Gulf Research Reports

Volume 7 | Issue 2

January 1982

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DOI: 10.18785/grr.0702.13

Gulf Research Reports, Vol. 7, No. 2, 175–178, 1982

ELEVATIONAL VARIATIONS IN THE LOWEST LIMIT OF *SPARTINA* COLONIZATION IN A VIRGINIA SALT MARSH

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ABSTRACT Elevations of lowest colonization of smooth cordgrass, *Spartina alterniflora*, were surveyed along the edge of a juvenile salt marsh at Wallops Island, Virginia. This lowest limit of *Spartina* varied over one-third of the local mean tidal range, with lowest occurrences between mean low water and mean low water neaps. Four geographical factors appeared to influence the lowest limit of *Spartina*: (1) tidal scouring in areas where tidal channels were constricted, (2) scalloping of the marsh edge over a sloping substrate, (3) patterns of historical development of the marsh, and (4) ice scouring of previously colonized *Spartina* over winter. Marsh edge scallops occurred only in areas of former *Spartina* thatch islands, and probably resulted from lateral spreading of those islands.

INTRODUCTION

Vegetation boundaries may be used to set management boundaries in salt marshes, so it is especially important to accurately measure the distribution of plants within marshes. In salt marshes of the East Coast of the United States, the smooth cordgrass, *Spartina alterniflora*, is usually the dominant rooted plant, or only rooted plant, of regularly flooded zones. Even so, detailed study of *Spartina's* lower elevational limit is lacking; it has been described generally as occurring between the elevations of mean low water and mean tide level (Chapman 1940, Broome et al. 1974). For the present study, we measured the very lowest limit of *Spartina*, i.e. elevation of the farthest-seaward *Spartina* along its edge of colonization, in a single marsh.

METHODS AND MATERIALS

This study was conducted in the Project IBIS (Intensive Biometric Intertidal Survey) study site in the Cow Gut Flat salt marsh on northern Wallops Island, a Virginia barrier island. This is a juvenile marsh (according to the classification of Redfield 1972), dominated by tall and medium growth form *Spartina* (to about 2.0 m), on generally unidirectionally sloping substrate from bay to upland, with no mature tidal creeks (described in Reidenbaugh and Banta 1980; Reidenbaugh, in press). Tidal data at the site have been estimated from a series of tide staff observations compared to a tide gauge record from Mosquito Creek, Virginia, 8 km away (Reidenbaugh 1978). Mean tidal range is 0.8 m; salinity of tidal water if from 30.0 to 32.5 ppt.

Elevations of the lowest limit of *Spartina* were surveyed with transit and stadia along the entire length of the Cow Gut Flat marsh from Gunboat Point, near Chincoteague Inlet, to Cow Gut, 1.5 km toward Chincoteague Bay. One hundred forty-nine stations were surveyed, 21 of them below parallel rows of permanent stakes 10 m apart and roughly perpendicular to the marsh edge, and 128 stations located by cloth tape ever 10 m along the marsh edge in both directions from the stakes. At each station, the stadia was held flush with the sediment at the single farthest-seaward *Spartina* shoot. Transit shots were limited to about 100 m. Levels were read to the nearest 1 mm and converted to absolute elevations relative to the National Geodetic Vertical Datum (NGVD) by running level lines to a National Oceanic and Atmospheric Administration bench mark 1.5 km away. All surveying was done from June 27 to July 12, 1978.

A map of the Cow Gut Flat marsh was drawn from color infrared aerial photographs (Kodak film 2443) taken July 19, 1976. Transparencies of 1:2,000 original scale were enlarged to 1:1,333 on a reflecting projector. Portions of five frames were combined into one map. The lowest limit of *Spartina* was traced along the marsh edge as the division between reddish tones of vegetation and bluish tones of bare sediment. The upper limit of the marsh was drawn along the saltbush line of *Iva frutescens* and *Baccharis halimifolia*.

RESULTS AND DISCUSSION

Elevations of the lowest limit of *Spartina* in the study site ranged from –0.356 to –0.095 m NGVD (Fig. 1; elevations of tidal data are mean low water, –0.387 m; mean low water neaps, –0.311 m; and mean tide level, 0.009 m NGVD). Observed emergence at low water levels confirmed that this variation was in *Spartina* colonization, rather than local variations in tidal data. There were relatively frequent occurrences of the lowest limit of *Spartina* near mean low water neaps, though the distribution of occurrences was skewed toward higher elevations. The mean elevation of the lowest limit was –0.274 m (standard deviation ± 0.045 m); the median elevation was –0.287 m.

Manuscript received August 12, 1981; accepted January 15, 1982.

