as newborns. Therefore it is called "Fountain of Youth". Even today this source remains a fountain of youth but only on summer solstice, at midnight and under obscure and secret conditions.



1.6. The oak of Guillotin

The oak of Guillotin is more than 1000 years old and its coverage is 9.65 m and its height 20 m. This tree was classified as one of the most remarkable of Brittany. The name doesn't come from the Guillotine; its source is from the abbot Guillotin, born in 1750. In memoirs he is mentioned as a forward abbot who was hunted by the revolutionary movement of that time. He flees to an ideal hideout; the hollow of the oak. As the soldiers pass by the oak they noticed an intact spider web covering the hollow of the oak, so they assumed no one was inside it, even though the abbot was hiding inside it.



Source and credit: Tourist office in Broceliande / www.tourisme-broceliande.com

2. Broceliande forest

2.1. Geological characteristics

In Rennes area, the Central Brittany domain is composed of two main units.

-A lower one, upper precambrian in age (Brioverian) mainly composed of schists with local sandstones and discontinuous levels of conglomerates.

-It is overlain unconformably by paleozoic formations (Ordovician to Carboniferous) beginning by continental red series (« schistes rouges de Pont-Réan »; lateral equivalent of Erquy-Fréhel group) followed by shallow marine sandstones (« Grès Armoricaains ») (see geological map).

During Hercynian orogeny this domain is folded, schistosed, metamorphosed and intruded -to the west- by numerous granites (see cross-section); the resistant rocks (Grès armoricains) are put in relief by the erosion, the friable ones (Brioverian) occupy the low lands.

Late hercynian faults, trended N140°, are reactivated during Cenozoic period and underlined in the downward eastern blocks by small basins of red sands and pebbles, especially along the Quesoy-Nort-sur-Erdre fault system (see DEM).

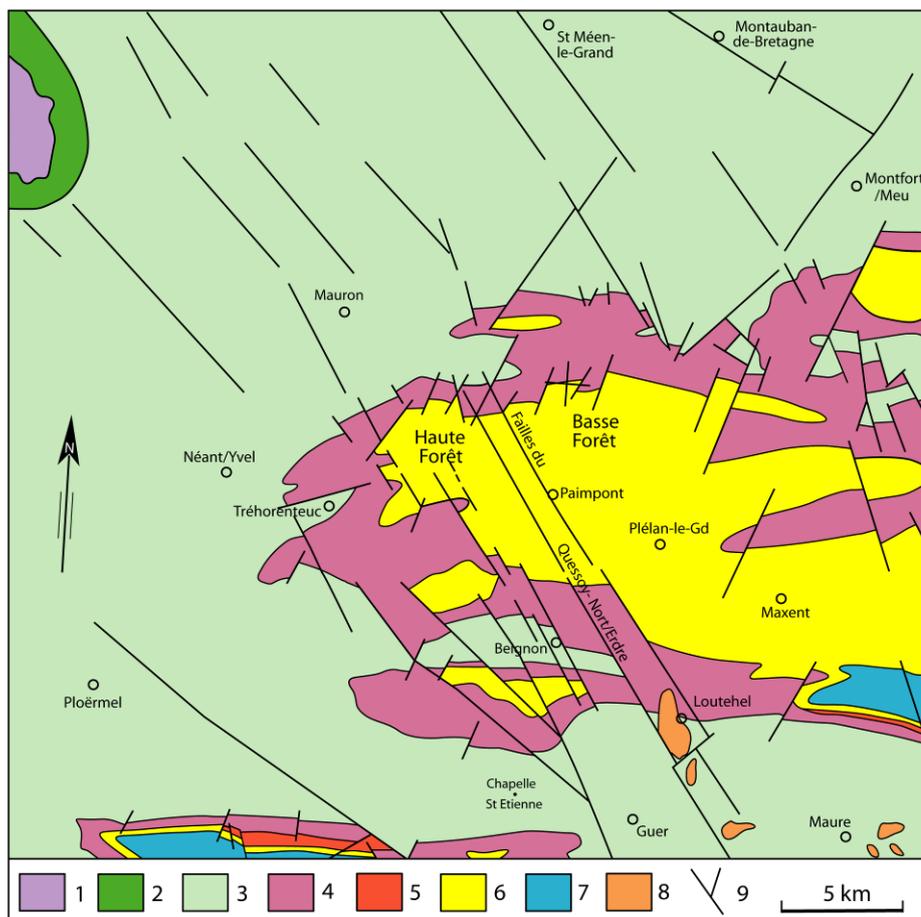


Figure 12. Geological map of Paimpont forest : 1 : granites ; 2 : micaschists ; 3 : Brioverian sediments ; 4 : « Red schists » (Pont-Réan Fm) ; 5 : volcanic strata ; 6 : Grès Armoricaains ; 7 : other paleozoic beds ; 8 : cenozoic basins ; 9 : Faults.(text P. Jégouzo; map J. Plaine; SGMB & University of Rennes 1)

