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REPORT TO THE VIRGINIA MARINE RESOURCES COMMISSION

Chincoteague Bay, Virginia: Effectiveness of the SAV Sanctuary and Revegetation of SAV Habitat Disturbed by Clam Dredging

by

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Introduction

In the fall of 1997, VIMS scientists alerted VMRC staff to destruction of submerged aquatic vegetation (SAV) beds in Chincoteague Bay which had apparently been caused by clam dredging (Moore and Orth, 1997). Review of aerial photographs taken annually for the mapping of SAV beds showed a dramatic increase in the number of circular scars caused by the dredging process from 1995 through 1997 and, in particular, a rapid increase from 1996 to 1997.

No circular dredging scars were observed in SAV aerial photography prior to 1995. In photography taken in May 1995, a total of 10 circular clam dredge scars averaging approximately 29 m (95 ft) in diameter were counted. These impacted approximately 2 acres of SAV vegetation resulting in loss of nearly all vegetation within the dredged circles (Figure 1).

In photography taken in July 1996, an additional 23 circular dredged areas within SAV beds were evident. These were somewhat larger, averaging approximately 44 m (145 ft) in diameter. The 1995 dredged areas demonstrated little change in appearance and all were evident in 1996. Newly dredged SAV bottom in 1996 was estimated to be approximately 7.4 acres (Figure 1).

Aerial photography taken in May 1997, revealed an additional 218 dredged areas within SAV beds. These dredged areas generally ranged in size from 36 m (119 ft) to 84 m (277 ft) although some were as large as 120 m (396 ft) in diameter. Because at some locations large areas were formed by many overlapping circular scars, the precise number of circles was difficult to determine. All dredged areas first observed in 1995 and 1996 were still evident, with little change in 1997. Total additional area of SAV dredged in 1997 was approximately 304 acres (Figure 1).

These data were brought before the Commission in November 1997. The Commission directed their staff to develop boundaries of a sanctuary for SAV. Proposed boundaries were then sent out for public comment, and voted on at the January 1998 meeting. Although the Commission rejected the initial proposed sanctuary, two alternative proposals were discussed, and final acceptance of a sanctuary was approved which included all existing SAV mapped through 1997, and a 200 m (656 ft) buffer zone. This sanctuary, which became effective on January 31, 1998, protected 8943 acres leaving 6491 acres open to clamming.

This report addresses two major issues: 1) was the implementation of the sanctuary effective in stopping the destruction of SAV? and 2) were scars created in previous years revegetating and at what rate? The latter question was prompted by comments from watermen who suggested that some of the scars were rapidly revegetating, in the time frame of a few months.

Background

Beds of SAV are important natural resources which are critical habitats for life stages of many commercially and recreationally important species of fish, crabs and shellfish in Virginia. SAV is comprised of rooted flowering plants which have historically grown throughout the Chesapeake Bay and Eastern Shore coastal lagoons in subtidal areas where water depths are less than 6 feet (Orth and Moore, 1983). The presence of SAV in an area is indicative of water quality conditions which are low in nutrient enrichment and turbidity (Dennison et al., 1993). Given this relationship between water quality and growth, SAV have been chosen as indicator species with which improvements in water quality conditions in Chesapeake Bay and coastal lagoon systems are assessed (Chesapeake Bay Executive Council, 1992).

SAV nearly disappeared from Virginia's coastal lagoons and lower Chesapeake Bay regions in the 1930's, attributable, in part to an infestation of disease. Subsequent recovery in the lower Chesapeake Bay was retarded in the 1970's with the extremely large inputs of sediments and nutrients from Tropical Storm Agnes, which reduced SAV to their lowest levels of abundance in recorded history (Orth and Moore, 1983, 1984). In Virginia's coastal lagoons, only Chincoteague Bay has experienced any recovery.

