Tampa Bay National Estuary Program
Technical Publication #05-94

National Estuary Program

RESULTS OF ANALYSIS OF PROP SCAR DAMAGE AT THE FORT DESOTO AQUATIC HABITAT MANAGEMENT AREA 1992/1993

FINAL REPORT
ACTION PLAN DEMONSTRATION PROJECT

AUGUST 1994

Results of Analysis of Prop Scar Damage at the Fort Desoto Aquatic Habitat Management Area

1992/1993

By:

J. Nicholas Ehringer
Hillsborough Community College

Assisted by:

James Wysong
Michael Rimaldi
Peter Chipman
April Kirali

Results of Analysis of Prop Scar damage at the Fort Desoto Aquatic Habitat Management Area 1992/1993

By: J. Nicholas Ehringer
Professor of Ecology
Hillsborough Community College / Brandon
10414 E. Columbus Drive
Tampa, FL 33619

Office: (813) 253-7833
Fax: (813) 661-6904

Summary:

Pinellas County has designated an aquatic zone at the southern tip of the county as the "Fort Desoto Wetlands and Aquatic Habitat Management Area." This aquatic zone has abundant meadows of seagrasses and is used extensively by recreational boaters and fishermen. Due to the number of boats that use the area there has been considerable damage done to the seagrasses by boat propellers. Damage to seagrasses by propellers can be widespread in aquatic habitats and it may take up to five years for damaged seagrasses to recover once a prop scar has occurred.

Taking a proactive approach to protect the seagrasses Pinellas County developed the "Fort Desoto Park Wetlands and Aquatic Management Ordinance." The ordinance established the Fort Desoto Park Wetlands and Aquatic Management Area to provide for the preservation, recovery and expansion of marine habitats. The intent of the ordinance was to minimize the extent of damage to seagrasses by propellers, to restrict boats from areas where seagrass damage is likely, by requiring "slow down/minimum wake zones", posting and monitoring the management area, and by providing a public education forum about the value of seagrasses. The monitoring program has been established for a five year period beginning in March of 1993.

The specific objectives of the monitoring program are as follows:

1. Establish and post "Boating Restriction Zones" and "Seagrass Caution Zones". Boating Restriction Zones will restrict operation of internal combustion engines to specifically marked "Navigation Channels" where slow down and minimum wake will be required.

2. Internal combustion engine use will be allowed in Seagrass Caution Zones but shall be utilized to avoid damage to seagrasses. Penalties of up to $500.00 and 60 days in jail may be levied for violation of this ordinance. In addition, restoration may be required.

3. A monitoring period will be established for a minimum of a 5 year period to determine the success or failure of the adopted restrictions. During this period aerial photography will be performed on a quarterly basis for purpose of seagrass mapping. Digitization and photointerpretation of the aerials will be performed to determine revegetation rates, additional damage or variations in seagrass communities.

4. The county will establish a public education program to provide for the distribution of information to citizens about the value of seagrasses and the restrictions placed upon boats in the Fort Desoto Area.

5. The management area will be buoyed, posted or marked by the County in accordance with Chapter 16N-23, Florida Administrative Code.

The purpose of this project relates to objective #3 from above. Aerial photographs were taken for the County by professional aerial photography companies. The film was analyzed by Hillsborough Community College. Computer images were made of the photographs and ground truthing was used to compare the images with the prop scars in the water in the aquatic management area.

Three sets of aerial photographs were used for our primary analysis. One set was taken in March of 1993. This set was used as our baseline because the boat restriction signs were placed in the field at that time. The second set of film was taken in the fall of 1993. Most of our comparisons were between these two sets of film. A third set was taken in the summer of 1992 and has also been used for correlations with the other sets of film.

When comparing the photographs from March of 1993 and the fall of 1993 we noted that the rate of scarring was rather low in seagrass zones that were marked for boat restrictions and for boat cautions. The increase in scarring was computed as 15.3% increase in scars for the boater restricted zones and an 18.7% increase in scars for boater caution zones. The non-restricted zone had an increase in scarring of 84.7%. The data shows that the presence of signs in the water, whether caution or restrictive, has the effect of reducing prop scar damage.

Introduction:

Hillsborough Community College was contracted to analyze three sets of aerial photographs taken over the Fort Desoto Aquatic Management Area for prop scar damage to the seagrasses. Three sets of photographs were ordered by the department with flight times in July of 1992, March of 1993 and November of 1993. The photographs were taken on nine by nine inch positive transparency film by two separate aerial photographic companies.

The following services were proposed for the mapping and computer documentation of seagrasses and prop scars in the Fort Desoto Management area:

1. The Department of Environmental Management photos were assembled into a mosaic and used to create paper transparencies with markings for each identifiable type of grass. Each subunit will be digitized on the computer for accurate mapping of the seagrasses and the prop scars. The subunits can be put together to create a computer map of the entire management area at Fort Desoto.

2. The computerized information will be in AutoCad format. This information can be transferred via compressed data disk to the Geographic Information System of Pinellas County. The data will be delivered in the appropriate format to the county computer services for their use as needed. We will seek written information from the Pinellas County computer personnel to specify exactly which format they require and we will conform to that format. The image files will conform to the GINA (General Interchange and Archive) format and will conform to the CCITT Group Four standard format.

3. Seagrass scars will be identified individually and semi-continuous segments linked except in areas where scarring is very dense. In these areas the methodology may require the use of polygons around a collective group of scars. Polygons shall be classified as moderately or severely damaged based on percent of actual damage to the seagrass beds. Moderate damage shall include damage in the 20 - 50% range and severe damage shall include damage in the 50+% range. The computer images will be done in layers, with one layer as a base map, another layer showing the seagrasses and another layer showing the prop scars. In the seagrass areas, the "bare" areas will be distinguished from the grass areas, and every effort will be made to differentiate different species of grass beds from one another. The grass beds will be computed in square foot units. The prop scars will be calculated in linear feet.

4. Aerial photographic information will be rectified to the base map to correct any parallax deficiencies. This will be verified by "ground truthing" the images for accuracy of scale and orientation.

5. The seagrass scars and the bare areas in the grass beds will also be measured in the

field to ascertain the accuracy of the photographs. This form of measurement, referred to as "ground truthing" is essential in the verification process. Seagrasses will be differentiated from algal beds and deep water areas that can be confused with actual grasses on the photographs. In many cases we will differentiate between the various types of seagrasses. The grasses will also be delineated as "continuous" or "discontinuous" and other areas as "deep water" and "bare substrate." The bare areas will be denoted as sand, mud or other substrate. The same transect (mosaic) system as identified in the photographic discussion from # 1 above will be used in the field. This will be worked out in conjunction with the Department of Environmental Management as the most optimum method of transect evaluation.

Ground truthing will be done in three phases. In the first part of the proposal we will measure all of the prop scars in the study site and compare them to the computer images. In the second and third phases we will select certain scars from each of the three zones in the field (caution zones, boat restriction zones and no restriction zones). About one third of the scars in each of these areas will be followed from film set to film set over time to see the rate of recovery.

The ground truthing method allows for sufficient data to account for:

A. Regrowth of seagrasses into prop scars.
B. A biological review of the scars to see what, if anything, is growing in the scars.
C. Sand movement within the scars.
D. The ability to note new scars as they appear in time from this baseline study.

6. The Departmental of Environmental Management has provided three sets of photographs (Summer of 1992, Spring of 1993 and Fall of 1993). From these we will generate three sets of computer images. The March 1993 set of films constitute the baseline study and requires an initial setup with the computer and ground truthing. The second and third sets of photos will require less computer time and less ground truthing, as will all other subsequent sets of film.

7. Progress on the contract can be reviewed at any time by the county Department of Environmental Management. In addition, we will present reports to the Pinellas County Board of Commissioners on the project as requested.

8. All materials and information for this project shall be the sole property of Pinellas County.

The Value of Seagrasses

Available scientific literature gives several reasons for the importance of seagrasses. Among the reasons are the following:

1. Seagrasses tend to have very high growth rates and production rates. They tend to add to the overall productivity of a region because of their growth rates.

2. The leaves of seagrasses tend to support large numbers of epiphytic organisms with biological mass approaching that of the seagrasses themselves.

3. Seagrasses, and the organisms on them, produce large amounts of detritus which become food for other organisms.

4. Seagrasses have extensive root systems and lateral rhizome structures that tend to hold sediments together and prevent erosion.

5. Seagrasses act as nutrient sinks and sources.

6. Seagrass beds become the home to many forms of juvenile organisms as well as adult organisms. In areas where seagrasses have been destroyed, the populations of shrimp, snook, and many other species, tend to decline dramatically.

7. Seagrasses are used as a food source for Manatees, which have been seen in and around Tampa Bay.

For these reasons it is important to protect and to monitor seagrasses in the Fort Desoto Management area.

Delineation of Zones

The Department of Environmental Protection established three types of zones in the aquatic preserve. The establishment of the zones was designed to study the effects of different aspects of boat traffic on the number of scars that would be produced. The zones were as follows:

1. Boat Restricted: in this zone no boats are allowed. Signs are posted in the water to notify boaters of the restrictions.

2. Seagrass Caution: in this zone signs are posted for boaters to advise them of the presence of seagrasses. Boats are not restricted from this zone, only warned about the location of the grasses.

3. Non-restricted Zone: in this zone no restrictions are placed upon boaters.

The three types of zones allowed for a comparison of boat activity, i.e. scars, from one type of zone to another.

Delineation of Areas

The aquatic preserve area was divided into six aquatic areas by the Department of Environmental Protection. Each aquatic area was designated as a boat restricted zone, a caution zone, or a non-restricted zone. The areas are as follows (also note the attached map):

1. Area I: this area surrounds Indian Key, a National Wildlife Refuge. This area is designated as a boat restricted zone.

2. Area II: this area is bordered by the "Main Channel" to the north; to the east by the channel in front of the Skyway approach; to the west by Cabbage Key and Isla Del Sol; and to the south by a line drawn from Pardee Key to the east. This is a non-restricted zone.

3. Area III: this area is south of area II and is bordered to the south by Bunces Pass channel; to the west by Cabbage Key; and to the east by a line drawn just to the west of Tarpon Key. This is a caution zone.

4. Area IV: this area surrounds Tarpon Key and is a boat restricted zone.

5. Area V: this area is in Mullet Key Bayou and is a boat restricted zone.

6. Area VI: this area surrounds Bonne Fortune Key and extends up to the channel at Conception Key. This is a boat caution zone.

Seagrass Square Footage

We measured the square footage of the seagrasses at each of the areas listed above. The available square footage of seagrasses was based on the aerial photographs taken in the spring of 1993. The numbers are as follows:

Location	Square Feet	Acres
Area I	548,812	12.6
Area II	2,702,098	62.2
Area III	4,637,528	106.4
Area IV	1,801,377	41.4
Area V	3,341,351	76.7
Area VI	4,844,994	111.2
Total	17,884,160	420.5

Seagrass Densities

We measured the approximate density of seagrasses at each area to set a baseline for future studies. The densities will be compared from year to year to see is there is a general loss of seagrasses in each area. The densities were determined by counting *Thalassia sp.* shoots in the water in random square foot zones. There were nine samples taken per zone and the numbers were averaged to give us the following baseline data:

Location	Shoots/square feet
Area I	25.11 (Std 3.07)
Area II	14.89 (Std 3.21)
Area III	19.89 (Std 2.13)
Area IV	24.11 (Std 3.57)
Area V	29.5 (Std 2.83)
Area VI	16.44 (Std 2.01)

In all of the areas *Halodule sp.* was mixed with *Thalassia sp.* As is typical for the plants, *Halodule sp.* was prevalent in locations closer to shore and in sites that may have been disturbed at one time, but are now recovering. The most dense patches of *Halodule sp.* were seen in the shallows to the south of Indian Key (Area I).

Prop Scar Damage Procedure

The main focus of this study was to determine the damage caused by boats to the seagrass beds around the Fort Desoto Aquatic Preserve and to compare damage from one zone to another. The extent of prop scar damage was determined in several different ways. The first method was to measure the scars directly from the aerial photographs. First we divided the maps of the preserve into quadrants for ease of measurement (a copy of a quadrant map is attached). After determining the scale of the pictures, each scar was measured along its length and placed in a data base for computational purposes.

The second method was to draw each of the scars on a computer generated map of the preserve. This was accomplished by tracing each scar onto the computer screen and then measuring the length of the scars from the computer (AutoCad) files. Both methods proved to be compatible and to be accurate in comparing one method to the other (see the section below on inaccuracies). This method provided us with a cross check of the data.

Photographic Accuracy

The quality of aerial photographs that were presented to us for analysis made them very difficult to analyze for a number of reasons. The photographic problems were outlined to Jake Stowers in a letter dated February 8, 1994 listing the following problems comparing the spring and fall of 1993 films:

1. The overall quality of the photos is not as good as other aerial photos we have seen of the bay at a similar scale.

2. There is a gap in the photos taken over the middle of the site in the March set of films.

3. Each unit of photos was not taken at the same time. Apparently they were taken over several months. This has caused a variance in the film quality due to changes in the water.