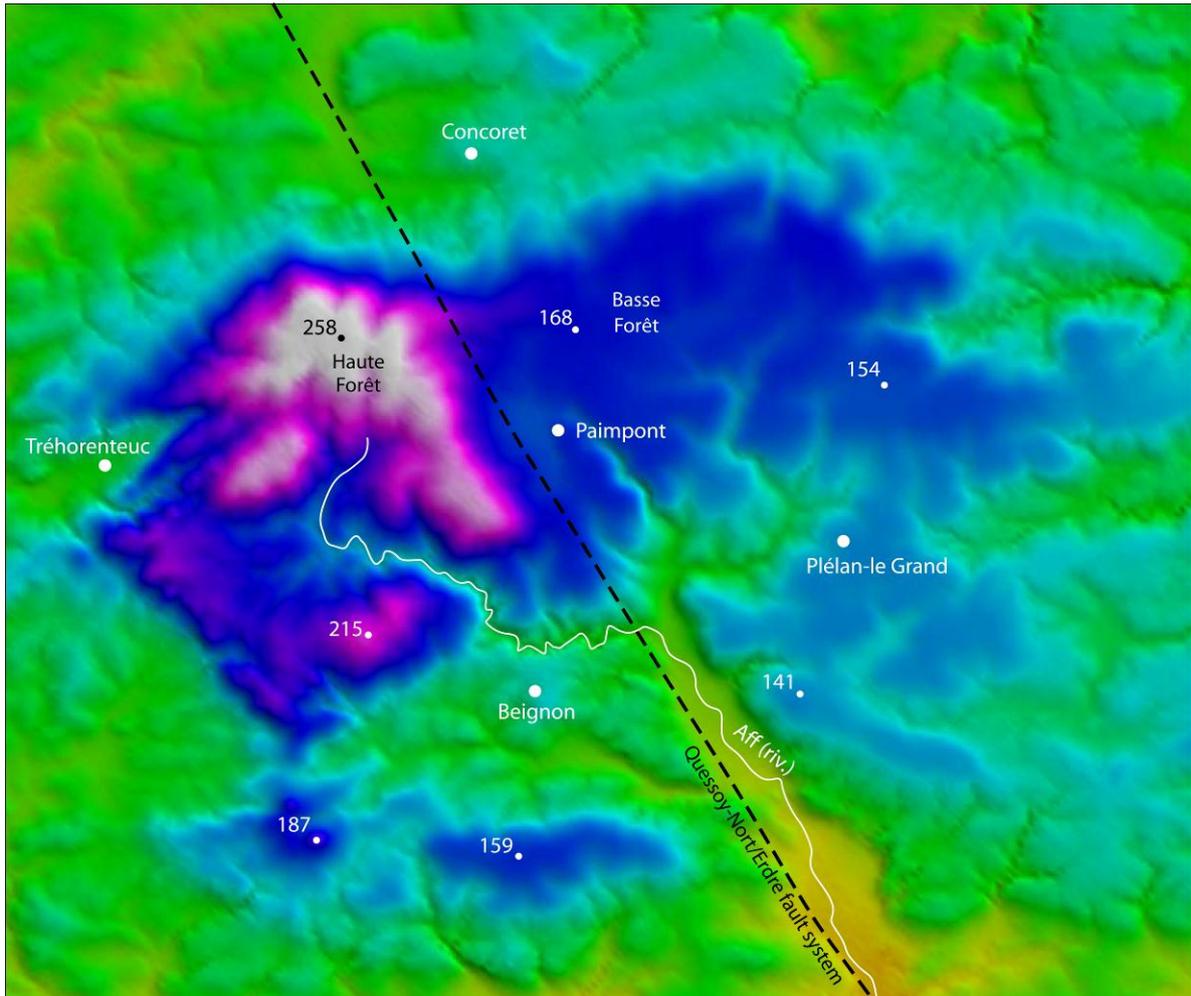
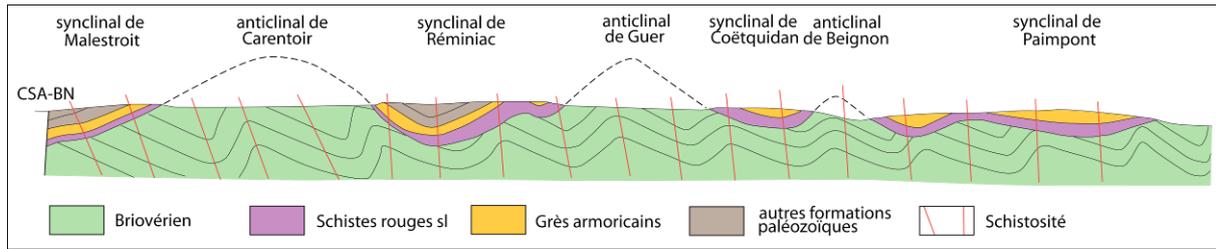


Figure 13. Geological transect of the Paimpont forest (above) and the Digital Elevation Model (below)

2.2. General description

The legendary Brocéliande forest and the Paimpont Forest are the one and the same geographical and cultural entity. The actual forest occupies the central, highest point and is today only a fragment of the vast forest that covered the major part of Armorica until the Middle Ages. To the west, heathlands and shrub thickets have established on the red shale substrate. In part of the southern sector, the Saint Cyr – Coëtquidan military academy that trains Army officers was established one century ago. In a circular zone of red shale around the sandstone massif, Neolithic humans left traces of their presence, with many megaliths dating back to 4000 to 4500 years ago. The large stone monuments were re-appropriated during the 6th century Christianisation movement and since then have inspired local literary and theatrical works based on Arthurian legends. Merlin's Tomb and Viviane's House are megalithic tombs that are 3000 years older than their legends. Between the 8th and the 12th centuries, Breton kings, such as King Judicael, erected monuments, churches, abbeys, such as those found in Paimpont.

2.2.1. *Le Val Sans Retour (Valley of No Return), heathlands and associated habitats*

Although the starting point is located in the town of Tréhorenteuc in Morbihan, the site itself is located in Paimpont.

The steep-sided valley is surrounded by red shale plateaus. Several thalwegs join together to form the main valley occupied by the Rauco stream. Today, two ponds remain after the restoration of dikes, including the Miroir aux Fées downstream. The ruins of an old watermill are still visible near the Arbre d'Or (Golden Tree). Two broken dikes upstream are the remains of two former ponds. Since the fire in late summer 1990, the site has been opened to hikers and many tourists visit the site.