Methods

1. Aerial Photography

Black and white vertical photography of Chincoteague Bay has been taken annually since 1986 from an altitude of 12,000 ft (a scale of 1 in. equals 2,000 ft). Flights are conducted between mid-May and mid-July, which is the time period that provides for the maximum coverage of the SAV in this region. All 1998 photographs of lower Chincoteague Bay, acquired on both June 18 and July 21, were visually scanned for dredge scars. In 1998, the photographs were additionally analyzed by digital scanning and computer analysis. All dredge scars evident in the 1998 photography were labeled as to the year the scar was formed in order to identify any new scars that may have occurred between the 1997 and 1998 photography. Scars formed between December 1, 1997 and March 31, 1998 were counted and their diameters measured digitally. Individual scars first observed in 1995 and those formed in 1996 and 1997 were compared to the photography made in subsequent years to determine if any recovery could be observed.

2. Field Surveys

Representative scars formed in each of the four years since they were first noted were chosen to determine the rate and mechanism by which revegetation may be occurring (two scars in 1995, 1996, 1998, and four scars in 1997). As the SAV species found in Chincoteague Bay grow both through rhizome extension as well as from seeds, scars have the potential for revegetating both from the edges of scars but also from within the scar by seeds which settle from the surrounding vegetation. Although there were numerous scars with which we could assess revegetation rates, we specifically chose only those scars which were distinct, and were not overlapping adjacent scars.

Field surveys were conducted on July 13 and 23, 1998. At each scar, two transects were set up across the scar with the transect extending 20 m (66 ft) beyond the outer scar edge. Transects were perpendicular to each other and ran through the middle of the scar. Percent cover estimates were made every five m (16 ft) along the transect in 10% cover increments from 5 to 95% cover using a scale modified from the crown density scale used in the annual SAV aerial photographic monitoring program (see Orth et al., 1997). Edges of the vegetated portions of the scars (both interior as well as exterior) were noted, as well as any unusual features along the transect, such as holes which were likely caused by foraging activities of organisms such as the cownose ray (*Rhinoptera bonasus*). Although we were able to locate the two 1995 scars in our July survey, we did not transect them because we could not precisely locate the edges nor center, although there were still some unvegetated portions remaining.

Results

1. Aerial Monitoring

Assessment of the photography acquired on June 18 and July 21, 1998 revealed the presence of 13 new and discrete scars, all located within the sanctuary area, which did not occur in the 1997 photographs (Figure 2). This may be a conservative estimate because any dredging that may have occurred in areas that were intensively scarred in 1997 would be difficult to discern from the photography. The number of additional scars recorded in 1998 was significantly less than the 218 scars recorded in the 1997 photography. Mean width of the new scars observed in 1998 was 42 m (138 ft) and estimated total area of SAV disturbed was five acres (Figure 1). The total number of scars for the period from 1995 (the first year when scars were noted) through 1998 is 264 scars with an estimated bottom area disturbed of 318 acres.

2. Field Surveys

Analysis of percent cover estimates along the two transects in each of the scars studied revealed a consistent pattern. There generally was 70-100% seagrass cover outside the scarred area, an abrupt reduction in cover to 15% or less at the scar edge, low percent cover across the scar until a second abrupt increase in cover occurred in the center of the scarred area where seagrass had not been disturbed (Figure 3). This pattern was reversed along the second half of the transect moving back into the scarred area and then once again into the unscarred portion of the seagrass bed (Figure 3). There was generally no difference in percent cover in the seagrass bed outside the scar and the vegetated center of the scar. There were also no significant measurable differences in percent cover estimates in the scarred portions of the 1996, 1997, and 1998 scars chosen for this study. This suggests that revegetation in these scars was occurring very slowly. Since these seagrasses spread laterally through rhizome extension, it is possible that some regrowth has occurred from the edge of the vegetated portions into the scar. Given recorded lateral expansion rates of approximately 25 cm (10 in) per year (VIMS, unpublished data), the maximum regrowth we would expect to have observed after two years (as in the 1996 scar) would be 50 cm (20 in) from one edge or a closure rate of 100 cm (39 in) per year given growth from both edges of the scar.