4. Most of the frames were taken at a 1 to 4,800 scale. Some photos were taken at a scale of 1 to 2,400. This tends to throw off our data and cause confusion. The photographer should have been consistent.

5. The set of films taken in November has a blue cast to them, while the earlier set does not. This is a lack of consistency.

Later a meeting was held with the photographers and they admitted that they had taken photographs at different dates, different altitudes, at high tide, and at a time of day close to noon (causing sun glare to appear in the middle of the photographs). All of these factors make the interpretation of the photographs very difficult. The most difficult problem that we see is the problem of taking photographs at high tide. This causes the turbidity of the water to obscure the scars and makes analyzing of the photos most difficult.

In addition, the photos taken in the summer of 1992 were taken by a different photographer, at a medium tide, and at a time of day close to noon. Therefore, we are somewhat unsure of the accuracy of the data (this was shown to be true with the ground truthing). These concerns have been expressed to the photographers and they have promised to abide by the specifications in their photography in 1994.

There is one more point to consider about the photographs. Since all of the photographs were taken under less than optimum conditions, all of the photographs suffer from the same inaccuracies. It is therefore, possible that we are comparing "apples to apples". We are comparing one set of poor films to another set of poor films. Another problem will come up when we try to compare the old films to the films taken in 1994. Accurate films taken in 1994 may be difficult to compare to

inaccurate films taken in 1992 and 1993. We may, therefore, declare the 1994 films as the new baseline. As a result, we will see a big increase in scars on the 1994 photos that will not reflect "new" damage.

The next two pages show data computed from the photographs. A discussion of the data follows.

Comparison of Prop Scar Damage at The Fort Desoto Aquatic Preserve

	Summer 1992		Spring 1993		Fall 1993	
	Scars #	Feet Linear	Scars #	Feet Linear	Scars #	Feet Linear
Area I	16	6,260	20	1,606	30	2,302
Area II	19	6,953	66	16,119	123	29,777
Area III	74	77,379	96	36,548	115	42,141
Area IV	18	12,375	86	18,569	91	19,664
Area V	59	18,715	61	16,747	86	20,622
Area VI	24	9,856	120	29,868	147	36,707
Total	210	131,538	449	119,457	592	151,213

Comparison of Prop Scar Damage at The Fort Desoto Aquatic Preserve

Comparison of sites according to protective status

Zone	Summer 1992		Spring 1993		Fall 1993	
	Scars #	Feet Linear	Scars #	Feet Linear	Scars #	Feet Linear
Boat Restricted	93	37,350	167	36,922	207	42,570
Seagrass Caution	98	87,235	216	66,416	262	78,848
Non-Restricted	19	6,953	66	16,119	123	29,777

Analysis of Prop Scar Damage

The first chart compares each area of the preserve from the three sets of film to the number of scars and the linear feet of scars. The second set of data compares the damage done to seagrasses in restricted zones, caution zones and non-restricted zones from the three sets of photos.

Most of the data are fairly consistent with the concept that as time passes more and more scars should appear at each area as boat traffic increases and the rate of healing is very slow. We have found in our studies at Cockroach Bay that prop scars may take from three to five years to heal, therefore, we would expect prop scar damage to be cumulative. This concept is true for most of the data but not for areas I and III in 1992. The 1992 data for both of these areas shows much more scarring at an earlier date than at a later date. At both of these sites we are seeing some very long, winding scars that extend for quite a distance through the seagrasses. They appear to be real on the photos, yet, we cannot find them in the water, nor any trace of them on later photos. We have no explanation for the scars unless they are an anomaly on the earlier photos. If we look at rest of the data the quantity of scarring from one date to the next increases.

When we compared the data from one type of zone to another, we generally found that the use of signs to warn boaters about seagrasses and about boat restrictions worked. Apparently boaters are noticing the signs and heeding the warnings, despite a lack of enforcement in the area. In other words, the amount of new scarring in the restricted and caution zones is much less than that in the non-restricted zones. Since the signs were placed in the field in March of 1993, let us compare the per cent increase in scarring for the three sites from March of 1993 to November of 1993 as follows:

Zone	Per cent change from Spring 1993 to the Fall of 1993	
	Number of scars	Linear Feet
Restricted	23.9%	15.3%
Caution	21.3%	18.7%
Non-Restricted	86.4%	84.7%

From this data it is relatively clear that the rate of scarring is much greater in the non-restricted areas than the others. This shows that boaters are paying attention to

the signs and are being careful. The next question would be: how does the rate of scarring here compare to the rate of scarring at another site where signs and enforcement are being used. At Cockroach Bay, in Hillsborough County, both signs and enforcement have been in effect since December of 1992 and some comparisons are possible.

Cockroach Bay Zone	Linear feet increase in 12 months
Restricted #1	0%
Restricted #2	95.1%
Caution Area	21.6%

The data are similar except for the scarring at restricted site #2 at Cockroach Bay. This was an area that showed an increase in scarring during the fall months that is consistent with commercial use of netting. The scars were concentric in the fashion of a netter placing nets in a circle to trap fish. When we delete these numbers, the data is comparable, however, keep in mind that this data is for one year, while the Fort Desoto data is for six months. This could mean that enforcement might reduce the scar damage at Fort Desoto.

We were able to measure a number of the scars in the field. When the field measurements were compared to the measurements on the photos, they were shown to be very accurate. In other words, ground truthing confirmed the accuracy of our other measurements.

It is often useful to compare the amount of scarring in an area as a percentage of seagrasses lost. This shows actual footage of seagrasses that have been lost to boats (the average width of a scar at Fort Desoto was computed in the field to be 12 inches). We can compare the data for the spring and fall of 1993 photos as follows:

Per cent of seagrasses lost per zone as a per cent of the total seagrasses in each area at the time of measurement

Zone	Spring 1993 Loss	Fall 1993 Loss
Restricted	0.62%	0.71%
Caution	0.70%	0.83%
Non-restricted	0.60%	1.10%

The loss of seagrasses as a percentage of the whole shows that the rate of loss was most dramatic in the non-restricted zone in comparison to the others. The total loss during this time period for all of the zones is 31,738 square feet of seagrasses, or about .73 of one acre. This represents a loss of .18% of the total seagrass area.

Conclusions

The establishment of caution and restricted zones in the seagrasses at Fort Desoto appears to have been a success in the first six months of operation. The rate of scarring in these two zones is less than the rate of scarring in the non-restricted zone. Pinellas County's Department of Environmental Protection has set a plan in motion that can protect seagrasses. Their efforts in this regard have been very thorough and well thought out. Their actions are to be highly commended.

Recommendations

As a result of this study of seagrasses at the Fort Desoto Preserve we are making the following recommendations for improvement of the system for protecting the grasses:

1. Convert Area II from a non-restricted zone to a caution zone. The project has proven that the rate of scarring can be reduced by putting up caution signs. Since this has now been proven, there is no point in continuing the comparison while losing more seagrasses.

2. There are numerous signs in the preserve to warn boaters of the zones where they should not enter or should be cautious. Most boaters, myself included, have difficulty following zones when markers are spaced far apart. Therefore, it would appear logical that if there were more signs in the water, then the average boater would be able to follow them more easily. Attached is a map of the preserve with recommendations for increased markers noted. In addition, reflective tape should be added to the markers to make them more visible at night. This recommendation was made by one of the commercial fishermen. He also suggested that light deflectors should be added to the lights on the approach to the Skyway Bridge.

3. There are seagrasses between Cabbage Key and Sawyer Key (and around Sawyer Key north of Bunces Pass) that are not part of the property that is under the control of Pinellas County. Perhaps Pinellas County could petition the state of Florida to place some caution signs along the channel to warn

boaters of the grasses and shallows in the area. If not, Pinellas County may consider placing markers there just to assist boaters and to protect the seagrasses.

4. Pinellas County should consider the use of enforcement to protect the grasses. Enforcement could reduce the rate of scarring significantly.

5. Better photographic techniques should be used in the future. This has been stated clearly in the text above. If we are provided with better photographs, then we can produce more accurate data.

6. We have noticed that some boaters launch their small motored vessels from the side of the roadway. We have also seen jet skis launched in the same manner. Launching from the roadway often puts the boater into a shallow restricted seagrass area with the potential to damage seagrasses as they depart from the land. Pinellas County should consider some signs along the roadway to deter boaters from launching at these sites. The signs could also educate them about the value of seagrasses.

Drawings From the

Fall of 1993

Tampa Bay National Estuary Program
Technical Publication #05-94

National Estuary Program

RESULTS OF ANALYSIS OF PROP SCAR DAMAGE AT THE FORT DESOTO AQUATIC HABITAT MANAGEMENT AREA 1992/1993

FINAL REPORT
ACTION PLAN DEMONSTRATION PROJECT

AUGUST 1994

Results of Analysis of Prop Scar Damage at the Fort Desoto Aquatic Habitat Management Area

1992/1993

By:

J. Nicholas Ehringer
Hillsborough Community College

Assisted by:

James Wysong
Michael Rimaldi
Peter Chipman
April Kirali

Results of Analysis of Prop Scar damage at the Fort Desoto Aquatic Habitat Management Area 1992/1993

By: J. Nicholas Ehringer
Professor of Ecology
Hillsborough Community College / Brandon
10414 E. Columbus Drive
Tampa, FL 33619

Office: (813) 253-7833
Fax: (813) 661-6904

Summary:

Pinellas County has designated an aquatic zone at the southern tip of the county as the "Fort Desoto Wetlands and Aquatic Habitat Management Area." This aquatic zone has abundant meadows of seagrasses and is used extensively by recreational boaters and fishermen. Due to the number of boats that use the area there has been considerable damage done to the seagrasses by boat propellers. Damage to seagrasses by propellers can be widespread in aquatic habitats and it may take up to five years for damaged seagrasses to recover once a prop scar has occurred.

Taking a proactive approach to protect the seagrasses Pinellas County developed the "Fort Desoto Park Wetlands and Aquatic Management Ordinance." The ordinance established the Fort Desoto Park Wetlands and Aquatic Management Area to provide for the preservation, recovery and expansion of marine habitats. The intent of the ordinance was to minimize the extent of damage to seagrasses by propellers, to restrict boats from areas where seagrass damage is likely, by requiring "slow down/minimum wake zones", posting and monitoring the management area, and by providing a public education forum about the value of seagrasses. The monitoring program has been established for a five year period beginning in March of 1993.

The specific objectives of the monitoring program are as follows:

1. Establish and post "Boating Restriction Zones" and "Seagrass Caution Zones". Boating Restriction Zones will restrict operation of internal combustion engines to specifically marked "Navigation Channels" where slow down and minimum wake will be required.

2. Internal combustion engine use will be allowed in Seagrass Caution Zones but shall be utilized to avoid damage to seagrasses. Penalties of up to $500.00 and 60 days in jail may be levied for violation of this ordinance. In addition, restoration may be required.

3. A monitoring period will be established for a minimum of a 5 year period to determine the success or failure of the adopted restrictions. During this period aerial photography will be performed on a quarterly basis for purpose of seagrass mapping. Digitization and photointerpretation of the aerials will be performed to determine revegetation rates, additional damage or variations in seagrass communities.

4. The county will establish a public education program to provide for the distribution of information to citizens about the value of seagrasses and the restrictions placed upon boats in the Fort Desoto Area.

5. The management area will be buoyed, posted or marked by the County in accordance with Chapter 16N-23, Florida Administrative Code.

The purpose of this project relates to objective #3 from above. Aerial photographs were taken for the County by professional aerial photography companies. The film was analyzed by Hillsborough Community College. Computer images were made of the photographs and ground truthing was used to compare the images with the prop scars in the water in the aquatic management area.

Three sets of aerial photographs were used for our primary analysis. One set was taken in March of 1993. This set was used as our baseline because the boat restriction signs were placed in the field at that time. The second set of film was taken in the fall of 1993. Most of our comparisons were between these two sets of film. A third set was taken in the summer of 1992 and has also been used for correlations with the other sets of film.

When comparing the photographs from March of 1993 and the fall of 1993 we noted that the rate of scarring was rather low in seagrass zones that were marked for boat restrictions and for boat cautions. The increase in scarring was computed as 15.3% increase in scars for the boater restricted zones and an 18.7% increase in scars for boater caution zones. The non-restricted zone had an increase in scarring of 84.7%. The data shows that the presence of signs in the water, whether caution or restrictive, has the effect of reducing prop scar damage.

Introduction:

Hillsborough Community College was contracted to analyze three sets of aerial photographs taken over the Fort Desoto Aquatic Management Area for prop scar damage to the seagrasses. Three sets of photographs were ordered by the department with flight times in July of 1992, March of 1993 and November of 1993. The photographs were taken on nine by nine inch positive transparency film by two separate aerial photographic companies.

The following services were proposed for the mapping and computer documentation of seagrasses and prop scars in the Fort Desoto Management area:

1. The Department of Environmental Management photos were assembled into a mosaic and used to create paper transparencies with markings for each identifiable type of grass. Each subunit will be digitized on the computer for accurate mapping of the seagrasses and the prop scars. The subunits can be put together to create a computer map of the entire management area at Fort Desoto.