On the plateaus and the steep hills, dry grasslands and heaths develop on thin soils, ranker soils and brown earths. The southern exposure of the right bank slope provides a habitat where many Mediterranean plant and animal species thrive. This site is the northern and western limit of the distribution range for some of these species. The 1990 fire, qualified as a humus fire, completely destroyed all vegetation and burned the humus in the soil. After 15 years, plants have shown resilience. The traces of the fire are now only visible on the ground, where sporadic piles of ashes can be found in the soil.

2.2.2. *Paimpont Forest, a history of intensive use*

The current Paimpont Forest is what remains after intensive clearing, during the Middle Ages until the beginning of the 19th century. Its present state in terms of plant assemblages is the result of intensive exploitation that began in the 17th century. The hamlet called 'Les Forges de Paimpont' is an architectural representative.

The presence of iron ore, wood and water were the readily available resources for the local foundry. The manufacture of charcoal led to overexploitation of the forest, already in a fragile state due to the paucity of the substrata and the fragility of the soils.

Forest management consisted of a simple coppice system, with clear felling every 25 to 30 years in a given plot. Some isolated old trees, with low-hanging branches, attest to this silvicultural system. In the second half of the 19th century, the introduction of pine trees (*Pinus pinaster* and *P. sylvestris*) was the first move towards a more resinous forest. Since the 1950s, other resinous species (*Picea abies*, *P. sitchensis*, *Abies grandis*, *Pseudotsuga menziesii*, etc.) have been used in

sectors with degraded, often hydromorphic, soils. Paradoxically, the native deciduous forest has a natural appearance because its recent development has been virtually untouched by foresters.

The forest habitat is an oak (*Quercus robur*, *Q. petraea*) and beech (*Fagus sylvatica*) forest, associated with holly undergrowth (*Ilex aquifolium*) and, more sporadically, juniper trees (*Juniperus communis*). *Juniperus* and yew (*Taxus baccata*) are the only resinous species native to Brittany.

Podzosoils and hydromorphic soils overlain with moder or mor humus are colonised by undergrowth species *Vaccinium myrtillus*, *Molinia caerulea* and many bryophytes. *Vaccinio – Quercetum* and *Molinio – Quercetum* associations dominate the Paimpont Forest.

2.2.3. Lambrun Peat bogs, a juvenile state after major disturbance

The site is reached from the Rue d'Eon village named after the Eon de l'Etoile, a fanatical hermit.

After passing the Guillotin oak, the site is reached by a red shale footpath that leads to a forest path, located in Paimpont. This site is part of the 'Lambrun heath' established on the sandstone massif at the heart of heathlands largely colonised by pine trees.

After illegal land clearing in 1990 and overdeepening of the site to construct two ponds, the private land owner was forced to destroy the dikes. The successional dynamics were set back in motion and a pioneer community system, sometimes marshy, has become established. A botanist visited and inventoried the numerous rare and protected plant species including *Lycopodiella inundata*, the only station in all of the Ille-et-Vilaine *département*. In accordance with the Sensitive Natural Areas plan, the *département* acquired the site in 2005 and implements the appropriate management actions.

The system is still in a juvenile phase that requires further floristic and vegetation surveys. Some areas (see map) are sensitive to trampling and, accordingly, it is recommended to limit the number of visits, particularly in the areas where *Lycopodiella*, moss mounds and *Drosera* are found.

Reference: Daumas M. 2012 – Inventaire et cartographie de la végétation et des espèces végétales à forte valeur patrimoniale. Espaces Naturels Sensibles (ENS). Site de la tourbière de Lambrun. Commune de Paimpont. Rapport Ouest Am' / C.G.35, 2 volumes.

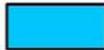
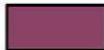


Figure 14. Vegetation map of Lambrun peatland in 2012 (Daumas 2012)

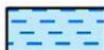
Habitat d'intérêt communautaire prioritaire :

-  Sphagno compacti-Ericetum tetralicis (Clément 1981) Thébaut 2011
-  Ulici minoris-Ericenion ciliaris (Géhu 1975) Géhu & Botineau in Bardat et al. 2004, association à définir
-  Proche du Erico tetralicis - Sphagnetum rubelli (Allorge 1926) Lemée ex Thébaut 2011

Habitat d'intérêt communautaire :

-  Eleocharitetum multicaulis (Allorge 1922) Tüxen 1937, groupement terricole
-  Eleocharitetum multicaulis (Allorge 1922) Tüxen 1937, groupement amphibie
-  Hyperico elodis-Potametum polygonifolii (Allorge 1921) Br.-Bl. & Tüxen 1952
-  Ulici minoris-Ericetum cinereae (Allorge 1922) Géhu 1975
-  Ulicion minoris Malcuit 1929, lande hygro-xérophile ouverte à éricacées (association à définir)
-  Ulicion minoris Malcuit 1929, lande hygro-xérophile boisée à éricacées (association à définir)
-  Ulici minoris-Ericetum ciliaris (Lemée 1937) Lenormand 1966
-  Proche du Caro verticillati-Molinietum caeruleae (Lemée 1937) Géhu 1976 ap. Clément 1978, association à définir
-  Caro verticillati-Molinietum caeruleae (Lemée 1937) Géhu 1976 ap. Clément 1978, association à définir
-  Sous-alliance du Caro verticillati-Juncenion acutiflori de Foucault & Géhu 1980, association à définir
-  Anagallido tenellae-Pinguiculetum lusitanicae (Rivas Goday 1964) de Foucault (1984) 2008
-  Sphagno-Eriophoretum angustifolii (Hueck 1925) Tüxen 1958
-  Rhynchosporion albae Koch 1926, groupement à Drosera intermedia et Lycopodiella inundata (association à définir)

Habitats non d'intérêt communautaire :

-  Salicion cinereae Müller & Görs 1958 (Osmundo regalis-Salicetum atrocinereae Br.-Bl. & Tüxen 1952 pour partie)
-  Plantation de résineux, à Pin maritime et Pin sylvestre
-  Quercion roboris Malcuit 1929
-  Mare temporaire sans végétation aquatique
-  Ecoulement permanent (ruisseau...)
-  Ecoulement temporaire (ruisseau ...)