There were two characteristics of the scars which we believe may delay revegetation: sediment depth changes and bioturbation activity. First, we observed a distinct increase in bottom depth of 10 - 20 cm (4 - 8 in) when moving from the undisturbed seagrass bed into the scar. This topographic relief was most likely caused by excavation during the initial clam dredging (Luckenbach et al., 1996), and is now being maintained by the absence of seagrass. As seagrasses are noted for their ability to bind sediments and result in the buildup of sediments, exposure of the unvegetated portions to waves and currents could prevent the scars from filling in with sediment.

Second, large holes up to one meter (3 ft) in diameter and 30 - 40 cm (12 - 16 in) deep were often noted inside the unvegetated portions of the scars, and especially along the edges of the scar. These holes were likely the result of foraging activity of organisms such as the cownose ray (Orth, 1975). We rarely noted these ray holes in the densely vegetated portions of the seagrass bed. The dense foliage and rhizome mat of the established bed may inhibit the rays from digging. Without the seagrass, rays can easily dig into the bottom by flapping their wings to remove the sediment. We believe this is what we are observing in the June 18, 1998, photograph (Figure 4) which has long sediment plumes streaming from the scarred areas. Note that most of the plumes are coming from the scarred areas and not the dense vegetated areas. Further evidence of this ray activity was noted on May 24, 1998, in scars formed in 1997 in the more northern part of the large bed. Close inspection of the bottom at these locations revealed numerous freshly broken clam shells that are generally an indication of recent ray activity.

Much of the vegetation noted in the scar consisted of either single shoots or small patches of shoots. These are most likely the result of seeds surviving and growing in these unvegetated areas, or possibly may be the remnant shoots that may not have been uprooted by the clam dredging. The number of small patches remaining after dredging may greatly effect recovery rates as new SAV grows laterally thereby filling in a scar from within.

Although direct observations of these eight scars show little regrowth, we have noted through detailed examination of the 1997 and 1998 photographs some scars that appear to be revegetating more rapidly than others. Figure 5 is an enlargement of a portion of the photograph showing three scars (1, 2, 3) formed in 1996. Figure 6 shows the same area in 1998. The photographs suggest that a differential rate of revegetation may be occurring in these three scars, possibly a result of the intensity of the initial dredging activity in those areas. The intensity of dredging appears to increase from scars 3 though 1 in 1996, while the revegetation rate appears to decrease. We suggest that the more lightly scarred area may have had many more adult plants left in place which provided for more rapid regrowth. An alternative hypothesis might be that the greater scarred areas are simply dredged deeper than the lighter ones creating: 1) a significant depth gradient at the scar edge (i. e. a ledge) which may make it impossible for vegetative rhizome expansion, and 2) significant changes in bottom type or other habitat characteristics which are inhibiting seedling re-establishment.

These hypotheses may be the reason why the 1995 scars, in general, appear to be more fully vegetated than scars formed in 1996 and 1997. Since 1995 was the first year we noted scars and because the 1995 scars were much smaller in diameter, it may be that either lighter dredges were used in the beds, or the clamming in these areas was unproductive and the clammers did not remain at the site to remove all the vegetation. In addition, the smaller size of the 1995 scars may have allowed a more rapid recovery.

Recovery rates of the dredge scars may only be estimated at this point since none of the scars formed since 1995 have fully revegetated. Based upon this observation we would propose that even the most lightly impacted areas will require a minimum of five (5) years to reach plant cover similar to surrounding areas. However, our knowledge of impacts to other environmentally valuable and sensitive habitats such as salt marshes suggests that many environmental characteristics of these impacted areas such as the organic content or nutrient levels of the sediments, as well as the resource value of these scarred areas to the Chincoteague Bay system will likely require a longer time period than this five year minimum.

The most heavily impacted scars will require a significantly longer period for recovery. Our recent observations of continual disruption of the sediments in many of these scars by both physical forces and animal foraging activities suggest that the rates of recovery may not be straightforward. Given the diameter of some of the large scars (over 100m - 325 ft) and a maximum lateral spread from the center and sides of two (2) meters per year, recovery may take 50 years. However, we would expect that since most of the scars are within very productive, large SAV beds that seedling growth and other natural revegetative processes would shorten this recovery interval. But recovery of the most heavily impacted scars may still take 20 years or more provided no additional natural (such as hurricanes) or man-induced stresses (water quality deteriorations) impact the bay system during this period.