2. The computerized information will be in AutoCad format. This information can be transferred via compressed data disk to the Geographic Information System of Pinellas County. The data will be delivered in the appropriate format to the county computer services for their use as needed. We will seek written information from the Pinellas County computer personnel to specify exactly which format they require and we will conform to that format. The image files will conform to the GINA (General Interchange and Archive) format and will conform to the CCITT Group Four standard format.

3. Seagrass scars will be identified individually and semi-continuous segments linked except in areas where scarring is very dense. In these areas the methodology may require the use of polygons around a collective group of scars. Polygons shall be classified as moderately or severely damaged based on percent of actual damage to the seagrass beds. Moderate damage shall include damage in the 20 - 50% range and severe damage shall include damage in the 50+% range. The computer images will be done in layers, with one layer as a base map, another layer showing the seagrasses and another layer showing the prop scars. In the seagrass areas, the "bare" areas will be distinguished from the grass areas, and every effort will be made to differentiate different species of grass beds from one another. The grass beds will be computed in square foot units. The prop scars will be calculated in linear feet.

4. Aerial photographic information will be rectified to the base map to correct any parallax deficiencies. This will be verified by "ground truthing" the images for accuracy of scale and orientation.

5. The seagrass scars and the bare areas in the grass beds will also be measured in the

field to ascertain the accuracy of the photographs. This form of measurement, referred to as "ground truthing" is essential in the verification process. Seagrasses will be differentiated from algal beds and deep water areas that can be confused with actual grasses on the photographs. In many cases we will differentiate between the various types of seagrasses. The grasses will also be delineated as "continuous" or "discontinuous" and other areas as "deep water" and "bare substrate." The bare areas will be denoted as sand, mud or other substrate. The same transect (mosaic) system as identified in the photographic discussion from # 1 above will be used in the field. This will be worked out in conjunction with the Department of Environmental Management as the most optimum method of transect evaluation.

Ground truthing will be done in three phases. In the first part of the proposal we will measure all of the prop scars in the study site and compare them to the computer images. In the second and third phases we will select certain scars from each of the three zones in the field (caution zones, boat restriction zones and no restriction zones). About one third of the scars in each of these areas will be followed from film set to film set over time to see the rate of recovery.

The ground truthing method allows for sufficient data to account for:

A. Regrowth of seagrasses into prop scars.
B. A biological review of the scars to see what, if anything, is growing in the scars.
C. Sand movement within the scars.
D. The ability to note new scars as they appear in time from this baseline study.

6. The Departmental of Environmental Management has provided three sets of photographs (Summer of 1992, Spring of 1993 and Fall of 1993). From these we will generate three sets of computer images. The March 1993 set of films constitute the baseline study and requires an initial setup with the computer and ground truthing. The second and third sets of photos will require less computer time and less ground truthing, as will all other subsequent sets of film.

7. Progress on the contract can be reviewed at any time by the county Department of Environmental Management. In addition, we will present reports to the Pinellas County Board of Commissioners on the project as requested.

8. All materials and information for this project shall be the sole property of Pinellas County.

The Value of Seagrasses

Available scientific literature gives several reasons for the importance of seagrasses. Among the reasons are the following:

1. Seagrasses tend to have very high growth rates and production rates. They tend to add to the overall productivity of a region because of their growth rates.

2. The leaves of seagrasses tend to support large numbers of epiphytic organisms with biological mass approaching that of the seagrasses themselves.

3. Seagrasses, and the organisms on them, produce large amounts of detritus which become food for other organisms.

4. Seagrasses have extensive root systems and lateral rhizome structures that tend to hold sediments together and prevent erosion.

5. Seagrasses act as nutrient sinks and sources.

6. Seagrass beds become the home to many forms of juvenile organisms as well as adult organisms. In areas where seagrasses have been destroyed, the populations of shrimp, snook, and many other species, tend to decline dramatically.

7. Seagrasses are used as a food source for Manatees, which have been seen in and around Tampa Bay.

For these reasons it is important to protect and to monitor seagrasses in the Fort Desoto Management area.

Delineation of Zones

The Department of Environmental Protection established three types of zones in the aquatic preserve. The establishment of the zones was designed to study the effects of different aspects of boat traffic on the number of scars that would be produced. The zones were as follows:

1. Boat Restricted: in this zone no boats are allowed. Signs are posted in the water to notify boaters of the restrictions.

2. Seagrass Caution: in this zone signs are posted for boaters to advise them of the presence of seagrasses. Boats are not restricted from this zone, only warned about the location of the grasses.

3. Non-restricted Zone: in this zone no restrictions are placed upon boaters.

The three types of zones allowed for a comparison of boat activity, i.e. scars, from one type of zone to another.

Delineation of Areas

The aquatic preserve area was divided into six aquatic areas by the Department of Environmental Protection. Each aquatic area was designated as a boat restricted zone, a caution zone, or a non-restricted zone. The areas are as follows (also note the attached map):

1. Area I: this area surrounds Indian Key, a National Wildlife Refuge. This area is designated as a boat restricted zone.

2. Area II: this area is bordered by the "Main Channel" to the north; to the east by the channel in front of the Skyway approach; to the west by Cabbage Key and Isla Del Sol; and to the south by a line drawn from Pardee Key to the east. This is a non-restricted zone.

3. Area III: this area is south of area II and is bordered to the south by Bunces Pass channel; to the west by Cabbage Key; and to the east by a line drawn just to the west of Tarpon Key. This is a caution zone.

4. Area IV: this area surrounds Tarpon Key and is a boat restricted zone.

5. Area V: this area is in Mullet Key Bayou and is a boat restricted zone.

6. Area VI: this area surrounds Bonne Fortune Key and extends up to the channel at Conception Key. This is a boat caution zone.

Seagrass Square Footage

We measured the square footage of the seagrasses at each of the areas listed above. The available square footage of seagrasses was based on the aerial photographs taken in the spring of 1993. The numbers are as follows:

Location	Square Feet	Acres
Area I	548,812	12.6
Area II	2,702,098	62.2
Area III	4,637,528	106.4
Area IV	1,801,377	41.4
Area V	3,341,351	76.7
Area VI	4,844,994	111.2
Total	17,884,160	420.5

Seagrass Densities

We measured the approximate density of seagrasses at each area to set a baseline for future studies. The densities will be compared from year to year to see is there is a general loss of seagrasses in each area. The densities were determined by counting *Thalassia sp.* shoots in the water in random square foot zones. There were nine samples taken per zone and the numbers were averaged to give us the following baseline data:

Location	Shoots/square feet
Area I	25.11 (Std 3.07)
Area II	14.89 (Std 3.21)
Area III	19.89 (Std 2.13)
Area IV	24.11 (Std 3.57)
Area V	29.5 (Std 2.83)
Area VI	16.44 (Std 2.01)

In all of the areas *Halodule sp.* was mixed with *Thalassia sp.* As is typical for the plants, *Halodule sp.* was prevalent in locations closer to shore and in sites that may have been disturbed at one time, but are now recovering. The most dense patches of *Halodule sp.* were seen in the shallows to the south of Indian Key (Area I).

Prop Scar Damage Procedure

The main focus of this study was to determine the damage caused by boats to the seagrass beds around the Fort Desoto Aquatic Preserve and to compare damage from one zone to another. The extent of prop scar damage was determined in several different ways. The first method was to measure the scars directly from the aerial photographs. First we divided the maps of the preserve into quadrants for ease of measurement (a copy of a quadrant map is attached). After determining the scale of the pictures, each scar was measured along its length and placed in a data base for computational purposes.

The second method was to draw each of the scars on a computer generated map of the preserve. This was accomplished by tracing each scar onto the computer screen and then measuring the length of the scars from the computer (AutoCad) files. Both methods proved to be compatible and to be accurate in comparing one method to the other (see the section below on inaccuracies). This method provided us with a cross check of the data.

Photographic Accuracy

The quality of aerial photographs that were presented to us for analysis made them very difficult to analyze for a number of reasons. The photographic problems were outlined to Jake Stowers in a letter dated February 8, 1994 listing the following problems comparing the spring and fall of 1993 films:

1. The overall quality of the photos is not as good as other aerial photos we have seen of the bay at a similar scale.

2. There is a gap in the photos taken over the middle of the site in the March set of films.

3. Each unit of photos was not taken at the same time. Apparently they were taken over several months. This has caused a variance in the film quality due to changes in the water.

4. Most of the frames were taken at a 1 to 4,800 scale. Some photos were taken at a scale of 1 to 2,400. This tends to throw off our data and cause confusion. The photographer should have been consistent.

5. The set of films taken in November has a blue cast to them, while the earlier set does not. This is a lack of consistency.

Later a meeting was held with the photographers and they admitted that they had taken photographs at different dates, different altitudes, at high tide, and at a time of day close to noon (causing sun glare to appear in the middle of the photographs). All of these factors make the interpretation of the photographs very difficult. The most difficult problem that we see is the problem of taking photographs at high tide. This causes the turbidity of the water to obscure the scars and makes analyzing of the photos most difficult.

In addition, the photos taken in the summer of 1992 were taken by a different photographer, at a medium tide, and at a time of day close to noon. Therefore, we are somewhat unsure of the accuracy of the data (this was shown to be true with the ground truthing). These concerns have been expressed to the photographers and they have promised to abide by the specifications in their photography in 1994.

There is one more point to consider about the photographs. Since all of the photographs were taken under less than optimum conditions, all of the photographs suffer from the same inaccuracies. It is therefore, possible that we are comparing "apples to apples". We are comparing one set of poor films to another set of poor films. Another problem will come up when we try to compare the old films to the films taken in 1994. Accurate films taken in 1994 may be difficult to compare to

inaccurate films taken in 1992 and 1993. We may, therefore, declare the 1994 films as the new baseline. As a result, we will see a big increase in scars on the 1994 photos that will not reflect "new" damage.

The next two pages show data computed from the photographs. A discussion of the data follows.

Comparison of Prop Scar Damage at The Fort Desoto Aquatic Preserve

	Summer 1992		Spring 1993		Fall 1993	
	Scars #	Feet Linear	Scars #	Feet Linear	Scars #	Feet Linear
Area I	16	6,260	20	1,606	30	2,302
Area II	19	6,953	66	16,119	123	29,777
Area III	74	77,379	96	36,548	115	42,141
Area IV	18	12,375	86	18,569	91	19,664
Area V	59	18,715	61	16,747	86	20,622
Area VI	24	9,856	120	29,868	147	36,707
Total	210	131,538	449	119,457	592	151,213

Comparison of Prop Scar Damage at The Fort Desoto Aquatic Preserve

Comparison of sites according to protective status

Zone	Summer 1992		Spring 1993		Fall 1993	
	Scars #	Feet Linear	Scars #	Feet Linear	Scars #	Feet Linear
Boat Restricted	93	37,350	167	36,922	207	42,570
Seagrass Caution	98	87,235	216	66,416	262	78,848
Non-Restricted	19	6,953	66	16,119	123	29,777

Analysis of Prop Scar Damage

The first chart compares each area of the preserve from the three sets of film to the number of scars and the linear feet of scars. The second set of data compares the damage done to seagrasses in restricted zones, caution zones and non-restricted zones from the three sets of photos.

Most of the data are fairly consistent with the concept that as time passes more and more scars should appear at each area as boat traffic increases and the rate of healing is very slow. We have found in our studies at Cockroach Bay that prop scars may take from three to five years to heal, therefore, we would expect prop scar damage to be cumulative. This concept is true for most of the data but not for areas I and III in 1992. The 1992 data for both of these areas shows much more scarring at an earlier date than at a later date. At both of these sites we are seeing some very long, winding scars that extend for quite a distance through the seagrasses. They appear to be real on the photos, yet, we cannot find them in the water, nor any trace of them on later photos. We have no explanation for the scars unless they are an anomaly on the earlier photos. If we look at rest of the data the quantity of scarring from one date to the next increases.

When we compared the data from one type of zone to another, we generally found that the use of signs to warn boaters about seagrasses and about boat restrictions worked. Apparently boaters are noticing the signs and heeding the warnings, despite a lack of enforcement in the area. In other words, the amount of new scarring in the restricted and caution zones is much less than that in the non-restricted zones. Since the signs were placed in the field in March of 1993, let us compare the per cent increase in scarring for the three sites from March of 1993 to November of 1993 as follows:

Zone	Per cent change from Spring 1993 to the Fall of 1993	
	Number of scars	Linear Feet
Restricted	23.9%	15.3%
Caution	21.3%	18.7%
Non-Restricted	86.4%	84.7%

From this data it is relatively clear that the rate of scarring is much greater in the non-restricted areas than the others. This shows that boaters are paying attention to

the signs and are being careful. The next question would be: how does the rate of scarring here compare to the rate of scarring at another site where signs and enforcement are being used. At Cockroach Bay, in Hillsborough County, both signs and enforcement have been in effect since December of 1992 and some comparisons are possible.