Mosaïque d'habitats :

-  Hyperico elodis-Potametum polygonifolii (Allorge 1921) Br.-Bl. & Tüxen 1952 en mosaïque avec Eleocharitetum multicaulis (Allorge 1922) Tüxen 1937, groupement amphibie
-  Eleocharitetum multicaulis (Allorge 1922) Tüxen 1937, groupement amphibie en mosaïque avec proche du Erico tetralicis - Sphagnetum rubelli (Allorge 1926) Lemée ex Thébaut 2011
-  Ulici minoris-Ericetum ciliaris (Lemée 1937) Lenormand 1966 en mosaïque avec Substrat nu
-  Ulici europaei-Prunetum spinosae Géhu & Delelis 1972 en mosaïque avec Plantation de résineux, à Pin maritime et Pin sylvestre
-  Rhynchosporion albae Koch 1926, groupement à Drosera intermedia et Lycopodiella inundata (association à définir)
-  Plantation de résineux, à Pin maritime et Pin sylvestre en mosaïque avec Salicion cinereae Müller & Görs 1958

3. Plant species list present in Paimpont site (except common ones)

<i>Agrostis canina</i>	<i>Lysimachia nummularia</i>	<i>Vulpia bromoides</i>
<i>Agrostis capillaris</i>	<i>Melampyrum pratense</i>	
<i>Agrostis curtisii</i>	<i>Milium effusum</i>	
<i>Agrostis vinealis</i>	<i>Molinia caerulea</i>	<i>Athyrium filix-femina</i>
<i>Aira praecox</i>	<i>Montia fontana</i>	<i>Blechnum spicant</i>
<i>Anemone nemorosa</i>	<i>Microphyrum lachenalii</i>	<i>Dryopteris affinis</i>
<i>Arnoseris minima</i>	<i>Orchis morio</i>	<i>Dryopteris carthusiana</i>
<i>Asphodelus macrocarpus ssp</i>	<i>Ornithopus perpusillus</i>	<i>Dryopteris dilatata</i>
<i>arrondeaui</i>	<i>Osmunda regalis</i>	<i>Dryopteris filix-mas</i>
<i>Asphodelus albus</i>	<i>Oxalis acetosella</i>	<i>Polypodium interjectum</i>
<i>Calluna vulgaris</i>	<i>Pedicularis sylvatica</i>	<i>Polypodium vulgare</i>
<i>Carex binervis</i>	<i>Thyselinum lancifolium</i>	<i>Pteridium aquilinum</i>
<i>Carex echinata</i>	<i>Picea abies</i>	
<i>Carex laevigata</i>	<i>Picea sitchensis</i>	<i>Atrichum undulatum</i>
<i>Carex paniculata</i>	<i>Pinus pinaster</i>	<i>Campylopus introflexus</i>
<i>Carex pilulifera</i>	<i>Pinus sylvestris</i>	<i>Campylopus polytrichoides</i>
<i>Carex remota</i>	<i>Plantago coronopus</i>	<i>Dicranella heteramalla</i>
<i>Carpinus betulus</i>	<i>Polygala serpyllifolia</i>	<i>Dicranum scoparium</i>
<i>Carum verticillatum</i>	<i>Polygonatum multiflorum</i>	<i>Funaria hygrometrica</i>
<i>Cicendia filiformis</i>	<i>Potentilla erecta</i>	<i>Hedwigia ciliata</i>
<i>Conopodium majus</i>	<i>Prunus spinosa</i>	<i>Hylocomium splendens</i>
<i>Ceratocarpus claviculata</i>	<i>Pyrus cordata</i>	<i>Hypnum cupressiforme</i>
<i>Crataegus monogyna</i>	<i>Pyrus pyraster</i>	<i>Isotbecium myosuroides</i>
<i>Cytisus scoparius</i>	<i>Quercus petraea</i>	<i>Leucobryum glaucum</i>
<i>Dactylorhiza maculata</i>	<i>Quercus robur</i>	<i>Mnium hornum</i>
<i>Danthonia decumbens</i>	<i>Ranunculus bulbosus</i>	<i>Pleurozium scheberii</i>
<i>Deschampsia flexuosa</i>	<i>Ranunculus ficaria</i>	<i>Polytrichum commune</i>
<i>Digitalis purpurea</i>	<i>Ranunculus flammula</i>	<i>Polytrichum formosum</i>
<i>Erica ciliaris</i>	<i>Ranunculus paludosus</i>	<i>Polytrichum juniperinum</i>
<i>Erica cinerea</i>	<i>Ranunculus repens</i>	<i>Polytrichum piliferum</i>
<i>Erica tetralix</i>	<i>Rumex acetosa</i>	<i>Pseudoscleropodium purum</i>
<i>Eriophorum angustifolium</i>	<i>Rumex acetosella</i>	<i>Racomitrium canescens</i>
<i>Festuca lemanii</i>	<i>Ruscus aculeatus</i>	<i>Racomitrium lanuginosum</i>
<i>Filago minima</i>	<i>Salix atrocinerea</i>	<i>Rhytidiadelphus loreus</i>
<i>Frangula alnus</i>	<i>Salix aurita</i>	<i>Rhytidiadelphus squarrosus</i>
<i>Galium saxatile</i>	<i>Scilla autumnalis</i>	<i>Rhytidiadelphus triquetrus</i>
<i>Gaudinia fragilis</i>	<i>Scleranthus annuus</i>	<i>Sphagnum capillifolium</i>
<i>Hedera helix</i>	<i>Scleranthus perennis</i>	<i>Sphagnum fallax</i>
<i>Hyacinthoides non-scripta</i>	<i>Sesamoides purpurascens</i>	<i>Sphagnum palustre</i>
<i>Hydrocotyle vulgaris</i>	<i>Scorzonera humilis</i>	<i>Sphagnum papillosum</i>
<i>Hypericum elodes</i>	<i>Sedum anglicum</i>	<i>Sphagnum rubellum</i>
<i>Hypericum humifusum</i>	<i>Senecio sylvatica</i>	<i>Thuidium tamariscinum</i>
<i>Hypericum linarifolium</i>	<i>Silene nutans</i>	
<i>Hypericum perforatum</i>	<i>Silene uniflora ssp uniflora</i>	
<i>Hypericum pulchrum</i>	<i>Stellaria holostea</i>	<i>Cladonia ciliata</i>
<i>Ilex aquifolium</i>	<i>Tamus communis</i>	<i>Cladonia furcata</i>
<i>Isolepis fluitans</i>	<i>Taxus baccata</i>	<i>Cladonia gracilis</i>
<i>Jasione montana</i>	<i>Teesdalia nudicaulis</i>	<i>Cladonia implexa</i>
<i>Juncus acutiflorus</i>	<i>Teucrium scorodonia</i>	<i>Cladonia portentosa</i>
<i>Juncus articulatus</i>	<i>Trifolium subterraneum</i>	<i>Cladonia uncialis</i>
<i>Juncus bufonius</i>	<i>Tuberaria guttata</i>	
<i>Juncus bulbosus</i>	<i>Ulex europaeus</i>	
<i>Juncus capitatus</i>	<i>Ulex minor</i>	
<i>Juncus conglomeratus</i>	<i>Umbilicus rupestris</i>	
<i>Juncus effusus</i>	<i>Vaccinium myrtillus</i>	
<i>Lathraea clandestina</i>	<i>Viola canina</i>	
<i>Lonicera periclymenum</i>	<i>Viola lactea</i>	
<i>Lycbns flos-cuculi</i>	<i>Viola riviniana</i>	
<i>Lysimachia nemorum</i>	<i>Viscum album</i>	