Summary and Recommendations

On January 31, 1998, the first SAV sanctuary in Virginia was enacted into law. The legislation prohibited clam and crab dredging within the sanctuary which included a 200 m (656 ft) buffer around the existing vegetation. This was precipitated from clear evidence of damage to this important habitat by dredging for clams. Over 250 individual circular scars had been recorded from 1995 through 1997, resulting in the destruction of over 300 acres of seagrass, or roughly 6.3% of the vegetated bottom in lower Chincoteague Bay. Only 13 new scars were clearly identified in the 1998 photography, less than the number of new scars noted in both 1996 (23) and 1997 (218). Since the sanctuary went into effect on January 31, 1998, and with clam dredging season already open on

December 1, 1997, it is possible that the scars we observed were formed before the sanctuary went into effect. Assuming this, we believe the adoption of the sanctuary was effective in preventing further destruction of the SAV.

Revegetation of the scars appears to be controlled by many factors. Scar size and intensity may be of primary importance, as the amount of grass remaining inside a scar can dictate recovery rates by lateral expansion within a scar. Some scars in the photographs are apparently lightly dredged, and their recovery was more rapid, while other scars remain as unvegetated as when they were formed. This lighter intensity of scarring may explain the revegetation of the 1995 scars which were smaller than scars created in subsequent years. Also, altered topography and possible sediment structure may hinder revegetation. Finally, rays may be selectively foraging in the scars (and uprooting seedlings or remnant plants not initially removed by clam dredging), as evidenced by large numbers of foraging pits within the scars. Given the recovery in some scars we have observed so far, the size of the scars, and our knowledge of the many factors which affect revegetation, we suggest that recovery of individual scars will range from a minimum of 5 to a maximum of 20 years or more.

The continued existence of the sanctuary will allow for the long term survival and expansion of one of the largest seagrass beds in the region. We recommend: 1) that the sanctuary be re-evaluated each year as these beds continue to develop for possible expansion of the sanctuary boundaries, 2) that the SAV beds continue to be monitored via aerial photography to determine if any new dredging activity occurs (i.e. compliance by watermen), and 3) to determine recovery rates of the scarred areas.