Cockroach Bay Zone	Linear feet increase in 12 months
Restricted #1	0%
Restricted #2	95.1%
Caution Area	21.6%

The data are similar except for the scarring at restricted site #2 at Cockroach Bay. This was an area that showed an increase in scarring during the fall months that is consistent with commercial use of netting. The scars were concentric in the fashion of a netter placing nets in a circle to trap fish. When we delete these numbers, the data is comparable, however, keep in mind that this data is for one year, while the Fort Desoto data is for six months. This could mean that enforcement might reduce the scar damage at Fort Desoto.

We were able to measure a number of the scars in the field. When the field measurements were compared to the measurements on the photos, they were shown to be very accurate. In other words, ground truthing confirmed the accuracy of our other measurements.

It is often useful to compare the amount of scarring in an area as a percentage of seagrasses lost. This shows actual footage of seagrasses that have been lost to boats (the average width of a scar at Fort Desoto was computed in the field to be 12 inches). We can compare the data for the spring and fall of 1993 photos as follows:

Per cent of seagrasses lost per zone as a per cent of the total seagrasses in each area at the time of measurement

Zone	Spring 1993 Loss	Fall 1993 Loss
Restricted	0.62%	0.71%
Caution	0.70%	0.83%
Non-restricted	0.60%	1.10%

The loss of seagrasses as a percentage of the whole shows that the rate of loss was most dramatic in the non-restricted zone in comparison to the others. The total loss during this time period for all of the zones is 31,738 square feet of seagrasses, or about .73 of one acre. This represents a loss of .18% of the total seagrass area.

Conclusions

The establishment of caution and restricted zones in the seagrasses at Fort Desoto appears to have been a success in the first six months of operation. The rate of scarring in these two zones is less than the rate of scarring in the non-restricted zone. Pinellas County's Department of Environmental Protection has set a plan in motion that can protect seagrasses. Their efforts in this regard have been very thorough and well thought out. Their actions are to be highly commended.

Recommendations

As a result of this study of seagrasses at the Fort Desoto Preserve we are making the following recommendations for improvement of the system for protecting the grasses:

1. Convert Area II from a non-restricted zone to a caution zone. The project has proven that the rate of scarring can be reduced by putting up caution signs. Since this has now been proven, there is no point in continuing the comparison while losing more seagrasses.

2. There are numerous signs in the preserve to warn boaters of the zones where they should not enter or should be cautious. Most boaters, myself included, have difficulty following zones when markers are spaced far apart. Therefore, it would appear logical that if there were more signs in the water, then the average boater would be able to follow them more easily. Attached is a map of the preserve with recommendations for increased markers noted. In addition, reflective tape should be added to the markers to make them more visible at night. This recommendation was made by one of the commercial fishermen. He also suggested that light deflectors should be added to the lights on the approach to the Skyway Bridge.

3. There are seagrasses between Cabbage Key and Sawyer Key (and around Sawyer Key north of Bunces Pass) that are not part of the property that is under the control of Pinellas County. Perhaps Pinellas County could petition the state of Florida to place some caution signs along the channel to warn

boaters of the grasses and shallows in the area. If not, Pinellas County may consider placing markers there just to assist boaters and to protect the seagrasses.

4. Pinellas County should consider the use of enforcement to protect the grasses. Enforcement could reduce the rate of scarring significantly.

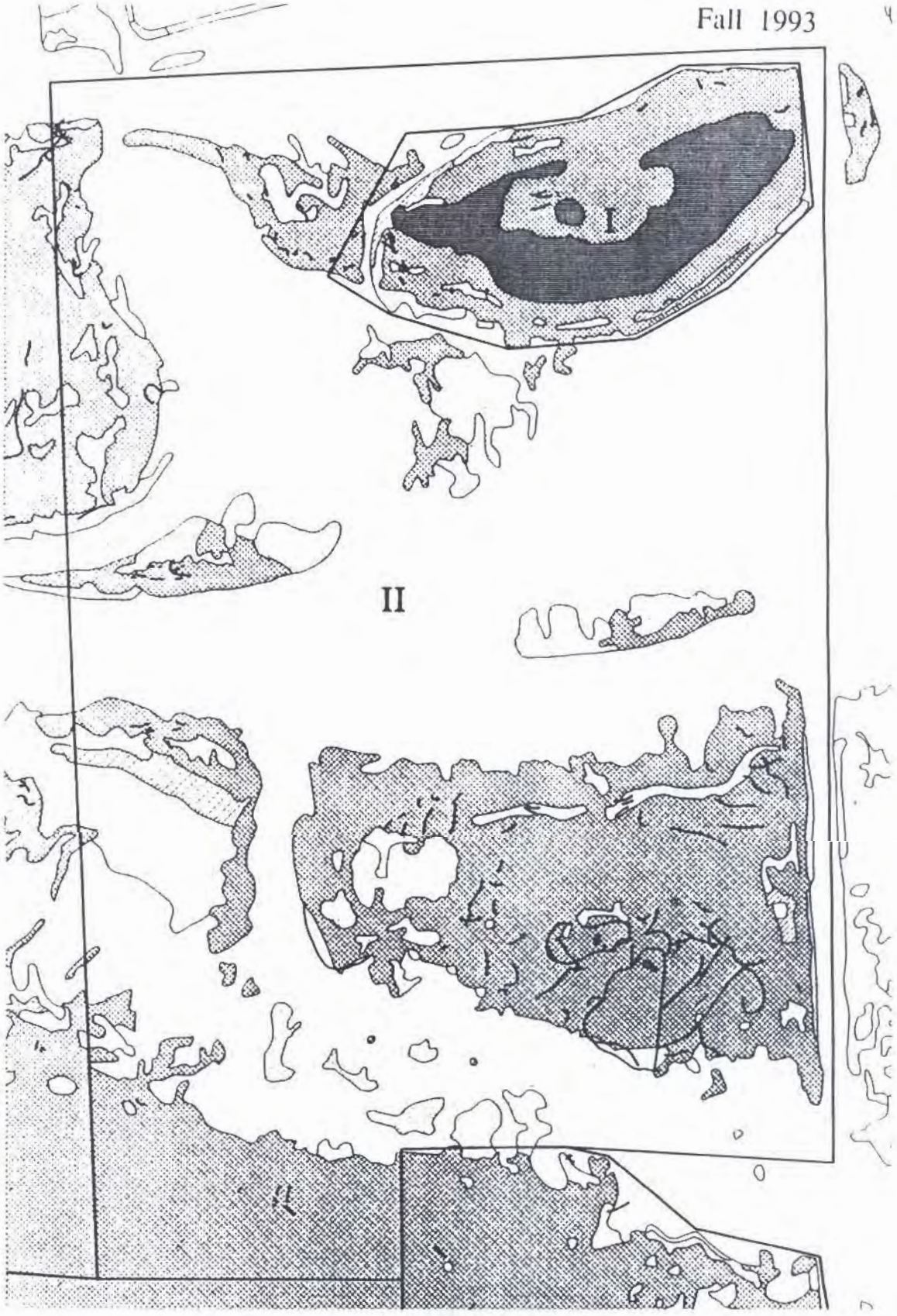
5. Better photographic techniques should be used in the future. This has been stated clearly in the text above. If we are provided with better photographs, then we can produce more accurate data.

6. We have noticed that some boaters launch their small motored vessels from the side of the roadway. We have also seen jet skis launched in the same manner. Launching from the roadway often puts the boater into a shallow restricted seagrass area with the potential to damage seagrasses as they depart from the land. Pinellas County should consider some signs along the roadway to deter boaters from launching at these sites. The signs could also educate them about the value of seagrasses.