4. Plant species list present in Lambrun peatland

Trees

Pinus pinaster
Pinus sylvestris
Salix atrocinerea
Betula pendula pubescens
Quercusobus
Castanea sativa
Strate arbustive
Pinus pinaster
Pinus sylvestris
Salix atrocinerea

Strate sous-arbustive et herbacée

Agrotis curtisii
Erica cinerea
Erica ciliaris
Calluna vulgaris
Ulex minor
Ulex europaeus
Ulex cf gallii
Holcus lanatus
Agrostis stolonifera
Polygala serpyllifolia
Pteridium aquilinum
Rubus s. sect. suberecti
Rubus s. sect. sylvatici
Potentilla erecta
Dactylorhiza maculata subsp. maculata
Centaurea jacea var. nemoralis
Hypochaeris adicata
Molinia caerulea
Juncus acutiflorus
Carex echinata
Scutellaria minor
Anagallis tenella
Pinguicula lusitanica
Carex binervis
Pedicularis sylvatica
Agrostis canina subsp. canina
Juncus effusus
Juncus conglomeratus (inclus J. kern-reichgeltii)
Cirsium palustre
Hydrocotyle vulgaris

Eriophorum angustifolium
Erica tetralix (inclus E. watsonii)
Drosera rotundifolia (inclus D.
Narthecium ossifragum
Lycopodiella inundata
Drosera intermedia
Juncus supinus
Carex viridula subsp. oedocarpa
(= Carex demissa)
Hypericum elodes
Potamogeton polygonifolius
Eleocharis multicaulis
Eleogiton fluitans
Osmundaegalis
Blechnum spicant
Dryopteris carthusiana
Frangula alnus
Salix atrocinerea (j)
Betula pubescens (inclus Betula aurata)
Pinus sylvestris (j)
Quercusobur (j)
Salix sp (j)
Salix multinervis (Salix atrocinerea aurata)
Populus tremula
Cytisus scoparius
Agrostis setacea
Teucrium scorodonia
Pinus pinaster (j)
Sorbus torminalis (j)

Strate bryophytique et algale

Campylopus introflexus
Hypnum jutlandicum
Pseudoscleropodium purum
Sphagnum sect subsecunda
Sphagnum compactum
Sphagnumubellum .
Sphagnum papillosum
Sphagnum capillifolium
Sphagnum palustre
Aulacomnium palustre
Polytrichum commune var. perigionale

5. Syntaxonomical references (paimpont area)

Cl Littorelletea uniflorae

Al Elodo palustris – Sparganion

Cl Scheuchzerio palustris – Caricetea fuscae

Al Rhynchosporion albae

Al Caricion lasiocarpae

Al Juncion acutiflori

Cl Nardetea strictae

Al Agrostion curtisii

Cl Trifolio medii – Geranietea sanguinei

Al Potentillo erectae – Holcion mollis

Cl Melampyro pratense – Holcetea mollis

Al Holco mollis – Pteridion aquilini

Cl Sedo albi – Sclerenthetea biennis

Al Sedion anglici

Cl Oxycocco palustris – Sphagnetetea magellanici

Al Oxycocco palustris – Ericion tetralicis

Cl Calluno vulgaris – Ulicetea minoris

Al Ulicion minoris

Cl Crataego monogymae – Prunetea spinosi

Al Lonicerion perichlymeni

Al Sarothamnion scoparii

Cl Quercu roboris – Fagetea sylvaticae

Al Carpinion betuli

Al Quercion roboris

Al Molinio caeruleae – Quercion roboris

APPENDIX 1: FARMER INVOLVEMENT AND ECONOMIC MANAGEMENT ALTERNATIVES IN WEST OF FRANCE (EXTRACT FROM GUILLON & CLÉMENT 2013)

Heathlands were developed in Brittany and especially in the West mountain area, during 800 years under a "cistercian" model which has encouraged the infield -outfield agrarian system. A post revolutionary model has led to the drastic regression of these huge areas (12000 km² en 1840) turned into arable land by privatisation and strong capitalisation.