Acknowledgements

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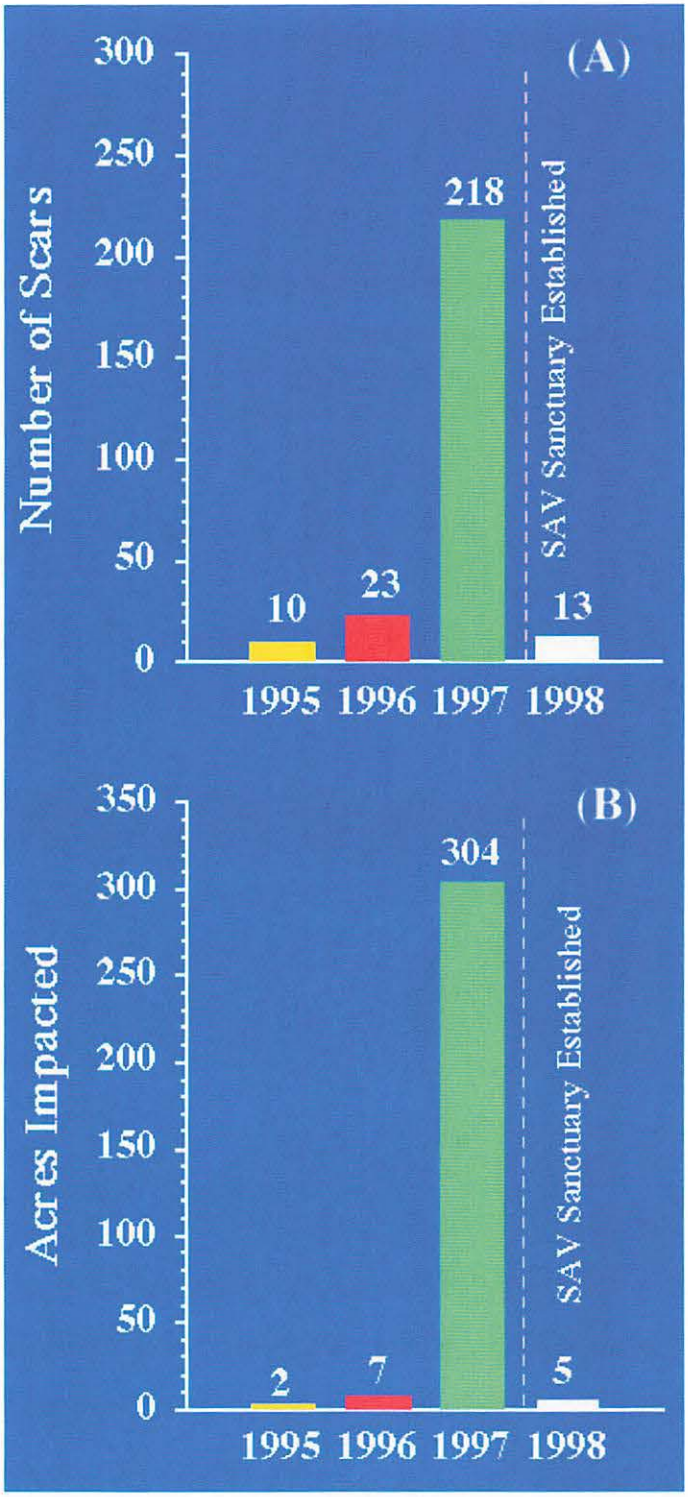

Figure 1. Number of new clam dredge scars (A) in Chincoteague Bay, Virginia and new acres of SAV impacted each year (B).

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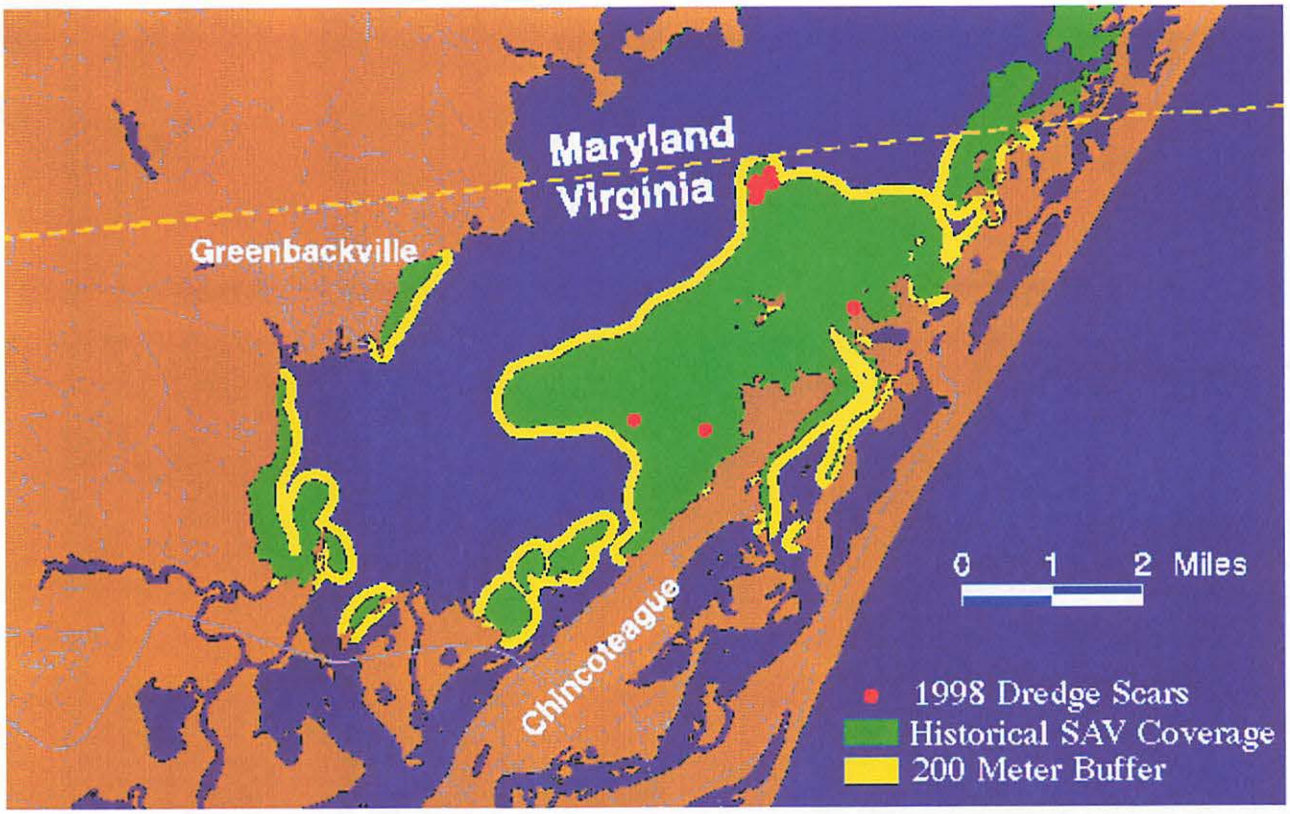

