The Effects of Fire on Beach Grass *(Ammophila breviligulata)* at Apostle Islands National Lakeshore

Peggy Burkman, Apostle Islands National Lakeshore, 415 Washington Avenue, Bayfield, WI 54814; peggy_burkman@nps.gov

Introduction

Apostle Islands National Lakeshore is one of four units designated as a National Lakeshore in the national park system. Established in 1970, the park comprises 21 islands and a mainland unit that stretches along 12 miles of Lake Superior shoreline in northern Wisconsin. This large body of water imposes a maritime influence on local conditions because it absorbs and releases heat more slowly than the surrounding lands. Subsequently, temperatures change at a lower rate and winters are warmer on the islands as compared with the adjacent Bayfield Peninsula. Spring also arrives later, summers are cooler, and fall is longer. The growing season is 120 days and precipitation averages 29 inches annually, with about 78 inches of snow.

Winds are variable, potentially strong, and impact a great deal of area, especially along the exposed perimeters of the islands. Historical data (National Oceanic and Atmospheric Administration [NOAA] Devils Island weather buoy DISW3 at www.ndbc.noaa.gov) indicate that between 1983 and 2001 average wind speeds were 3–26 miles per hour (mph) with a range of 0–69 mph. Gusts above 46 mph occurred in all months during this time and peak gusts of 69 mph and 76 mph have been reported in March.

Unique land features at Apostle Islands National Lakeshore include rocky cliff faces, clay banks, sandscapes, and bogs. Clay banks contain a high percentage of sand which is eroded rapidly and transported by long shore currents to form a variety of coastal sand features or sandscapes. Sandscapes include several unique landforms such as barrier beaches (Julian Bay on Stockton Island) and spits (Long Island); cuspate forelands, which are triangular-shaped seaward extentions (Raspberry and South Twin islands); tombolos, which are sand or gravel bars stretching from an island to the mainland or another island; a double tombolo (Stockton Island); and sand spits (Cat and Outer islands). These various landforms are located primarily on the southern sides of the islands. Sandscapes typically comprise a beach that is devoid of vegetation, active dunes vegetated with beach grass (*Ammophila breviligulata*), interdunal hollows, stabilized dunes and/or beach ridges, and frequently a former lake basin covered with bog or alder thicket community type vegetation.

Beach grass is a cool-season, perennial grass. Seed production is poor but the species is very strongly rhizomatous, and reproduction is primarily by vegetative means. Six to ten feet of expansion annually is common (NRCS 2002). Dispersal is aided by movement of the population towards the high-risk shoreline area which increases the likelihood of destruction by violent storms. During these conditions rhizomes are broken up into many pieces and then cast about by water. The emphasis on vegetative reproduction is reflected in the various floating capacities of reproductive parts: fruits were found to float for 108 hours, while rhizomatous fragments lasted up to 140 hours (Maun 1985). This species is highly adapted for unstable habitats. Beach grass has a strong capability to grow vertically when overtopped by sand and studies have shown individuals extending through 100 centimeters of soil both initiating and continuing dune formation. In addition Maun (1985) reported increased vigor in areas of continual sand accretion and decreased vigor in areas of more stable conditions.

Beach grass burns infrequently under natural situations and its response to fire is poorly represented in the literature. The fuel components for this community type are the grass itself and a nearly continuous and sometimes thick layer of dead beach grass. Approximately 24% of the total biomass of beach grass is accounted for in dead leaves and sheaths (Maun 1985). The species fits a grassland fuel model (Anderson 1982).

Stockton Island is the largest island at Apostle Islands National Lakeshore and the single location with the most campsites. Visitation is high at this island, both at the campsites and along beaches associated with day use purposes. On 1 July 2006, a visitor inadvertently ignited a fire at Julian Bay while using sparklers. The fire started on the landward side of the sand dunes and wind conditions were such that the fire moved northeastward towards the lake. The weather was sunny with temperatures in the low 80s and winds from the southwest at 15 to 20 knots. Visitors reported flame heights of one to three feet as the fire moved through the beach grass community. Visitors were able to put the fire out within 15 minutes of ignition, and park staff inspected the area upon their arrival and declared the fire out.

Beach grass is frequently planted to promote sand and dune stabilization near public travel corridors as well as during habitat restoration efforts. These types of areas are frequently affected directly or indirectly by public recreation, which is also often a source of fire ignitions. Considering these factors, the primary objectives of this project were to document the effects of fire on beach grass as well as to describe how this species responds to fire. A secondary objective was to increase the available knowledge base regarding this species.

Methods

The area of the burn was delineated with a global positioning system (GPS) unit and maps were later created in a geographic information system (GIS, ArcMap 9.2). Point-line intercepts were completed near the center of the burned area and in adjacent unburned habitat one month after the fire following methods outlined in the National Park Service's Fire Monitoring Handbook (1992). A total of 268 data points were recorded in the burned area and 100 from the adjacent, unburned habitat. Data was collected on the number of points with living vegetation, vegetation and litter, vegetation and sand, litter, or sand exclusively along transects. Vegetation heights (stretched to the maximum height, n = 30) were taken along parallel compass headings from both the burned area and the adjacent unburned habitat three months after the fire on 5 October. Photographic documentation of the effects of fire on the plants and regeneration were also obtained during both visits.