Drawings From the

Fall of 1993

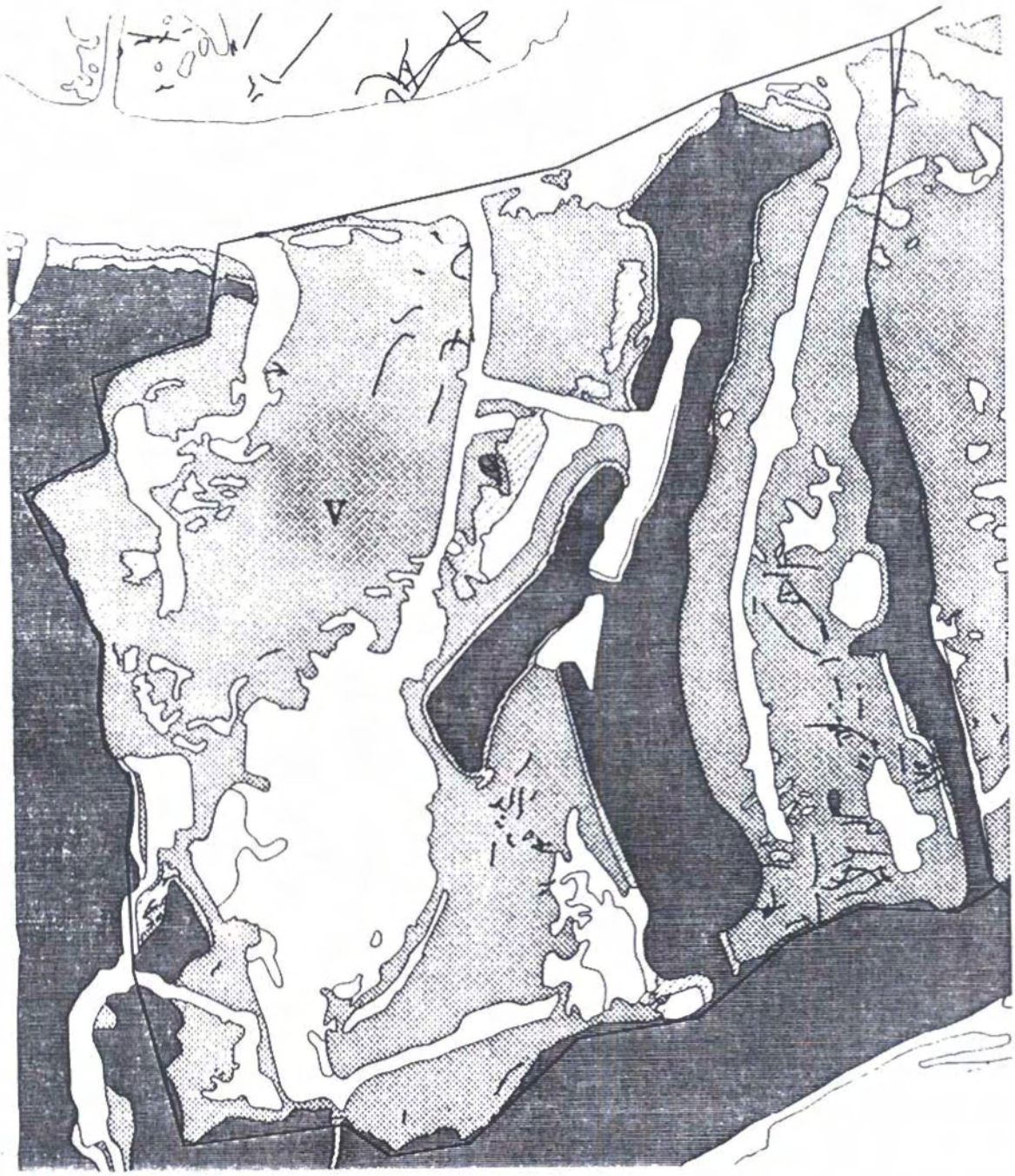

Fall 1993


I
II

Fall 1993


Fall 1993
IV

Fall 1993

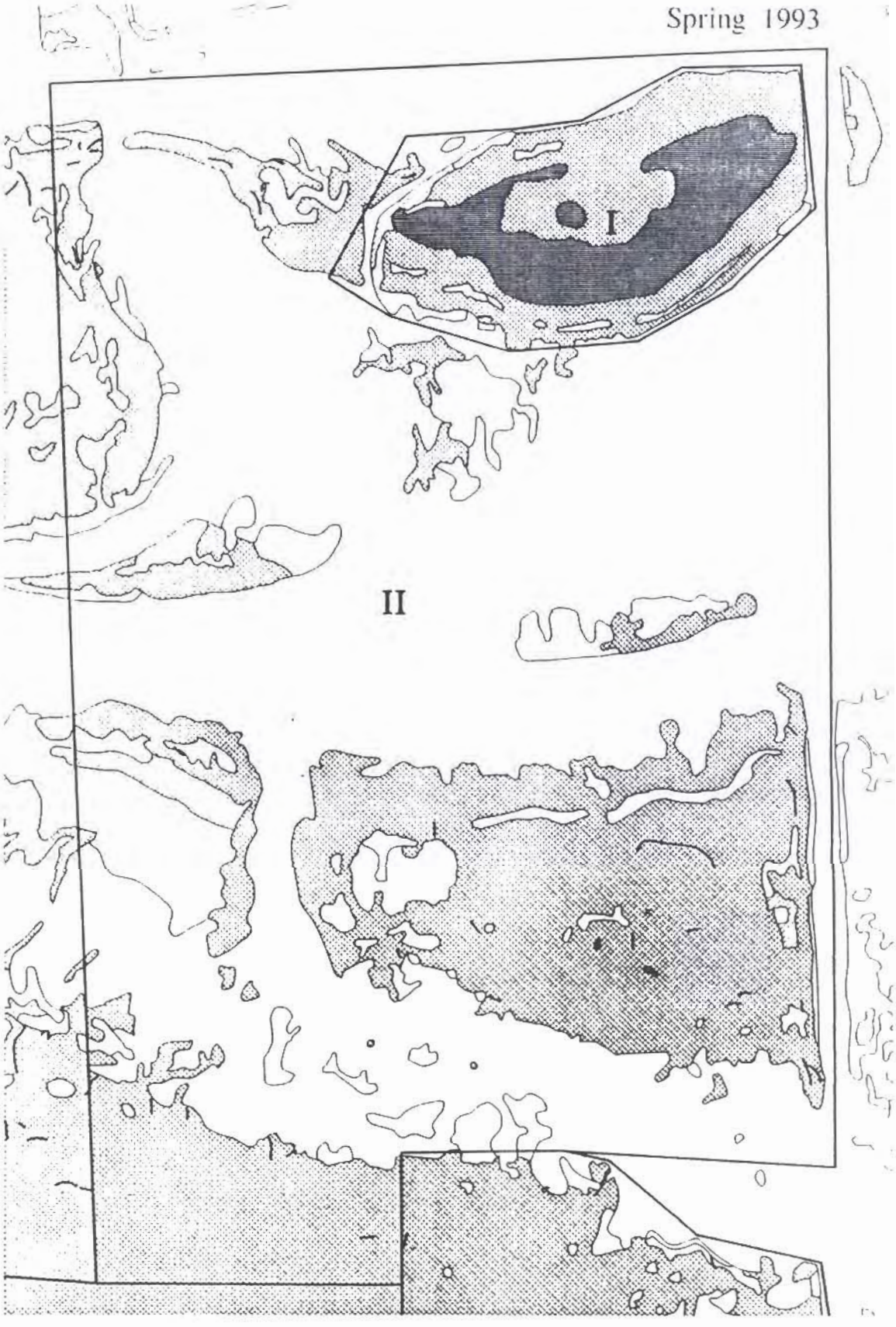


Fall 1993

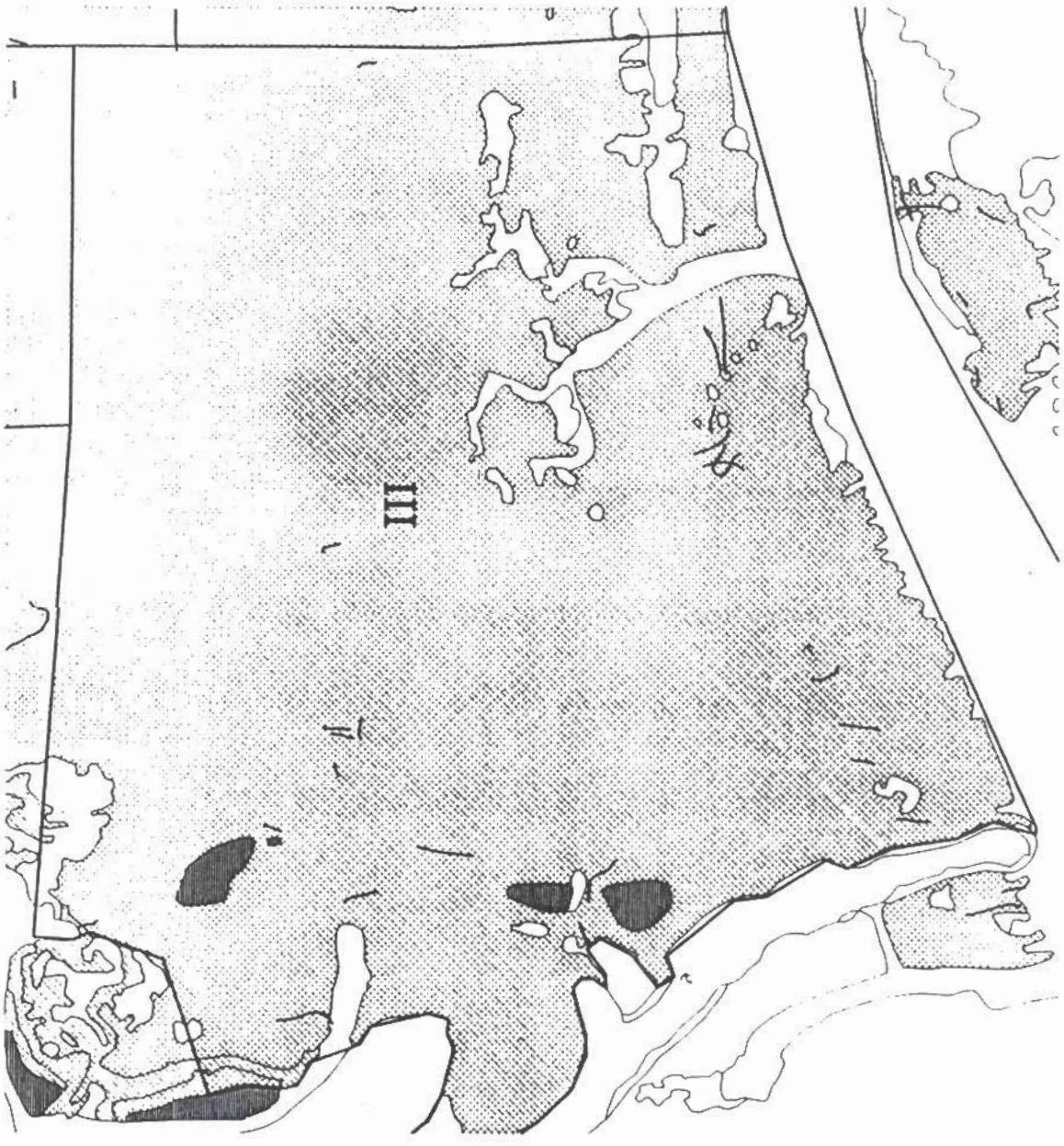
Drawings From the

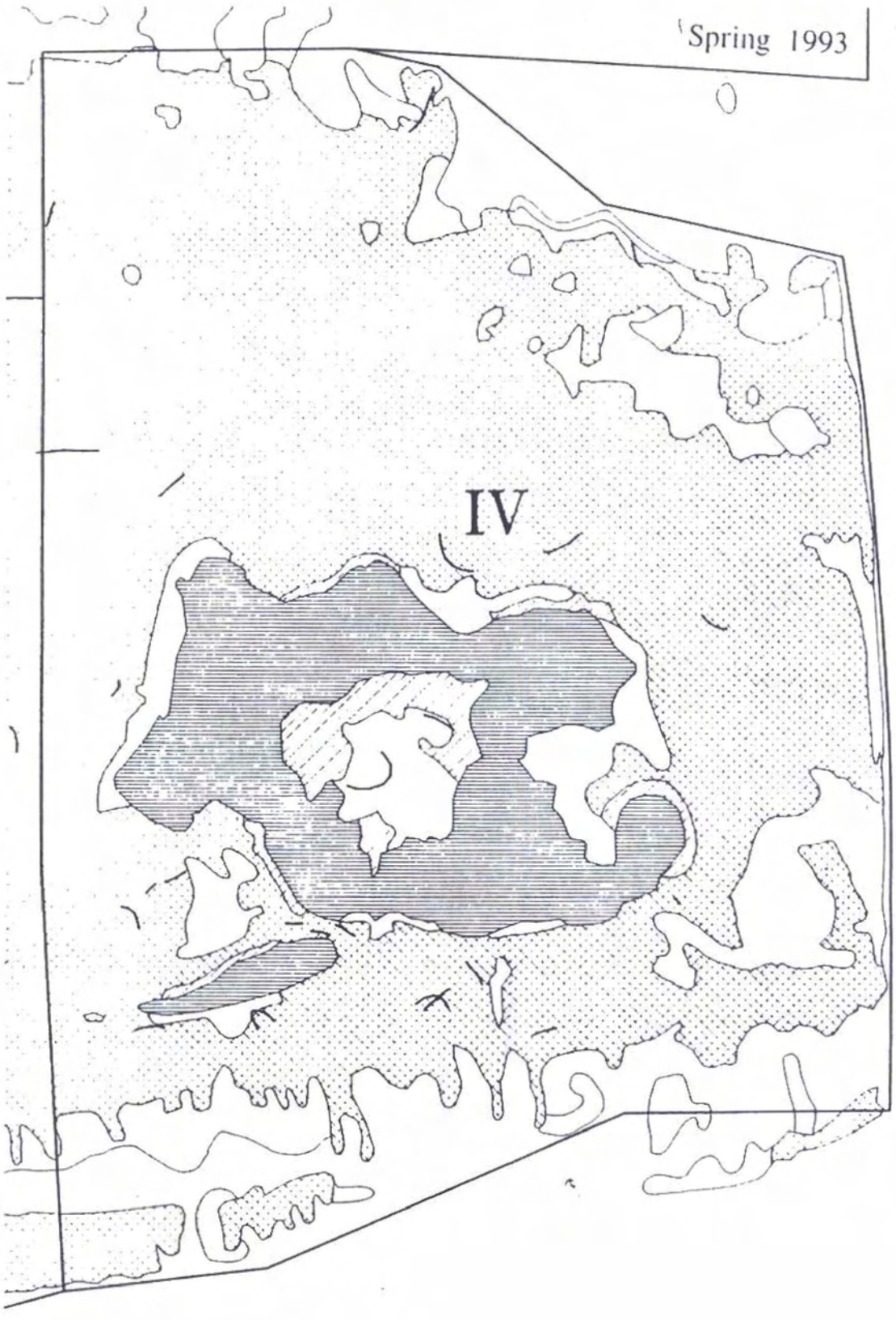
