

ELEMENT STEWARDSHIP ABSTRACT
for

Ammophila arenaria

European Beachgrass

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The Nature Conservancy
Element Stewardship Abstract
For AMMOPHILA ARENARIA

I. IDENTIFIERS

Common Name: EUROPEAN BEACHGRASS

Global Rank: G?

General Description:

Ammophila arenaria is a coarse, perennial grass growing in small tufts connected by deep, tough, extensively creeping rhizomes.

Diagnostic Characteristics:

Ammophila arenaria and *A. breviligulata* (American beachgrass) can be distinguished by their ligules, those of *A. arenaria* being thinner and longer ligules (10-30 mm) versus *A. breviligulata*'s firmer and shorter ligules (1-3 mm).

II. STEWARDSHIP SUMMARY

Ammophila arenaria threatens coastal sand dunes in the eastern and western United States. It displaces native dune species and significantly alters the morphology of dune systems where it invades. Successful management of coastal sand dune elements requires the control of this aggressive species.

The spread of *A. arenaria* can be controlled through manual removal, but this type of control requires on-going treatment. Control should be emphasized until eradication techniques are refined. Further research is a high priority and is currently being carried out by Humboldt State University, California.

III. NATURAL HISTORY

Range:

Native to the shores of Europe between 30 and 63 degrees north latitude. Introduced to other continents to stabilize drifting sands. In the United States it is found along the west coast.

Habitat:

Ammophila arenaria occurs on coastal sand dunes throughout the world. Along the west coast of the United States, it thrives in areas of active sand movement and most often occupies the windward slopes of exposed dunes. However, it may extend inland for several miles. It grows on well-drained soils with various mineral compositions, including the sands of the Pacific Coast. It tolerates a range of soil pH from 4.5-9.0 and soil temperatures from 10-40 C (Ranwell 1959).

Synecology:

Native habitat. *Ammophila arenaria* is native to the British Isles and the coasts of the Baltic and North seas from 30 to 63 degrees north latitude. It grows most vigorously on mobile and semi-fixed dunes of varying chemical and physical make-up. However, all of the substrates share instability, free drainage, low organic material content, and a homogeneous soil profile (Huiskes 1979a).

European beachgrass plays an important role in the process of dune formation. Young plants become established along the upper beach, often in the lee of driftwood or other beach plant species. As the grass grows taller, wind is deflected upward over the plant. An equilibrium is established between the growth of *A. arenaria* and sand deposition. The plant causes the wind to slow and sand particles to be deposited. Sand deposition stimulates growth of *A. arenaria*, which in turn encourages more sand deposition. Too much sand deposition slows growth; too little causes senescence. Thus, sand dune formation is largely determined by the interaction of *A. arenaria* and wind. Added protection from the wind and sand deposition results in the pattern of new growth to the lee of the existing tussocks (Willis et al. 1959a, 1959b).

In native habitats, *A. arenaria* alone makes up the foredune plant community. It also occupies dunes further inland where sand is actively moving. This community is known as "Pure *Ammophiletum*." As dunes become stabilized by this species, however, other species are able to take hold. This process creates a "Mixed *Ammophiletum*" community. This mosaic community is typically found on the lee slopes of dunes, mostly on inland, less active slip faces. Occasionally it is found in sheltered areas near the sea. It is an open community with only a moderate amount of bare sand. Since the sand supply is reduced by the fully colonized foredune, the vigor of *A. arenaria* generally declines in the "Mixed *Ammophiletum*" community (Willis et al. 1959a, 1959b).

Non-native habitat. *A. arenaria* has been introduced to stabilize sand on the west coast of the United States since the early 1900's (Knudson 1917, Barbour and Johnson 1977, Crook 1979a, 1979b). When planted on disturbed dunes or bare sand, it has initiated dune formation in the manner described above. Rhizome fragments washed along the shore may become buried on the beach, initiating the formation of foredunes (Wiedemann et al. 1974). However, the topography and composition of the foredunes differ from those formed by plant species native to the West Coast (Barbour and Johnson 1977).

A. arenaria has escaped and become naturalized north of San Francisco (Barbour and Johnson 1977) and forms extensive stands as far south as Vandenberg Air Force Base, San Luis Obispo county. Before the introduction of European beachgrass, foredunes in northern California were dominated by *Elymus*. The foredunes were low and rose above the beach with a gentle slope. Inland from the foredune was a series of dune ridges and swales aligned roughly perpendicular to the coast in the direction of the prevailing onshore winds.

Currently, where dominated by *A. arenaria*, the foredune topography has changed to a steep slope, and the orientation of the dunes is parallel to the coast. In addition to topographical alterations, *A. arenaria* replaces the native foredune vegetation, greatly reducing species diversity (Barbour and Johnson 1977).