Point-line intercept data was summarized by proportions of points with a given parameter and differences between the burned and unburned habitat were compared with a two-sample proportion test using Statistix 7 (2000). The height data was evaluated with a two-sample T-test with this same statistics program.

Results and discussion

Fire frequently moves through an area in a mosaic pattern, leaving small patches of unburned habitat. This was not strongly evident on Stockton Island. In one section of the burned area a few sand cherry (*Prunus pumila*) plants were growing and their woody nature seemed to have the effect of slowing the fire down. The typical effect of fire on individual beach grasses differed between two conditions, depending on location. Plants located along the perimeter of the fire showed evidence of scorch, which served to discolor the leaves. Scorch apparently does not strongly impact the plants however, as other portions of the leaves retained their green coloration through both monitoring timeframes, and plant vigor was not obviously impacted. In the majority of plants affected by the fire, all but the basal portion of the culms (approximately 8 cm) was consumed. The senescent layer of vegetation was completely removed throughout the burned area.

Post-burn monitoring one month later indicated significant differences for various parameters between burned areas and adjacent unburned habitat. The number of times living vegetation was detected in the burned area was less than that of the unburned habitat ($p = 0.00$). The same was true for the number of points with vegetation and litter ($p = 0.00$) between the two sites. In addition, significance was detected for the number of points that had only sand present ($p = 0.00$) with a higher percentage in the burned habitat.

Post-burn monitoring three months after the fire focused on how the plants were recovering. The site was still readily discernible due to the complete lack of senescent vegetation and the blackened stems that were still apparent. Visual inspection of the individual plants revealed that the majority of clumps that had burned were resprouting. A very few new shoots were noted throughout the burned area. These were readily identifiable because only a single culm was present in each case whereas the vast majority of the plants had existed as clumps. In addition, the basal portion was purplish in color rather than the typical straw color of plants existing prior to the fire.

The height data recorded indicated that the mean stretched height of plants in the unburned habitat was 50.1 cm while the mean height in the burned habitat was 45.0 cm, which was significantly different (two-sample T-test; $p = 0.0377$). In spite of this difference the burned vegetation had attained 90% of the height of the unburned plants within three months of the fire.

The area experienced a wind-driven fire that moved rapidly thus minimizing the conduction of heat into the soil. As a rhizomatous species the roots were apparently not harmed. It is not known from this case how the rhizomes and roots of beach grass would respond to a fire with a longer residence time and the associated stronger heat impacts that would undoubtedly occur in that situation.

The senescent vegetation was still absent three months after the fire. It is unknown what role this component of the beach grass community plays in soil stabilization, although it is assumed to contribute to some degree. Dunes are typically strongly affected by lakeward winds and this is indeed the case at Stockton Island. Follow-up monitoring is scheduled for the 2007 summer season to determine the condition of the dunes in the area of the fire.

Beach grass is seemingly a fire-tolerant plant, defined by Kramp et al. (1986) as a plant is able to survive fire and grow afterwards. These types of plants have also been identified as resprouters, some species of which have been shown to store additional energy in root systems for recovery after disturbance (Kramp et al. 1986; Knox and Clarke 2005). It is likely that beach grass adapted this strategy due to the ephemeral habitat it is associated with and the effects following a fire are coincidental, but beneficial to the species.

References

Anderson, H.E. 1982. *Aids to Determining Fuel Models for Estimating Fire Behavior.* General Technical Report INT-122. Ogden, Utah: U.S. Department of Agriculture–Forest Service, Intermountain Forest and Range Experiment Station.

Knox, K.J.E., and P. Clarke. 2005. Nutrient availability induces contrasting allocation and starch formation in resprouting and obligate seeding shrubs. *Functional Ecology* 19, 690–698.

Kramp, B.A., D.R. Patton, and W.W. Brady. 1986. *Run Wild: Wildlife/Habitat Relationships.* Albuquerque, N.Mex.: U.S. Forest Service, Southwestern Region.

Maun, M.A. 1985. Population biology of *Ammophila breviligulata* and *Calamovilfa longifolia* on Lake Huron sand dunes. I. Habitat, growth form, reproduction, and establishment. *Canadian Journal of Botany* 63, 113–124.

NOAA [National Oceanic and Atmospheric Administration]. 2007. National Weather Service, National Data Buoy Center, Stennis Space Center, Miss. On-line at www.ndbc.-noaa.gov/station_page.php?station=disw3. Accessed 25 April 2007.

NPS [National Park Service]. 1992. *National Park Service Western Region Fire Monitoring Handbook*. San Francisco: NPS Western Region.

NRCS [U.S. Department of Agriculture –Natural Resources Conservation Service]. 2002. Plant fact sheet and plant guide for American beach grass (*Ammophila breviligulata* Fern.). On-line at http://plant-materials.nrcs.usda.gov.

Statistix. 2000. Version 7.1. Tallahassee, Fla.: Analytical Software.