Spring of 1993


Spring 1993

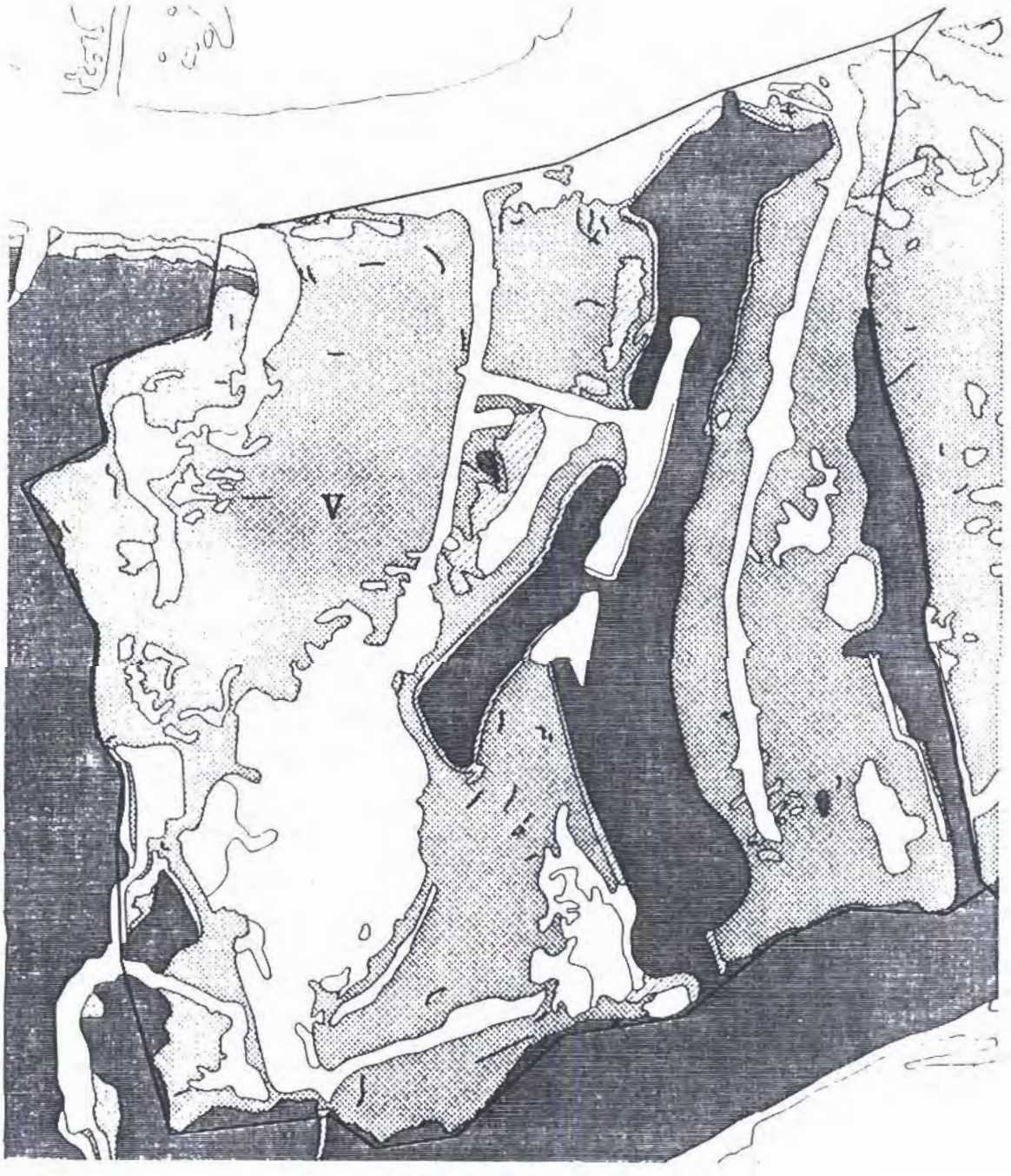

I
II

Spring 1993

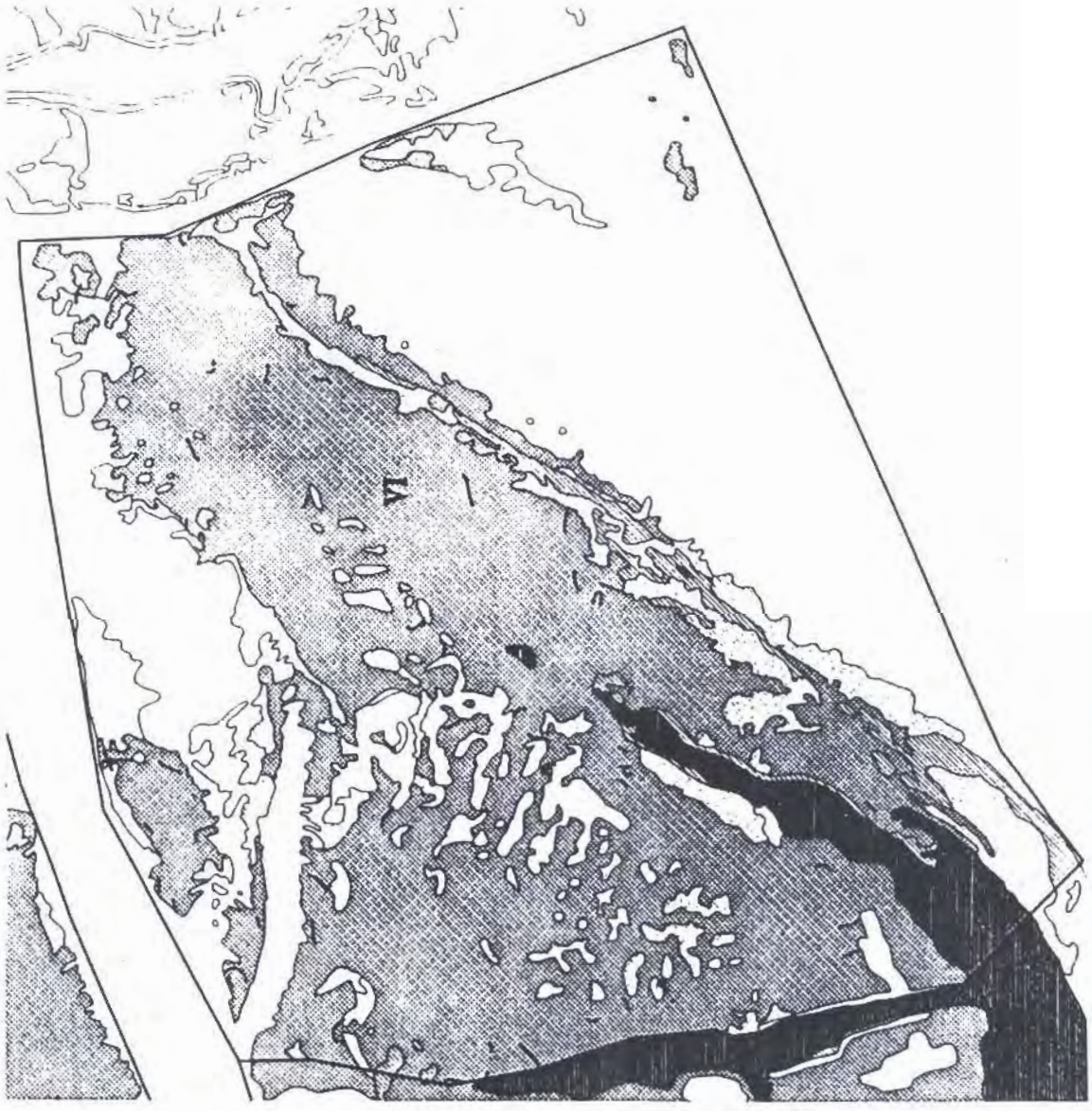



Spring 1993
IV

Spring 1993

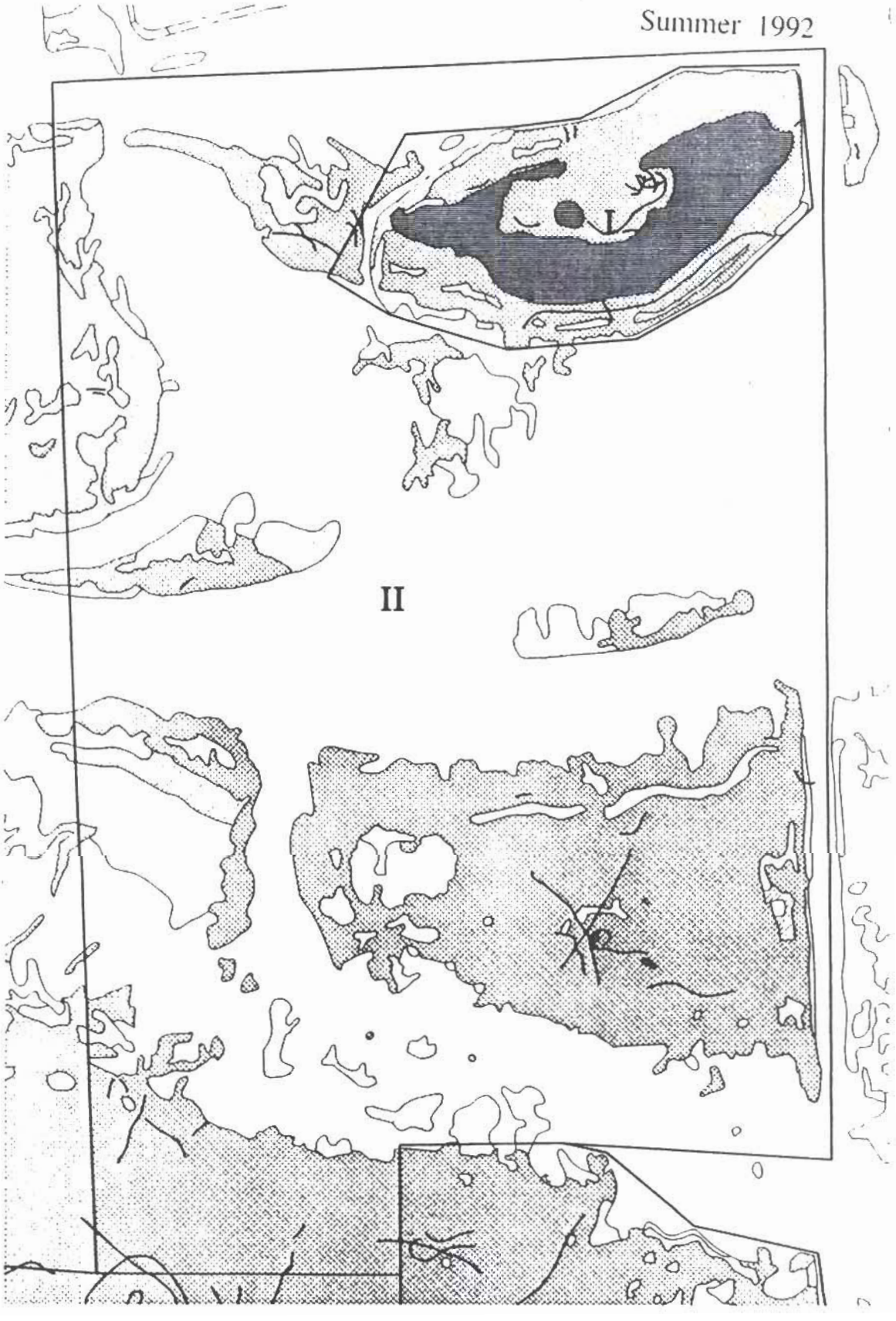


Spring 1993

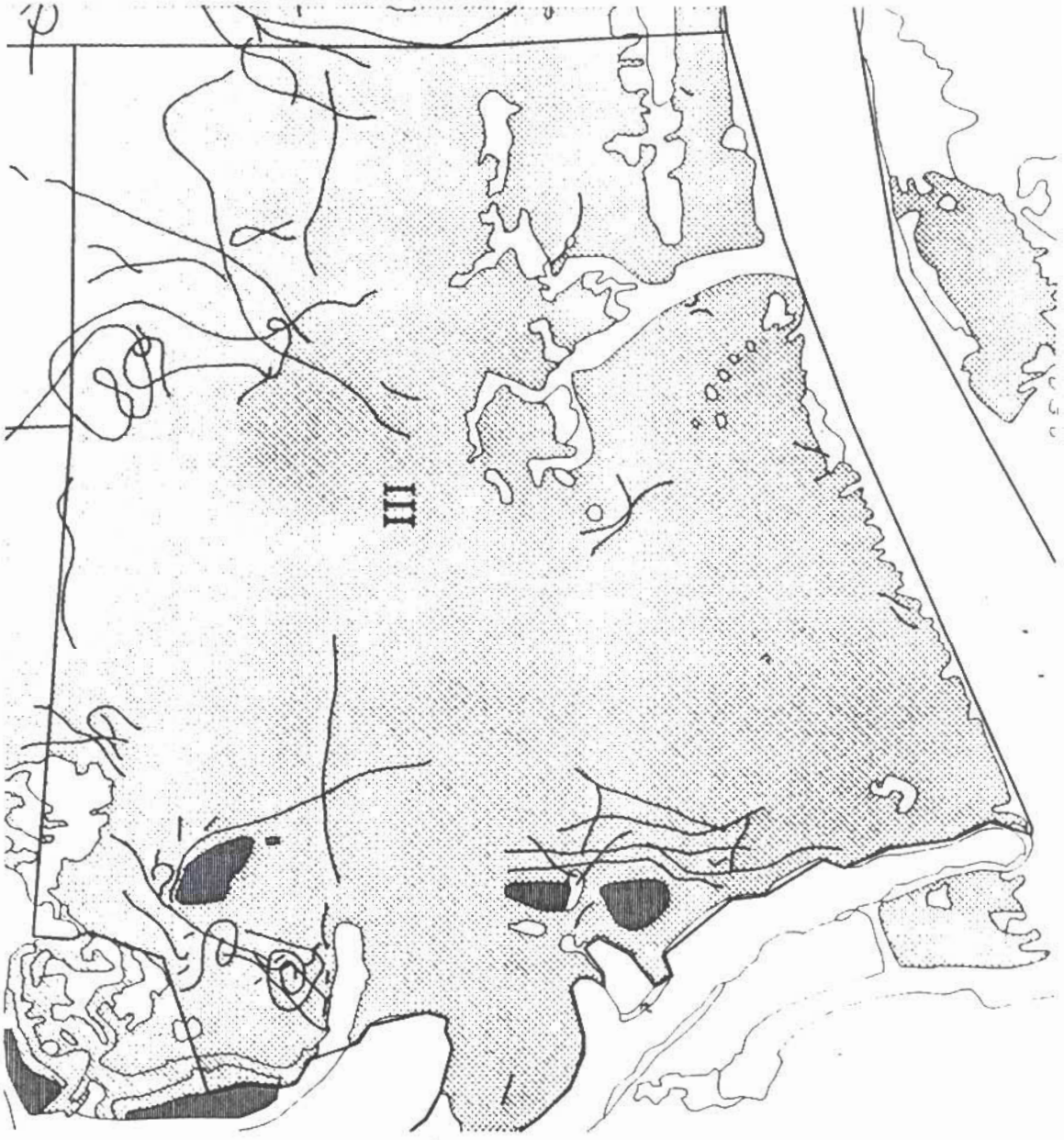