Figure 2. Location of the 13 new dredge scars recorded on the 1998 photography.

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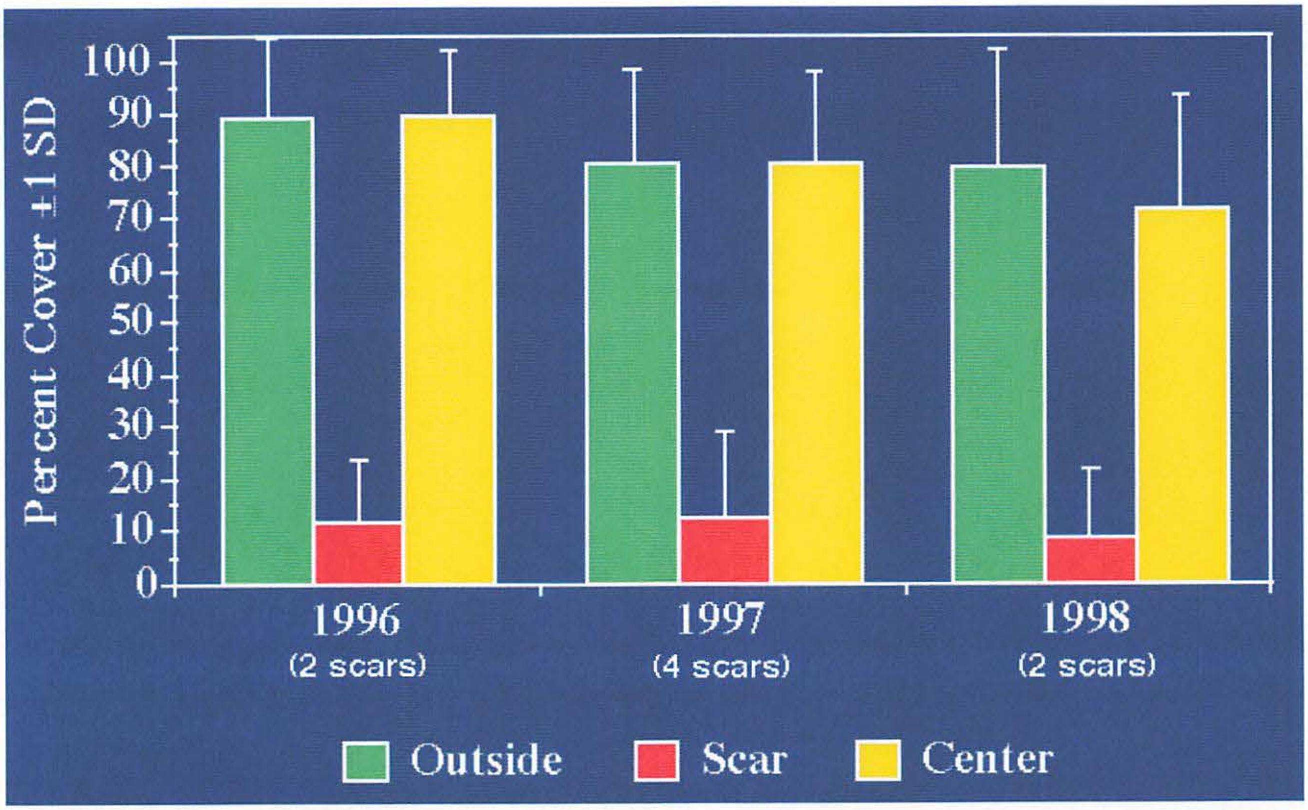