Today, a handful of farmers (less than 200 over all the West of France) uses a small part of the current heathlands (less than 7% of 37 000 hectares). Most of them cut the heathland every 4-5 years: they collect the vegetation used for bedding cattle kept indoor in winter. Few of them use heathland for grazing (mainly suckling cows or sheep). Whatever the uses, economical interest is mentioned by farmers: heathlands can advantageously replace straw and cattle and sheep can get 15 to 35% of their annual diet on heathland, according a proper grazing planning. Thus for 65% of the sampled farmers, the heathland is prominent in their productive system. Ecological studies confirm the relevance of the mowing practices on semi- dry heathlands. Grazing is less easy to handle for maintain heathlands of a high level of productivity.

The future of heathlands, today designed as habitat of European community interest (Natura 2000), seems clearly related to a new integrated policy which sustains the economical management of these areas, especially existing and new farming which needs to be acknowledged and supported both as ecological services and competitive food production.

1. Ecological determinants and constraints for farming on breton heathlands

Estimation of heathland total area in the west of France is very difficult because of:

- the various and inconsistent definitions from divers sources, which often mixed heathland, fallow, neglected land, scrub (Minsitry of Agriculture, Corine land cover)
- the high level of fragmentation, except few places identified on coastal and inland areas.

Using data collected from Natura 2000 network restricted to specific habitats of Atlantic heathlands (Eur 15 codes n° 4010, 4020, 4030 et 4040), we can estimated the total area of heathland in the Armorican massif around 37000 hectares spread into 66 sites (Géo Archi-UBO/PNRA, 2007).

The productivity of one ecosystem, which can be estimated by the aerial biomass accumulated, is the best indicator of its stability or its dynamics (Clément, 2008). In the case of heathlands, the biomass accumulated in one year ranges from less than one ton/ha (dry or wet heathlands) up to more than 3 tons/ha (mesophitic): the first ones stay mostly dominated by heaths (*Erica* and / or *Calluna*) whereas the second one shows the gorses progressively dominating: *Ulex minor*/ *Ulex gallii* and or *Ulex europaeus* (Table 1).

Table 1: main types and characteristics of heathland in Brittany (from Clément 1987)

Type of heathlands	Dynamics → productivity	Grazing effects	Mowing effects	Burning effects
Coastal <i>Erica cinerea</i> dry heathland (code 4030- 2 et 4030- 3)	Low or none	<i>Festuca rubra</i> sward		Bracken and <i>Molinia</i>
<i>Erica cinerea</i> - <i>Calluna vulgaris</i> dry heathland (code 4030)	Low → 0,8 à 1,6 T/ha/year			
Dry <i>Ulex europaeus</i> heathland	Medium (to blackthorn thickets)			
<i>Erica ciliaris</i> et <i>Ulex gallii</i> or <i>Ulex minor</i> mesophitic heathland (code 4030-5 et 4030-8)	Medium (to willow and <i>Frangula alnus</i> bushes) → 2,5 T/ha/year	<i>Holcus lanatus</i> mesophitic grassland	<i>Agrostis curtisii</i> and <i>Molinia</i> grassland	
<i>Ulex europaeus</i> Mesophitic tall heathland	High (to pré-forest vegetation of oak-beech wood) → 3 à 4 T/ha/year			
<i>Erica tetralix</i> wet heathland (code 4020)	Low → 0,8 T/ha/year	<i>Nardus stricta</i> sward	<i>Molinia</i> grassland	<i>Carex panicea</i> sward
<i>Erica tetralix</i> and <i>Sphagnum</i> moorland (code 7120)	Low			<i>Rhynchospora alba</i> and <i>Sphagnum pylaiei</i> sward

In other words, heathland subjected to strong physical constraints as a thin soil acid (podzolic or ranker soil) and exposure to wind, are relatively stable (case of coastal heath for example) while mesophitic heathlands in sheltered position and deep soil (mostly in inland areas of Brittany) have higher productivity combined with dynamic evolving, long-term, to preforest thickets.

For the Natural Regional Park authority, the relationship between past management that explains the today status of these inland mesophitic heathlands and the need of active management to maintain them at a correct conservation level seems fairly obvious. More specifically, the practices of mowing in late summer with export of biomass, with a frequency of 3 to 5 years have demonstrated their effectiveness in terms of conservation (Figure 15).