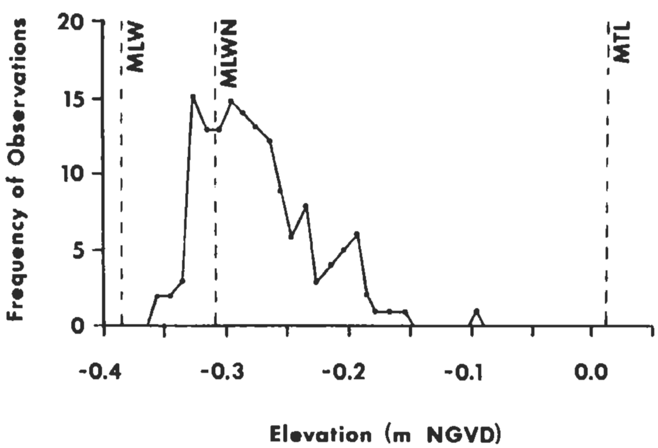

Figure 1. Elevational distribution of the lowest limit of *Spartina* (relative to the National Geodetic Vertical Datum, NGVD), compared to tidal data of mean low water (MLW), mean low water neaps (MLWN), and mean tide level (MTL).

Much of the elevational variation in the lowest limit of *Spartina* appeared to be related to geography of the marsh (Fig. 2). We hypothesize that four geographical factors influence the lowest limit of *Spartina* here: (1) tidal scouring, (2) scalloping of the marsh edge, (3) patterns of historical development of the marsh, and (4) ice scouring.

Tidal Scouring

Elevations of the lowest limit of *Spartina* increased in areas where tidal channels were constricted, where current velocities and tidal scouring likely increased. Thus, the lowest limit increased opposite a large marsh island about 100 m offshore (between letters C and L, Fig. 2). This island accreted alongside the former main tidal channel through Chincoteague Inlet (which was blocked by the modern growth of Gunboat Point; Reidenbaugh 1978), and constricted the remnant channel along Cow Gut Flat. Similarly, relatively high elevations of the lowest limit of *Spartina* farther southeast also corresponded to constrictions of this same channel by the inner shoreline of Gunboat Point (A and B, Fig. 2).

The lowest limit of *Spartina* increased sharply at the mouth of Cow Gut (U, Fig. 2), where tidal flow from bay to marsh was greatly constricted. It also increased sharply toward mouths of present or former inlets between *Spartina* thatch islands east of Cow Gut (thatch islands, N, P, and S, Fig. 2; inlet, M; former inlet, Q). Thatch islands are isolated stands of *Spartina* from seeding or ice-rafting of rhizomes (Redfield 1972). The oldest of these thatch islands (S, Fig. 2) was first colonized about 1955 (Reidenbaugh 1978).

Scalloping

At many places, the marsh edge was contoured into a series of scallops with alternating concavities and convexities; individual scallops were from 10 to 60 m long. Elevations of the lowest limit of *Spartina* were consistently lower along convexities, and higher in concavities (D, E, G, H, I, K, and L, Fig. 2). It thus seems likely that the scallops resulted from variations in lateral spreading of *Spartina* on a fairly uniformly sloping substrate, rather than from topographical variations of the substrate.

Coalescence of thatch islands resulted in scalloping near Cow Gut, and elevations of the lowest limit of *Spartina* varied along these scallops as they did elsewhere (O, R, and T, Fig. 2). Variations here probably reflected the lateral spreading of *Spartina* from initial centers of colonization; *Spartina* which spread seaward grew downslope to lower elevations. Radii of the roughly circular thatch islands suggest that they had spread at an average maximum of about 1 m/yr in all directions. The scallops to the southeast of these existing thatch islands probably resulted from similar spreading of former thatch islands which colonized before 1955 atop a longshore sandbar offshore from the marsh edge (Reidenbaugh 1978). *Spartina* has since filled the area behind the bar.

Historical Development

Patterns of the lowest limit of *Spartina* varied relative to a grographical division in the marsh. This division occurred where a projection of relatively high land (F, Fig. 2) resulted in different rates of marsh development on its northwest and southeast sides. Historically, this projection sheltered Cow Gut Flat to its northwest from waves and currents of the former channel through Chincoteague Inlet (Reidenbaugh 1978). Marsh had colonized there since 1949 (Reidenbaugh 1978), and was presently up to 130 m wide. Much of the seaward colonization was by *Spartina* thatch islands. The marsh edge was scalloped all along this area.

Southeast of the projection, the shore was unsheltered from the former channel. Marsh had only colonized since 1966 (Reidenbaugh 1978), and it was presently only 40 m at its widest. There were no thatch islands there, instead the marsh had grown by downslope spreading from high marsh. No scallops occurred, presumably because they develop from thatch islands. In this area of the marsh, the lowest limit of *Spartina* may have been more affected by topographical variations of the substrate.

Ice Scouring

The lowest limit of *Spartina* may have been increased locally by winter ice scouring of previously colonized *Spartina.* We observed ice scouring that completely denuded one area of *Spartina* shoots and rhizomes on January 24–25, 1977 (J, Fig. 2); the lowest limit of *Spartina* was highest there of all areas surveyed. Such ice scouring may partly account for the skewness in the distribution of the lowest limit of *Spartina* toward higher elevations (Fig. 1).

Elevations of the lowest limit of *Spartina* along the edge of the Cow Gut Flat marsh varied considerably over short distances, especially along present or former thatch islands.