Figure 3. Mean percent vegetated covers of field-surveyed scars. Measurements are visual estimates at 5 meter intervals along perpendicular transects, from outside of the scar edge, within the scar, and the central vegetated area.

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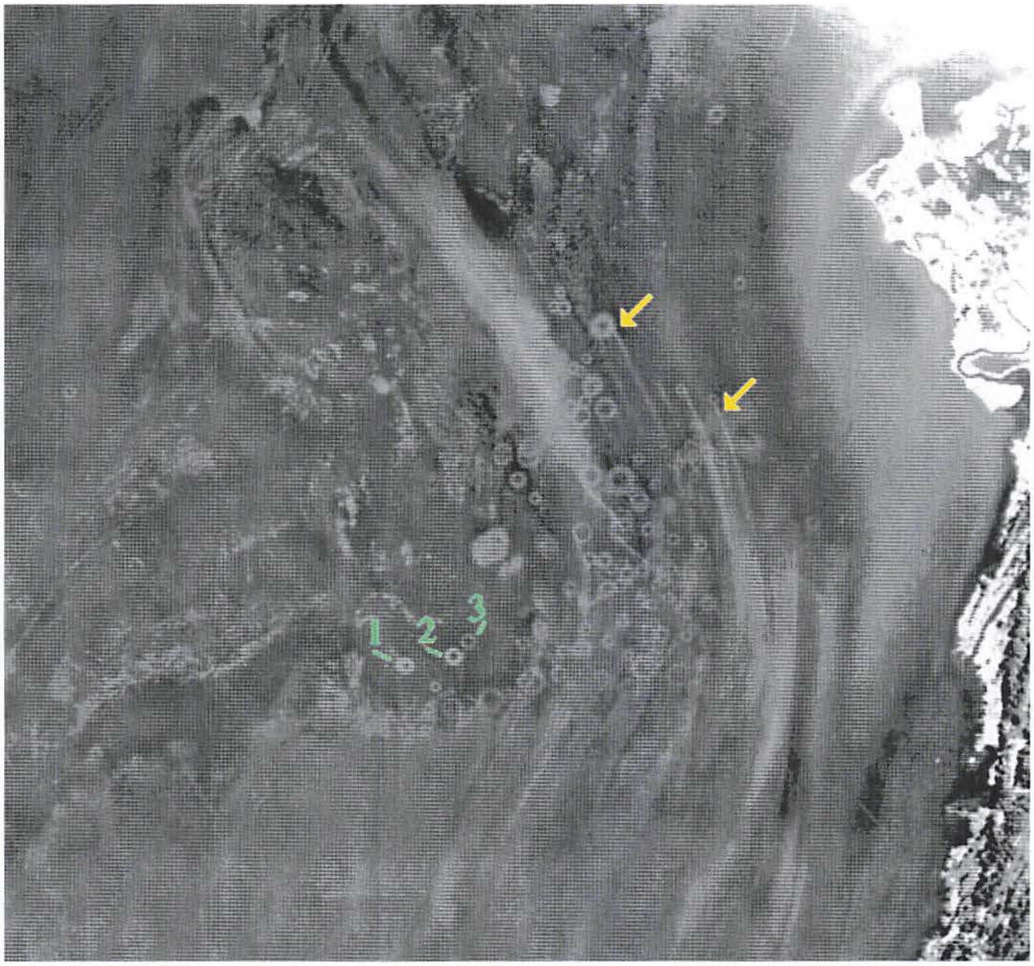