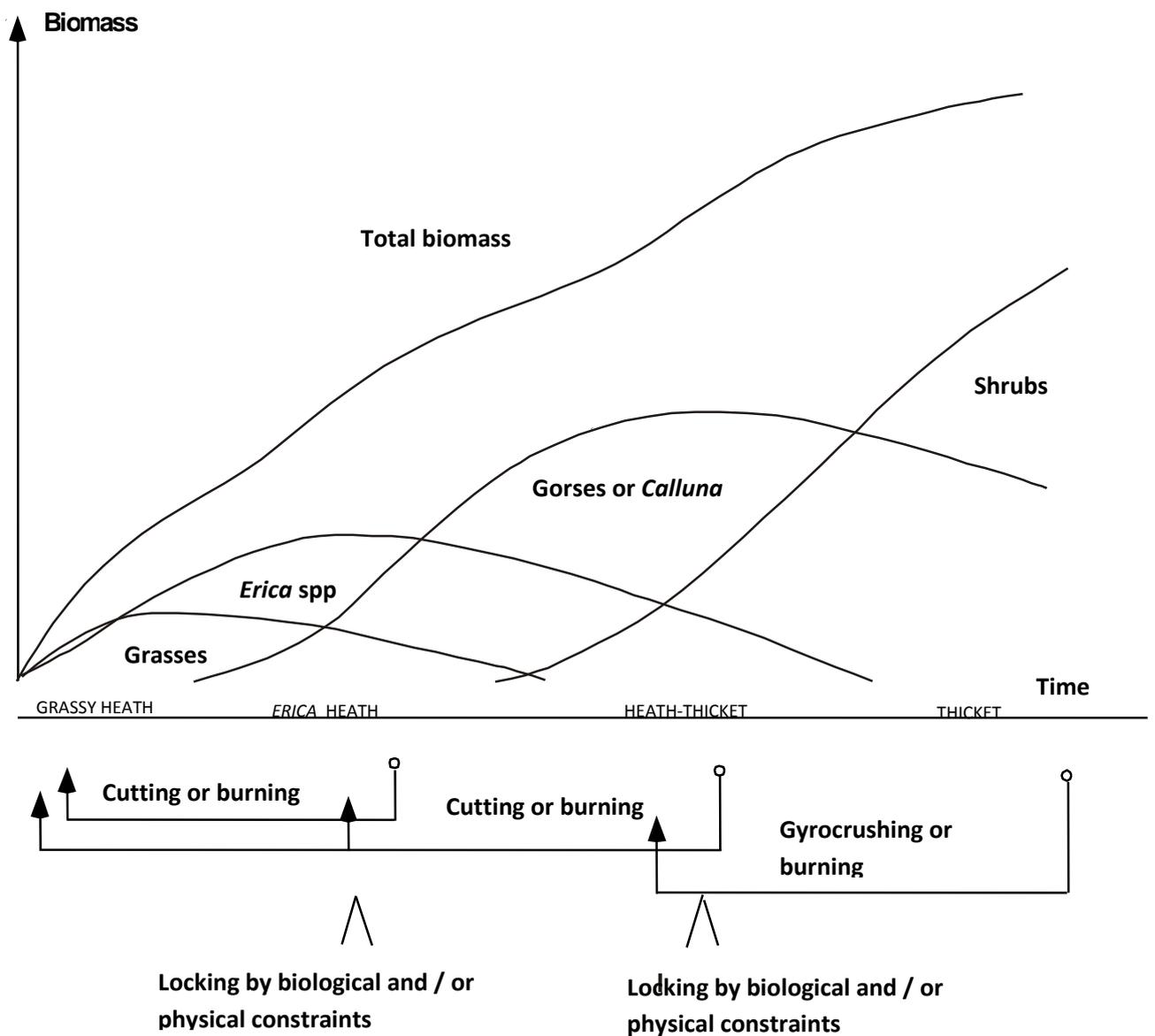


Figure 15. Biomass dynamics of different functional groups of plant populations within heath ecosystem, in relationship with medium physical or biological constraints and human uses. (Grasses : *Agrostis curtisii*; *Molinia caerulea*; *Erica* spp : *E. ciliaris* mainly and *E. cinerea* or *E. tetralix*; gorses : *Ulex gallii* or *U. minor*; bushes : *Ulex europaeus*; *Frangula alnus*).

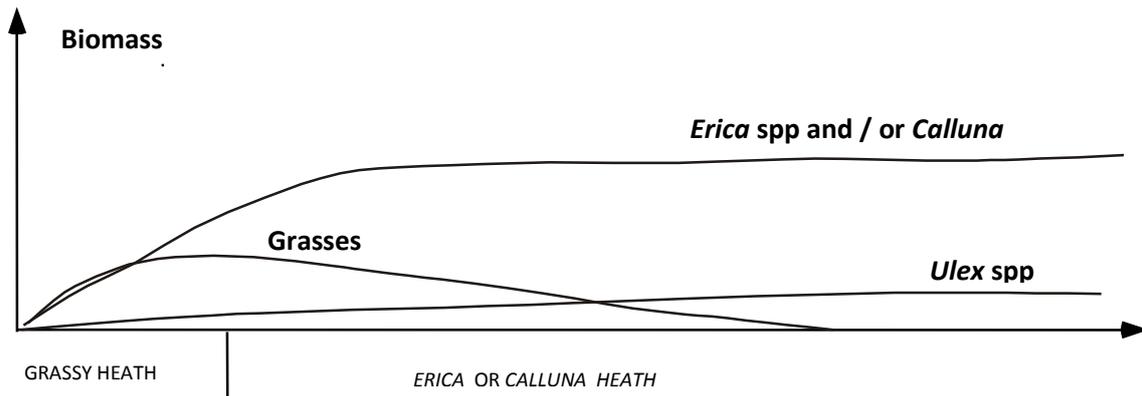


Figure 16. Biomass dynamics of different functional groups of plant populations within heath ecosystem, in relationship with strong pedological constraints : dry ou wet soils.

Grazing is a conservation management more difficult to control as it may, due to inputs of nitrogen and phosphorus (eutrophication), transform heathlands into meadows: farmers have understood and some of them use for this purpose horses or cattle intensive grazing on mesophitic heathland.

This is why the Natural Regional Park offers a preliminary diagnosis to farmers who wish to develop this practice: a minimal surface is desired, as well as a maximum stocking rate is recommended (less than 0.7 Livestock Unit / ha), and feeding at grazing is prohibited.