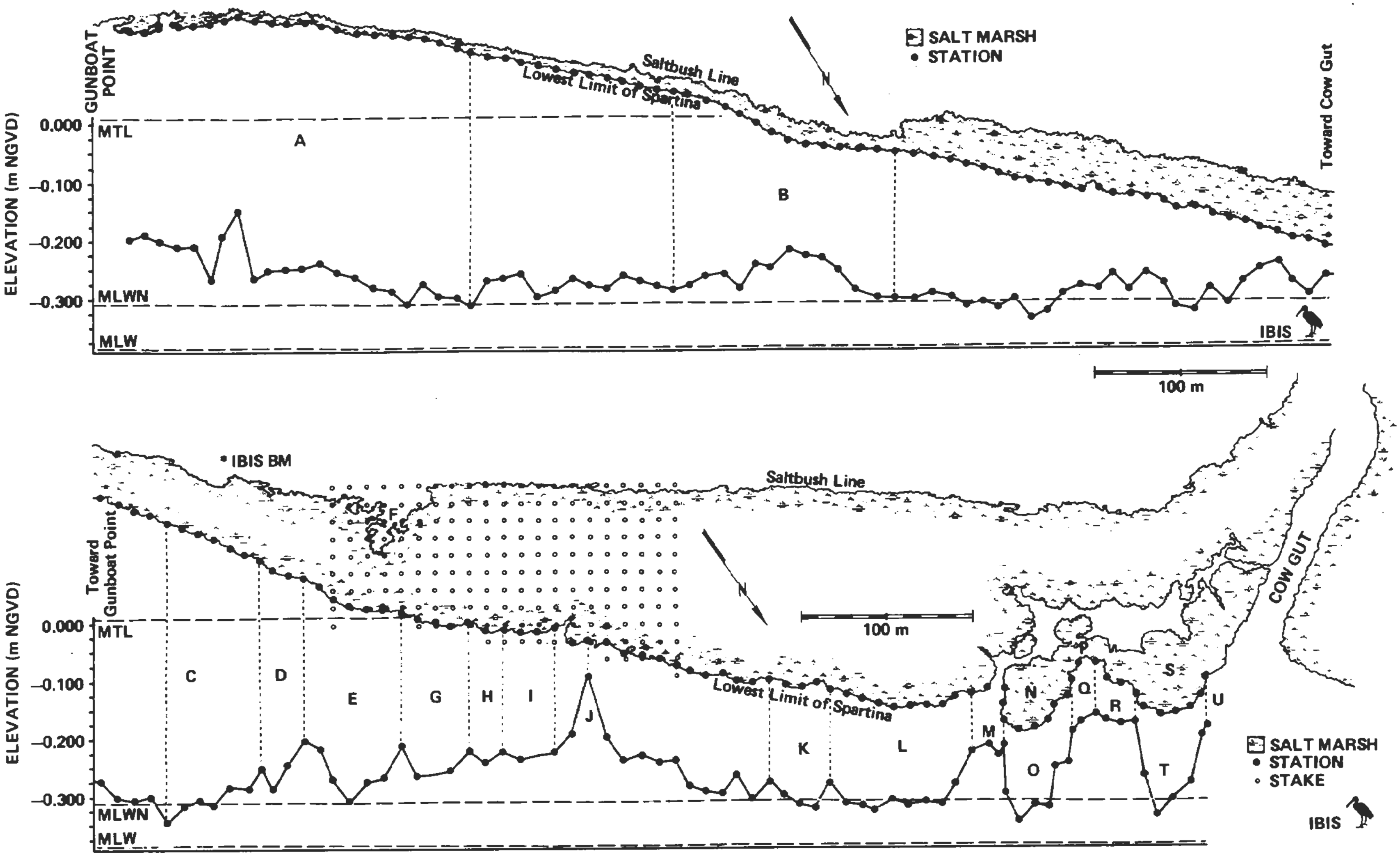

Figure 2. Elevations of the lowest limit of *Spartina* along the Cow Gut Flat salt marsh.

Much of this variation reflected differences in initial colonization and spreading of *Spartina* in this juvenile marsh. However, as the marsh matures, we expect these variations to become less significant as much of the farthest-seaward *Spartina* approaches its absolute physiological lowest limit. Patterns of historical development of the marsh and scalloping will be much less important factors than they are now. Instead, the mature marsh edge will be determined by the absolute physiological lowest limit of *Spartina,* tidal scouring, ice scouring, and possibly other factors. We did not determine the absolute physiological lowest limit of *Spartina* here, but it is at least as low as midway between mean low water and mean low water neaps, where we made several observations. Therefore, in regional management planning for *Spartina* marshes, presently uncolonized tidal flats contiguous with expanding *Spartina* marshes should be considered as potential *Spartina* marshes to elevations at least as low as midway between mean low water and mean low water neaps.

ACKNOWLEDGMENTS

This study was part of The American University's Project IBIS, and was funded by a grant from the Griffis Foundation. Aerial photographs were generously provided by the National Aeronautics and Space Administration–Wallops Flight Center.

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