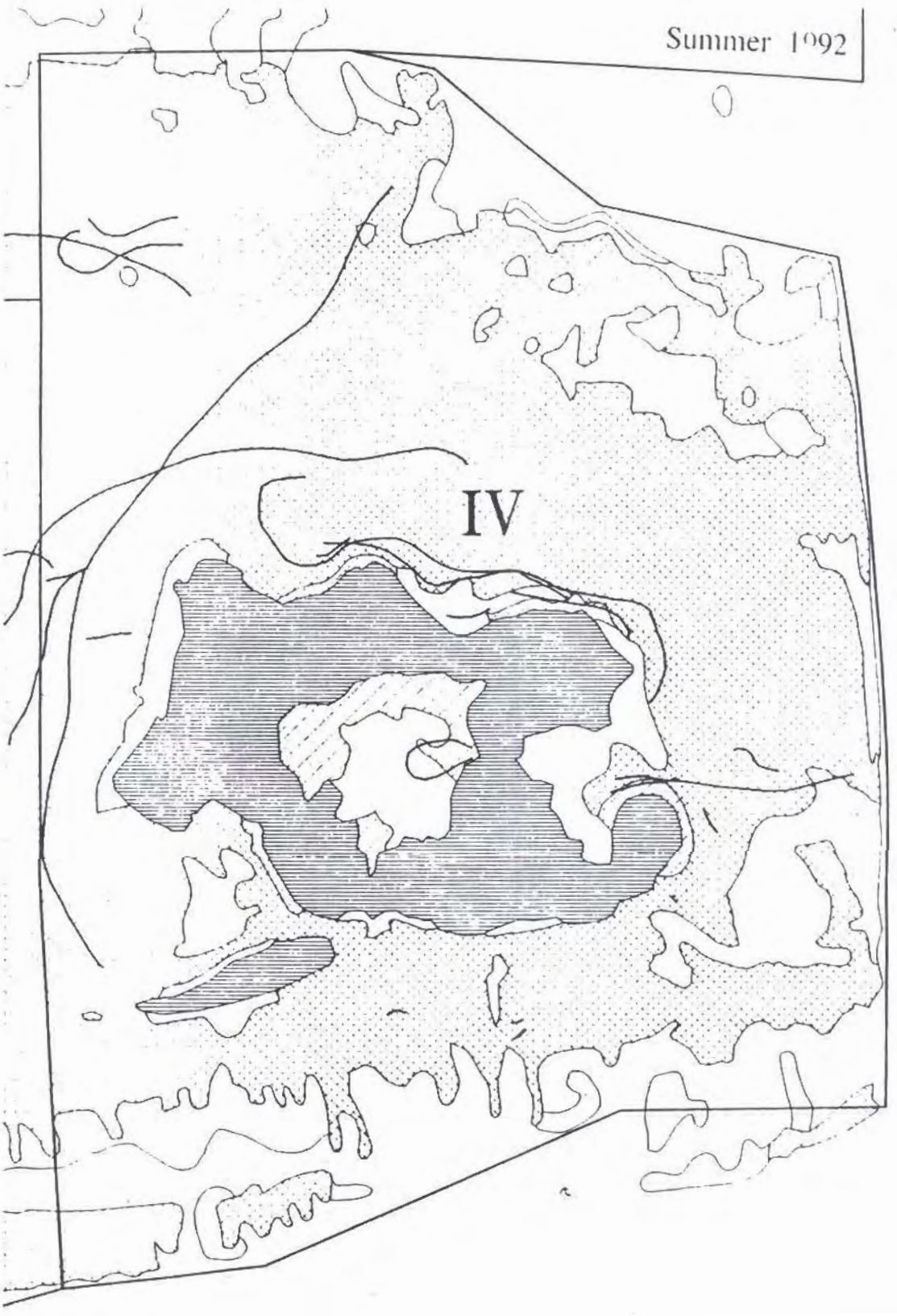
Drawings From the

Summer of 1992

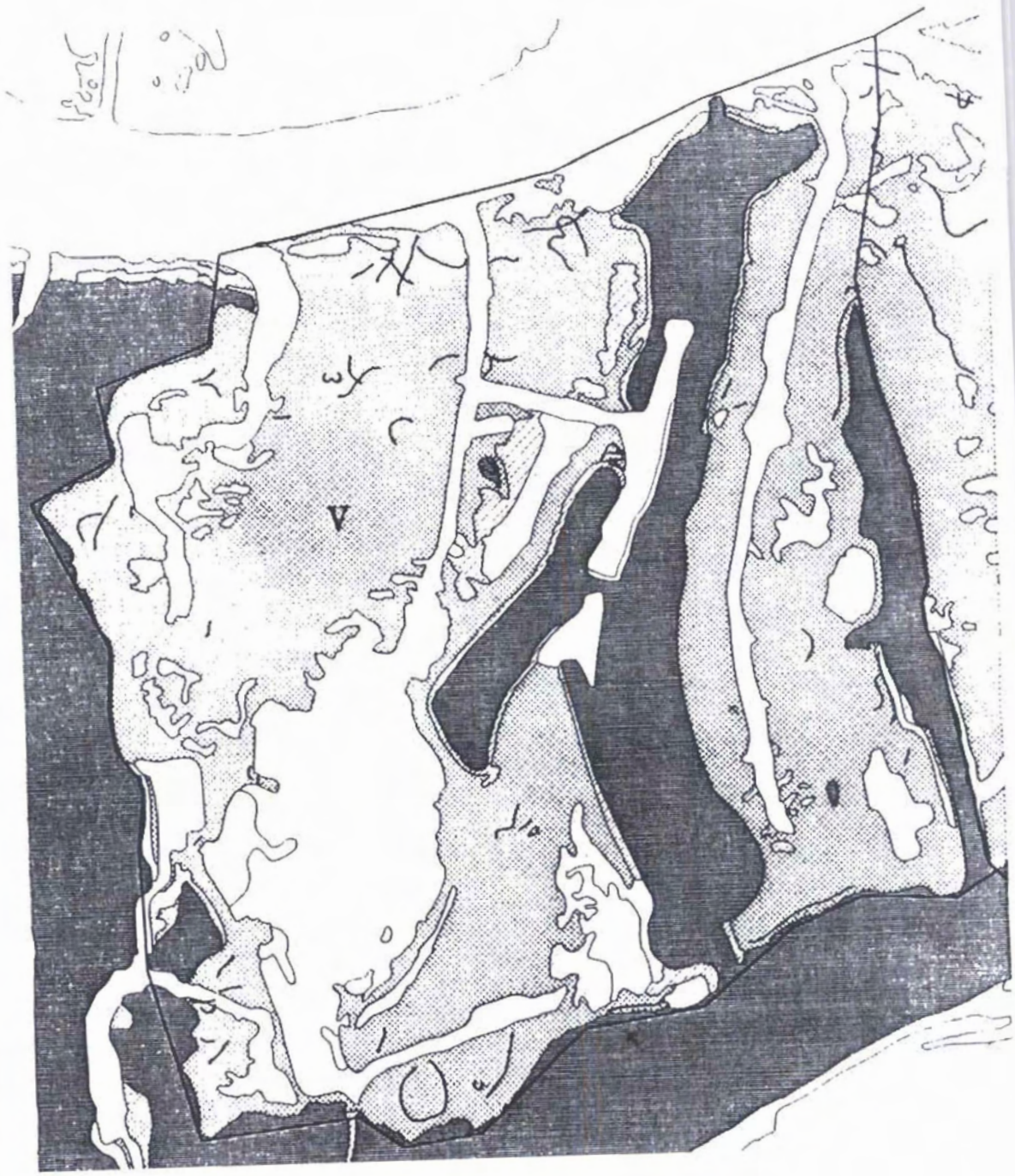

II

Summer 1992




Summer 1992
IV

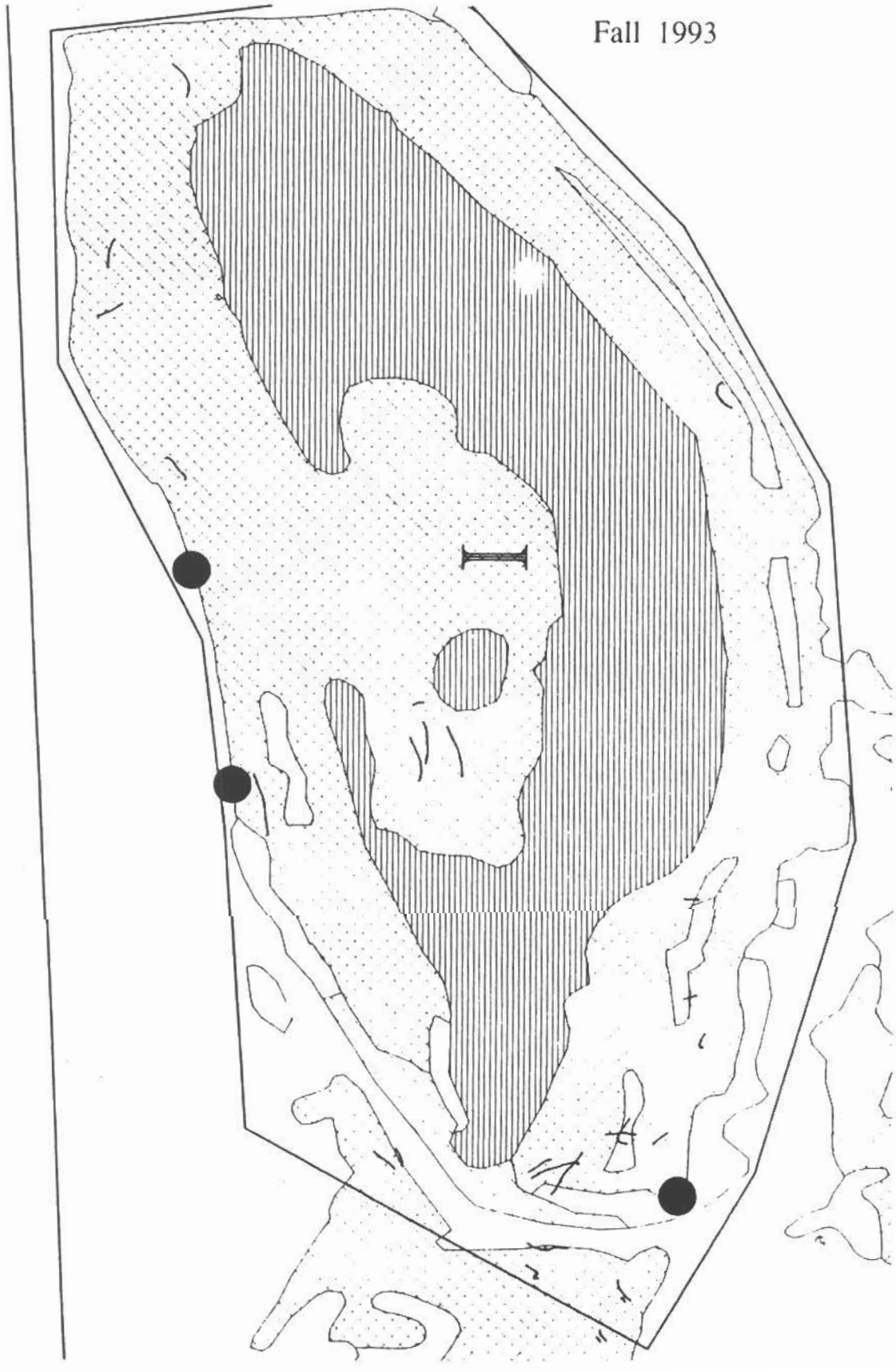
Summer 1992

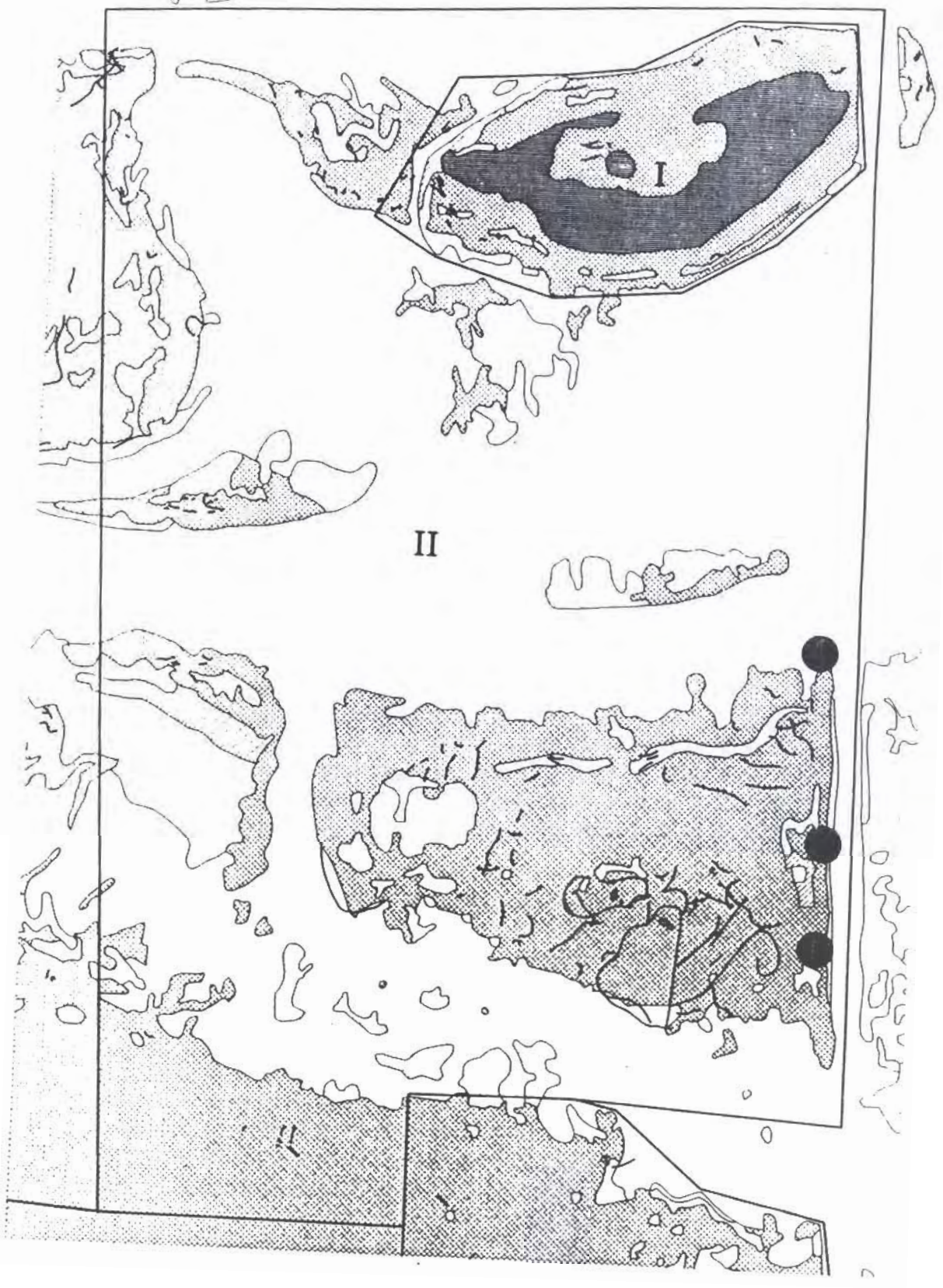


Summer 1992

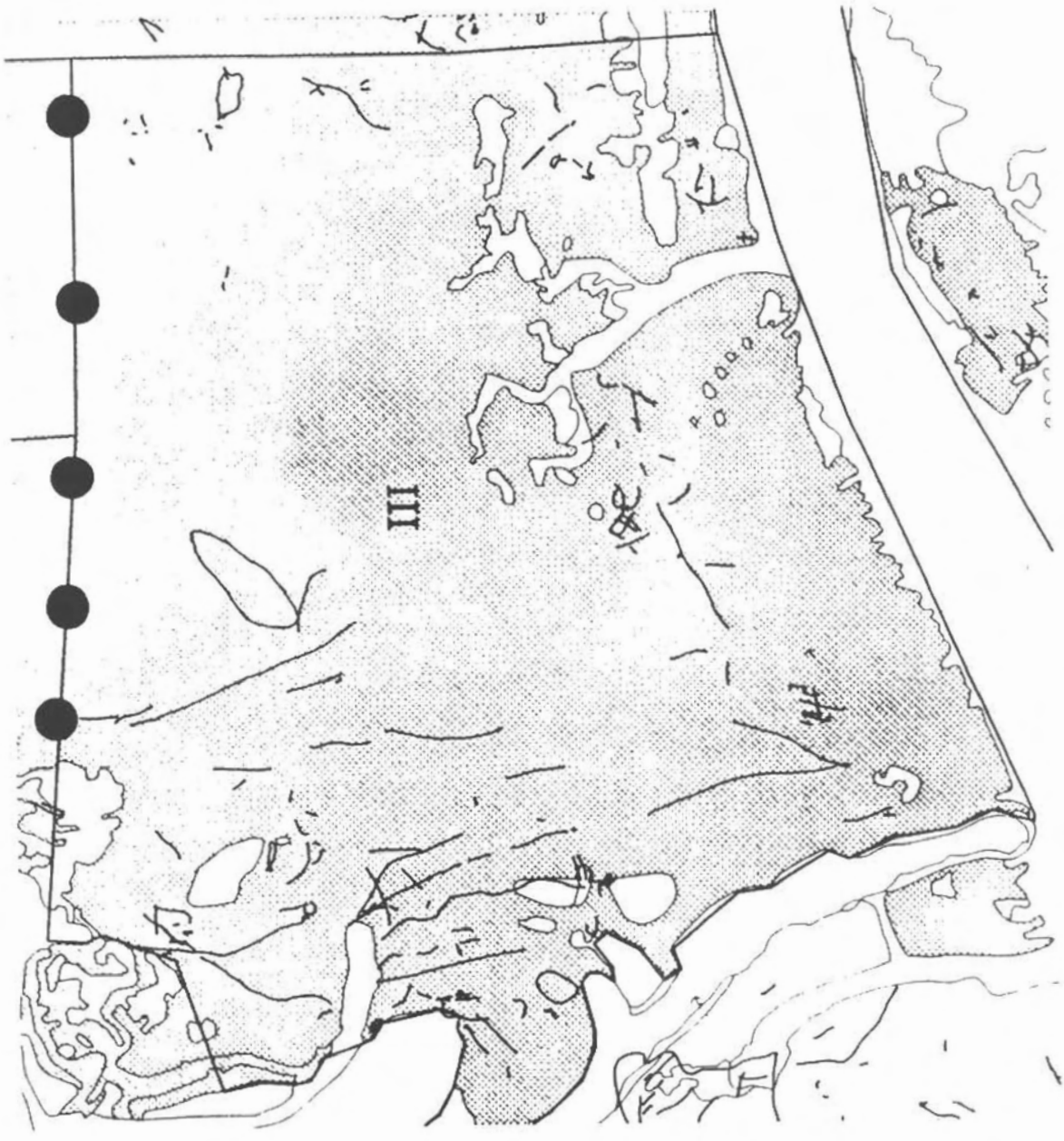