In Oregon, Crook (1979a, 1979b) reports that prior to the introduction of European beachgrass there were no foredunes along the coast. Since its introduction in 1910 near Coos Bay and in 1935 on the Clatsop Plains, *A. arenaria* has created a foredune and colonized portions of the deflation plains. In addition, it occupies the hummock dunes, the fields of vegetated sand dune mounds occurring inland from the foredune, and the deflation plain. The foredune, as a recent geomorphological feature, has greatly reduced sand supplies to the interior moving dunes and led to their decline (Crook 1979a, 1979b, Bruce 1983). It has recently been determined that *A. breviligulata*, native to the dunes of the East Coast and Great Lakes and introduced to Washington and Oregon, is actually more prevalent than *A. arenaria* in Washington (Wiedemann 1988).

Competitive relations:

A study of Pacific Coast beach vegetation (Barbour et al. 1976) revealed that *A. arenaria* exerts more control over community competition than any other beach dominant. The upper beach and foredune along much of northern California's coast were formerly dominated by *Elymus mollis* (Barbour and Johnson 1977). Research on *Elymus* and *Ammophila* ssp. has shown several morphological and physiological differences that may explain *A. arenaria*'s competitive advantage.

A. arenaria's adaptation to sand accretion is well known. Ranwell (1959) reports that it can survive 100 cm of sand deposition per year, whereas *Elymus mollis* can only tolerate 30 cm per year. Increased human disturbance and therefore sand dune destabilization, along the coastline favors *A. arenaria* (Barbour and Johnson 1977).

At Point Reyes, California, Barbour (1977) found that *A. arenaria* had twice the root density of *Elymus* at every depth measured from 1-5 m. Differences in root systems may provide *A. arenaria* greater resistance to drought and more efficient means of tapping soil moisture. In addition, the leaves of *A. arenaria* inroll during dry periods reducing water loss through transpiration (Huiskes 1979a).

Radioactive carbon studies suggest that *Ammophila* ssp. may have a higher photosynthetic rate than *E. mollis* during the September to May wet season (Barbour 1977).

In contrast, *Elymus mollis* is able to withstand tidal inundation and is tolerant of a wider range of soil salt concentrations. *A. arenaria* cannot tolerate salt concentrations greater than 1.5-2.0 percent, whereas *E. mollis* can withstand concentrations of 12 percent or more (Huiskes 1979a).

Reproduction:

Ammophila arenaria is a stout perennial grass with horizontal and vertical rhizomes. Horizontal rhizomes anchor the young plants and produce new shoots around the parent plant. Vertical rhizomes develop, branching from a horizontal rhizome, as sand accumulates around plants. Several aerial shoots or tillers per node arise from the vertical rhizome to form dense tufts.

Shoots grow most vigorously in spring when leaf production exceeds leaf senescence. In autumn the latter predominates. Growth slows during winter but never ceases entirely (Huiskes 1979a). On dune systems in Sweden, the average yearly above ground biomass production is 400 grams per square meter (Wallen 1980).

A. arenaria is highly adapted to sand accretion. It can withstand burial by as much as one meter per year. Sand burial promotes both leaf elongation and development of vertical rhizomes from axillary buds on the horizontal stems (Ranwell 1959). Internode length of vertical rhizomes varies according to the amount of sand burial and indicates seasonal sand accretion (Huiskes 1979a).

Inflorescences are initiated in autumn of the second year after germination and mature in May or June. Flowering occurs from May to August. In Europe, anthesis occurs in July and August (Huiskes 1979a) but has been reported as early as May (Munz and Keck 1973). Mature fruits are dispersed in September. Seeds germinate the following spring. Viability of seeds is low. Seedling survival is low as a result of desiccation, burial, and/or erosion.

Reproduction is primarily vegetative by rhizomes. Rhizome fragments are dispersed along the shore by wind and water (Wallen 1980).

A. arenaria usually invades from the upper beach. There, rhizome fragments of the grass are washed ashore, buried, and sprout. Rapid vertical growth of the grass initiates dune formation, and the grass spreads rapidly in all directions by horizontal rhizomes.

IV. CONDITION

Threats:

Coastal sand dune systems around the world are threatened by the introduction and establishment of *Ammophila arenaria*. First, it is able to outcompete native dune plants. Second, it interferes with the natural dynamics of dune systems. In northern California, *A. arenaria* changes the geomorphology of the foredune community from a gentle slope to a vertical wall which prevents adequate sand movement from beach to interior dunes (Barbour and Johnson 1977). In Oregon, it has severely reduced the sand supply from beach to large inland dunes. Along the mid-Atlantic coast of the United States it is known to greatly alter beach profiles and subsequently change the impact and effect of storms on the coastline (Dolan et al. 1973).