Conclusion

The socio-economic issues seem at the heart of landscape management in protected areas. In the case of heathland, agriculture is a key factor which implies:

- find motivated stakeholders and new skills compatible with environmental constraints and socio-economic requirements of today
- develop new markets in correlation with sociological demand sociological and economic potential
- help by the public support the development of these initiatives as ecological service, during a transition period marked by the emergence of a new context of agricultural competitiveness (re-localization of food supply chains).

Appendix 1: Farmer involvement and economic management alternatives in west of France (extract from Guillon & Clément 2013)

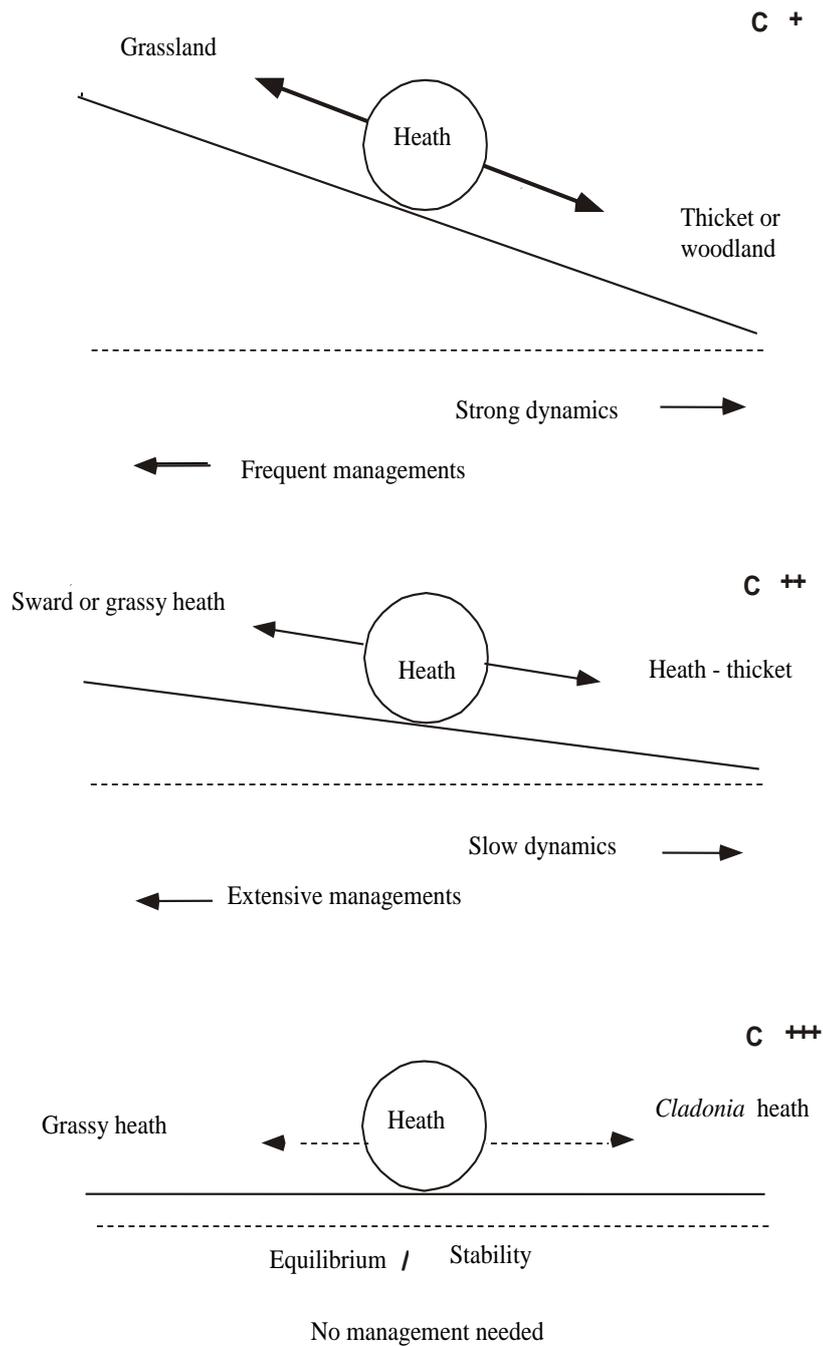


Figure 17. Successional forces tend to drive change in one direction towards thicket or woodland; management by cutting, burning or grazing tends to reverse the trend, in relationship with level of constraints: C+ - low level ; C+++ - high level - (Modified after Legg, 1995).

Reference: Guillon, L.M & Clément, B2013 In Diemont W H ,Heijman W J M ,Siepel H & Webb N - 2013 .Economy and ecology of heathlands KNNV Publishing 462 p.

APPENDIX 2 : BOCAGES AND THEIR POLLARDS IN GALLO-SPEAKING TERRITORY

Brittany is the peninsula of a natural geological region: Armorica

United with France in 1532, Brittany has retained a strong cultural identity. There are two [historical] linguistic entities: Breton, the Celtic language closely related to Welsh, in the western half (Lower Brittany) and along the coast, and Gallo in the eastern half (Upper Brittany), particularly spoken in rural areas. In addition, in Upper Brittany, farmers cultivated land that they did not own. Furthermore, until the middle of the 20th century, the main energy source (for cooking, heating, etc.) was wood. After the extensive forest clearings, wood was no longer widely available except from the hedge network and banks. Farmers rented their land under a nine-year contract and the contract specified that the farmer could not cut the trees (capital) but could cut the branches by pollarding (interest). Pollards, called “ragosse” in Gallo, reflect this usage and tradition. Pollards never exceeded 9 years of age; thus at the scale of a single farm, one-ninth of the hedges were pollarded each year. Despite the frequent levelling of hedges with the intensification of agriculture since the 1970s, there are patchy remnants of this bocage system.



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