Recommendations for Markers Using the Drawings From the Fall of 1993

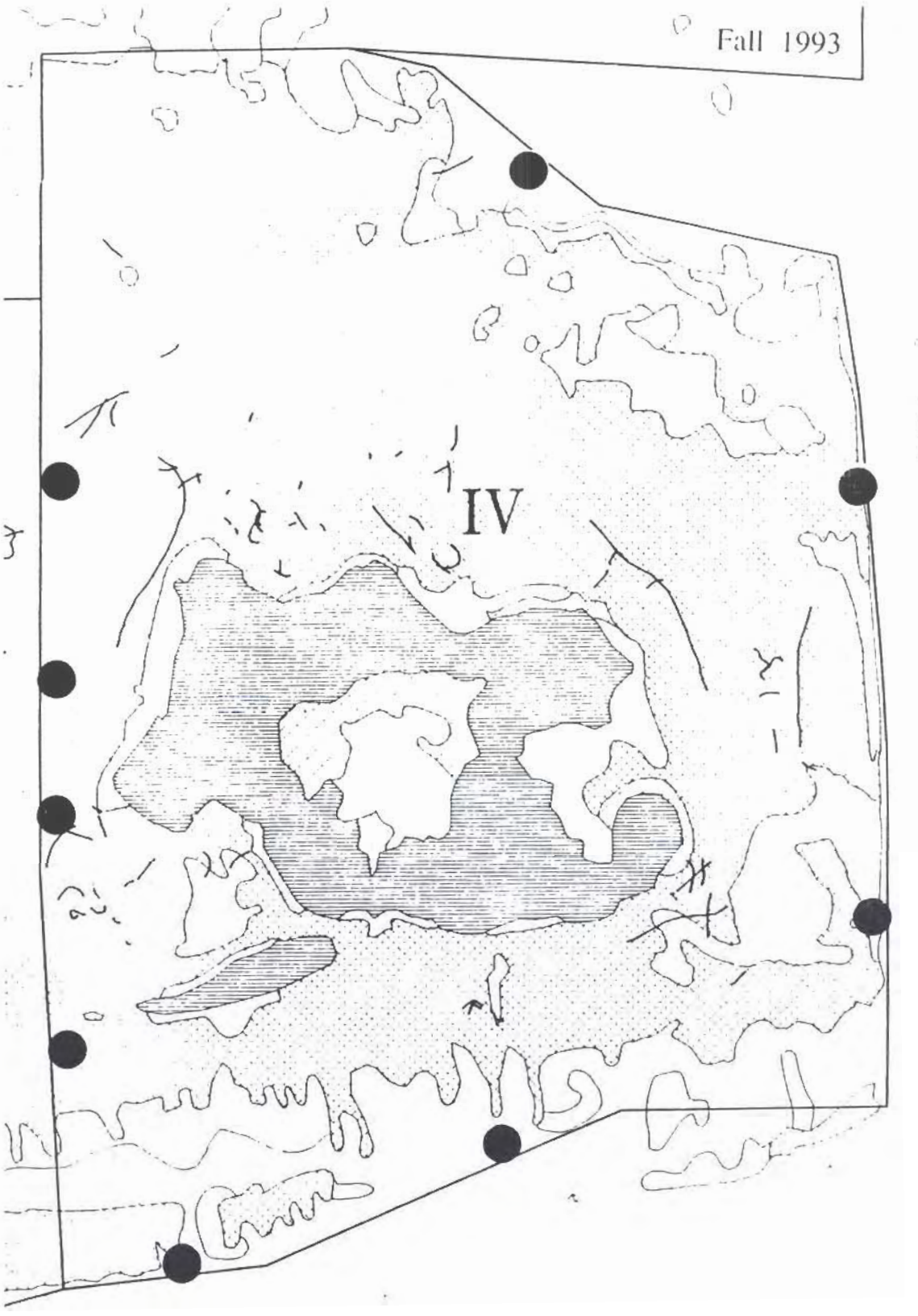
Blue dots on the drawings are recommended sites.


Fall 1993

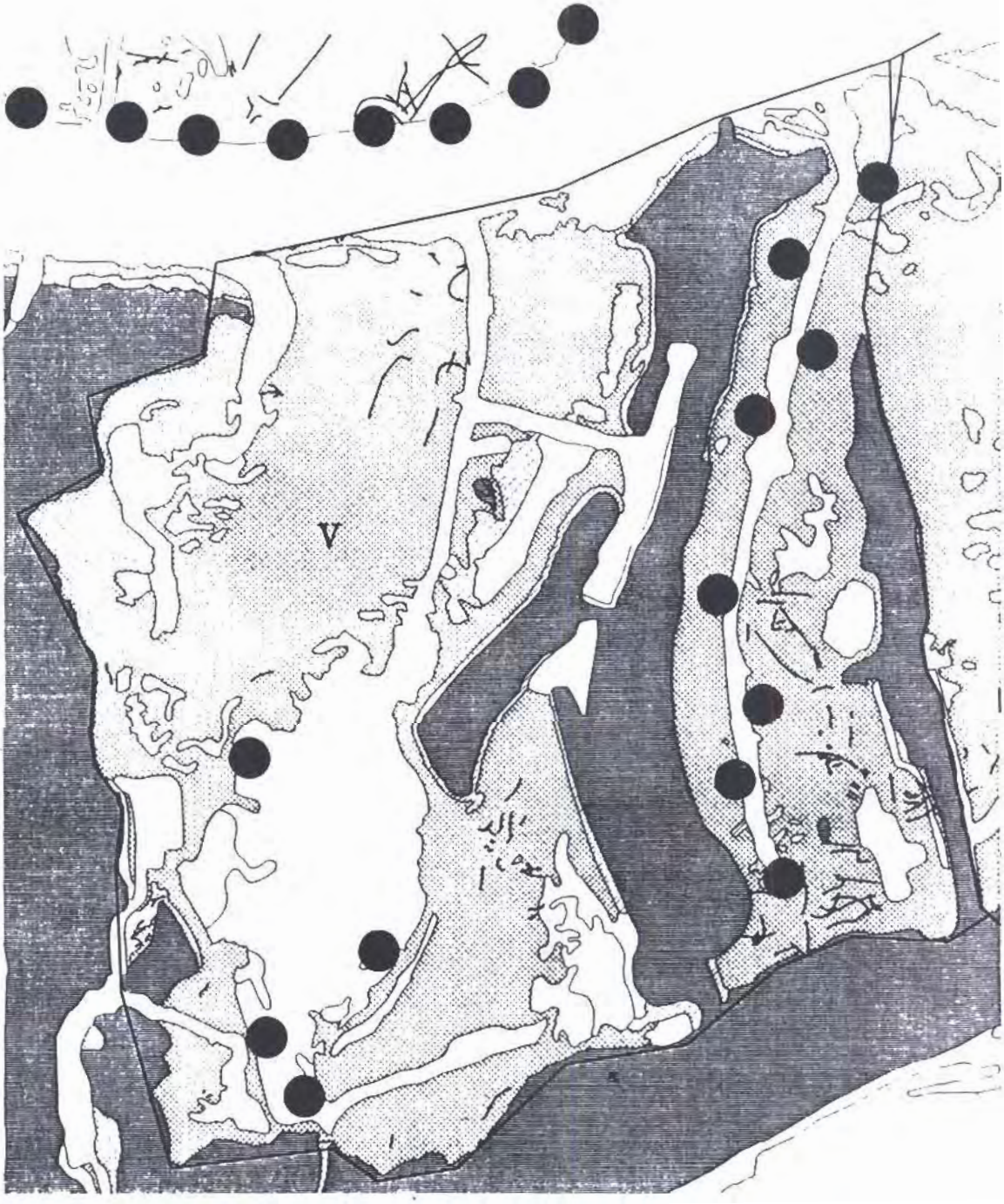

I
II

Fall 1993




Fall 1993
IV

Fall 1993



Fall 1993