The Northern Foredune Grassland Community described by Holland (1986) has been most severely threatened by the invasion of *A. arenaria*. This community is restricted to foredunes and is dominated by *Elymus mollis*. Only two undisturbed examples of this community remain in California, one of which occurs on the North Spit of Humboldt Bay (Holland 1986). The most pristine remaining occurrence is at the Lanphere-Christensen Dunes Preserve. In 1963, *A. arenaria* existed as one small clump 1 km north of the preserve boundary and as several clumps 4 km to the south. By 1984, it occupied 2.2 acres.

V. MANAGEMENT/MONITORING

Management Requirements:

Control of this introduced species is necessary to protect the limited occurrences of viable natural sand dune systems along our coastlines. Continued control of existing *Ammophila arenaria* stands and monitoring for new introductions are needed.

Manual removal (digging) controls the spread of *A. arenaria* but is labor intensive. In one case, complete removal was achieved, but the site was subsequently invaded by other exotic species. In the first year, monthly treatment intervals are suggested; in subsequent years, frequency can be decreased. Monitoring should be conducted to determine if exotic species, such as *Carpobrotus*, are replacing *A. arenaria*. Ultimately, re-vegetation with native species should be a standard part of management, once control techniques are refined.

Management Programs:

Management of *Ammophila arenaria* is being carried out by TNC at the Lanphere-Christensen Dunes Preserve, by Humboldt State University through the Menzies' Wallflower Research Project, by the California Department of Parks at McKenicher State Park, at Vandenberg Air Force Base, and by the Oregon Department of Fish and Wildlife.

Contact: Andrea Pickart Habitat Restoration Coordinator Menzies' Wallflower Research Project Lanphere-Christensen Dunes Preserve 6800 Lanphere Road Arcata, CA 95521 (707) 822-6378.

James Barry Resource Protection Division California Dept. of Parks PO Box 2390 Sacramento, CA 95811 (916) 322-8562

Charles Bruce Oregon Dept. of Fish and Wildlife Route 5, Box 325 Corvallis, OR 97330 (503) 757-4186.

Monitoring Requirements:

Biological monitoring should document the long-term spread of *A. arenaria* and the loss of native habitat. At the Lanphere-Christensen Dunes Preserve (LCDP), monitoring is part of an ongoing eradication program. After the grass has been removed from the preserve,

monthly monitoring for newly established plants invading from surrounding areas should be conducted on a continuing basis.

The current method for evaluating the control program at LCDP is through estimates of stand density and size, supported by photodocumentation before treatment and at annual intervals after treatment. Monitoring untreated stands is accomplished by measuring the increase in stand size at four points located at the windward, leeward, and lateral boundaries. Following control, monitoring for new invasion may be accomplished by thorough surveys of the foredune and upper beach each month.

Monitoring Programs:

The current monitoring program involves annual photodocumentation of stands before and after control treatments, and measurement of untreated stands.

Contact: Andrea Pickart, Preserve Manager Lanphere-Christensen Dunes Preserve 6800 Lanphere Road Arcata, CA 95521 (707) 822-6378.

VI. RESEARCH

Management Research Programs:

The Habitat Restoration Program of the Menzies' Wallflower Research Project (MWRP) at Humboldt State University, Arcata, California, is currently investigating three methods of *A. arenaria* control: salt application, use of herbicides, and manual removal. Previous research at LCDP indicates manual removal (digging up plants 10 cm below the surface at repeated intervals) is effective in reducing stand density. An ongoing eradication program has utilized this method with mixed results. Complete eradication has been accomplished on only one stand. The MWRP is implementing an experimental program which increases the frequency and depth of digging to remove the active rhizome bud bank.

Earlier small-scale experiments at the preserve found that a 2% solution of Roundup, applied during anthesis, resulted in 60 to 100% mortality. The MWRP is further refining methods and specifications. Timing of application may be critical.

Salt was believed to be a potential control since *A. arenaria* has a relatively low tolerance to soil salt (NaCl), although brief to moderate exposure to high salinity may stimulate bud emergence (Baye 1988). Unfortunately, the use of NaCl to control a weedy species is illegal as it is not registered as a pesticide in the state of California. The use of alternate salts has not been addressed.

Management Research Needs:

Research is needed on the effects of potential control methods including the use of herbicides (Roundup), manual removal, and salt application.

VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

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IX. DOCUMENT PREPARATION & MAINTENANCE

Edition Date: 88-11-22

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LANPHERE-CHRISTENSEN, SUE VAN HOOK (85-10-23), REVISED BY
MARY RUSSO, ANDREA PICKART, AND RICK YOUNG (1988).