Figure 4. Aerial photograph taken on June 18, 1998 showing clam dredge scars in Chincoteague Bay. Sediment plumes created by rays are indicated by yellow arrows, and appear to be affiliated with the dredge scars. Scars noted in Figures 5 and 6 are indicated by the same numbers (1,2,3).

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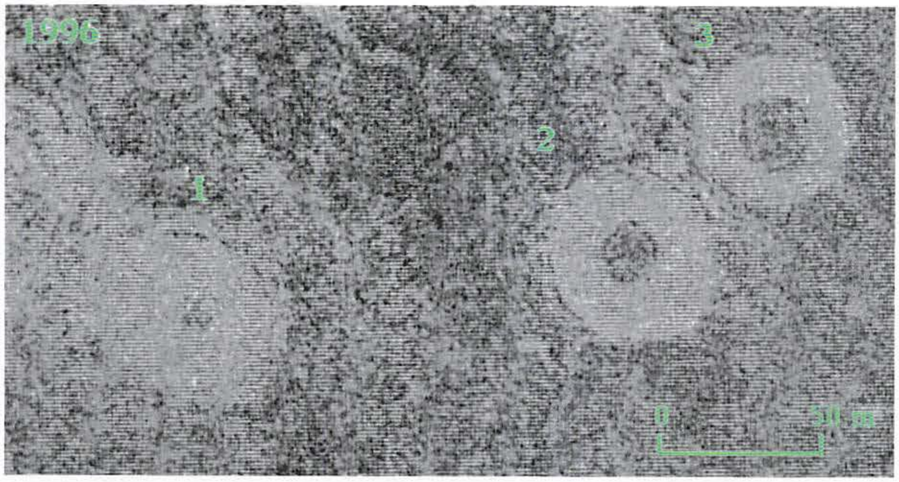

Figure 5. An enlargement of an area on the 1996 photograph showing three dredge scars that may have been formed with differing intensities of dredging. The intensity of dredging appears to decrease from scar 1 to scar 3.

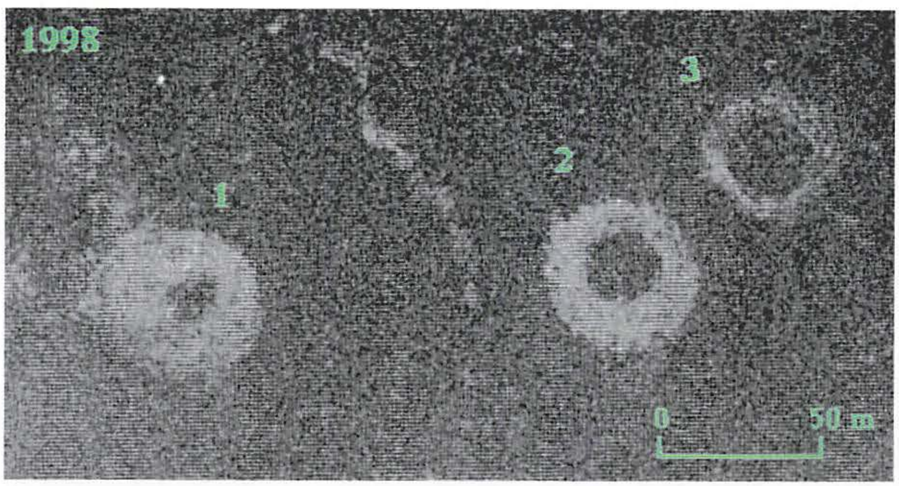

Figure 6. An enlargement of the same area on the 1998 photograph showing differing amounts of revegetation in the three scars. The amount of revegetation appears to increase from scar 1 to scar 3.

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