

*Lathrop et al 99 (see ref)*

## BARNEGAT BAY DATA SYNTHESIS PROJECT: habitat loss and alteration

The Center for Remote Sensing and Spatial Analysis (CRSSA), was one of several participants in the Barnegat Bay Data Synthesis Project, completed in August 1999.

CRSSA has composed this web document series which highlights and supports its results of the Habitat Loss and Alteration component of the Data Synthesis Project and provides a useful overview of the Barnegat Bay watershed region.

Accompanying the text are samplings of maps generated by CRSSA using GIS and its vast digital geo-spatial data base resulting from this and other projects within the New Jersey coastal region.

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2. Barnegat Bay Habitat Map
3. Watershed Development
4. Forest Loss and Fragmentation
5. Riparian Corridors
6. Shoreline Buffer Loss and Alteration
7. Salt Marsh Loss and Alteration
8. Submerged Aquatic Vegetation
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10. Summary

Funding for CRSSA's habitat loss and alteration research was provided by the Barnegat Bay Estuary Program, the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program, the Trust for Public Land, and the New Jersey Agricultural Experiment Station.

This site was modified from its [original version](#) and presented 18 May 2001. All web development by the Grant F. Walton Center for Remote Sensing and Spatial Analysis (CRSSA), Cook College - Rutgers University, :

*Reprint (unlabeled)*

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**Data Synthesis Effort for the Barnegat Bay Estuary Program: Habitat Loss and Alteration in the Barnegat Bay Region**

Richard G. Lathrop, Jr., John A. Bognar, Andrew C. Hendrickson and Paul D. Bowers

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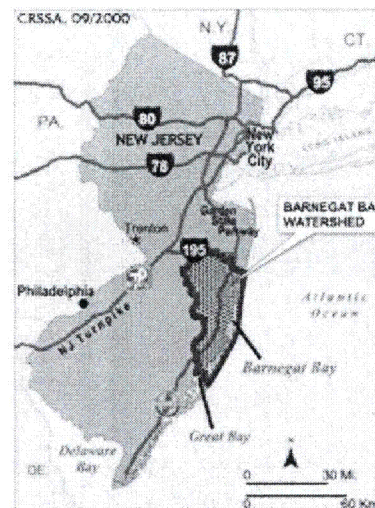
August 19, 1999

**ABSTRACT**

New Jersey's coastal zone, and the Barnegat Bay region in particular, has experienced extensive development and modification in the last five decades. In an attempt to ameliorate past change and more effectively manage future environmental change, the Barnegat Bay National Estuary Program (BBNEP) is in the process of developing a long range Comprehensive Conservation and Management Plan (CCMP).

One of the major BBNEP focus topics is the role of humans, in comparison to natural processes of disturbance and change, in shaping Barnegat Bay and its capability to nurture a rich and diverse biota.

To assist in developing the CCMP, we have analyzed a variety of satellite imagery, aerial photography, digital land use/land cover data and historical maps to document existing conditions, as well as assess long-term trends of habitat loss and alteration in Barnegat Bay and its watershed.



This web document series, which supports the CRSSA document, *Barnegat Bay Data Synthesis Project: Habitat Loss and Alteration*, describes the results of this habitat mapping and monitoring effort and

summarizes the observed trends in loss and alteration of shallow-water, tidal marsh, shoreline buffer and upland forest habitats. The efficacy of existing land use planning policies and the present network of open space / conservation lands in ensuring long-term integrity of the Barnegat Bay region as a functioning landscape of interconnected habitats was also evaluated.

## OBJECTIVE

Several key landscape level environmental indicators were identified based on their ecological importance, as well as social concerns such as aesthetic and open space issues.

Key Environmental Indicators	Concern
• Upland and Wetland Forests	Loss and Fragmentation due to Development
• Riparian Corridors	Alteration due to Development
• Upland/Bay Shoreline Buffer	Alteration due to Development and Bulkheading
• Coastal Salt Marshes	Loss and Alteration due to Development
• Submerged Aquatic Vegetation	Loss due to Declining Water Quality

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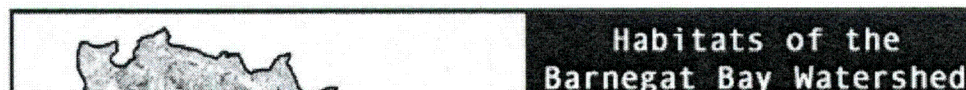
## MAPPING THE HABITATS OF THE BARNEGAT BAY WATERSHED

The Center for Remote Sensing and Spatial Analysis has generated a combined upland, wetland and benthic habitats of the Barnegat Bay watershed map for the Data Synthesis Project. This map was developed through the interpretation and analysis of a variety of sources including Landsat Thematic Mapper satellite imagery, aerial photography, land use/land cover and state/national wetland digital data.



The primary data set for the upland/watershed map was a series of Landsat Thematic Mapper satellite images from 1994 and 1995 (Nov. 4, 1994 image shown at left). The benthic aquatic habitat maps were developed from the U.S. Fish and Wildlife Service's National Wetland Inventory, several submerged aquatic vegetation survey maps, and bathymetry derived from the NOAA nautical chart for Barnegat Bay. The benthic aquatic and upland/watershed habitat maps were combined to create one seamless habitat map for the entire Barnegat Bay ecosystem.

The complex nature of the map which consists of thirty-eight habitat / land cover categories led the Center for Remote Sensing and Spatial Analysis to develop a web-based "Habitat Tour". The tour gives internet users a chance to gain a better understanding of individual Barnegat Bay habitats through the use of class distribution maps, species lists and ground photography. [Habitat Tour](#) ►





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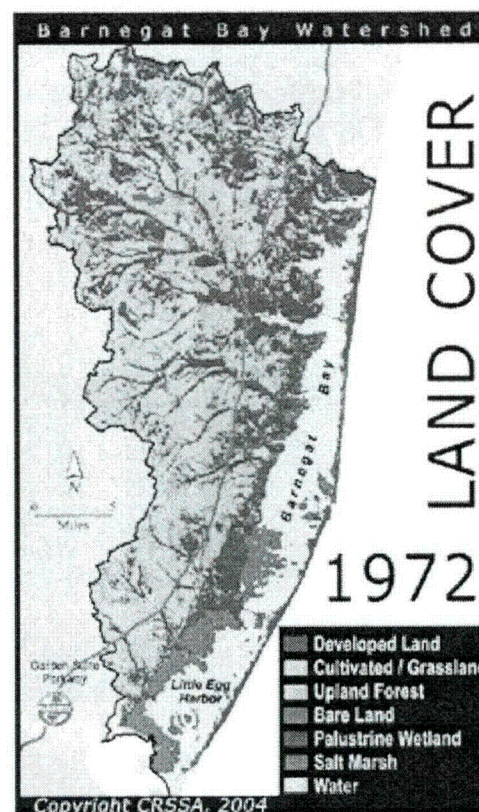
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## WATERSHED DEVELOPMENT

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A combination of multi-spectral and GIS-based approaches were used to classify leaf-on and leaf-off Landsat Thematic Mapper satellite imagery to map upland and wetland vegetation communities.

- **Years mapped by CRSSA were 1972, 1984 and 1995. Results show development within the Barnegat Bay watershed has increased 18% to 21% to 28% during the years 1972, 1984 and 1995 respectively.**



Animation by the Rutgers University  
 Center for Remote Sensing and  
 Spatial Analysis (CRSSA), 2004.

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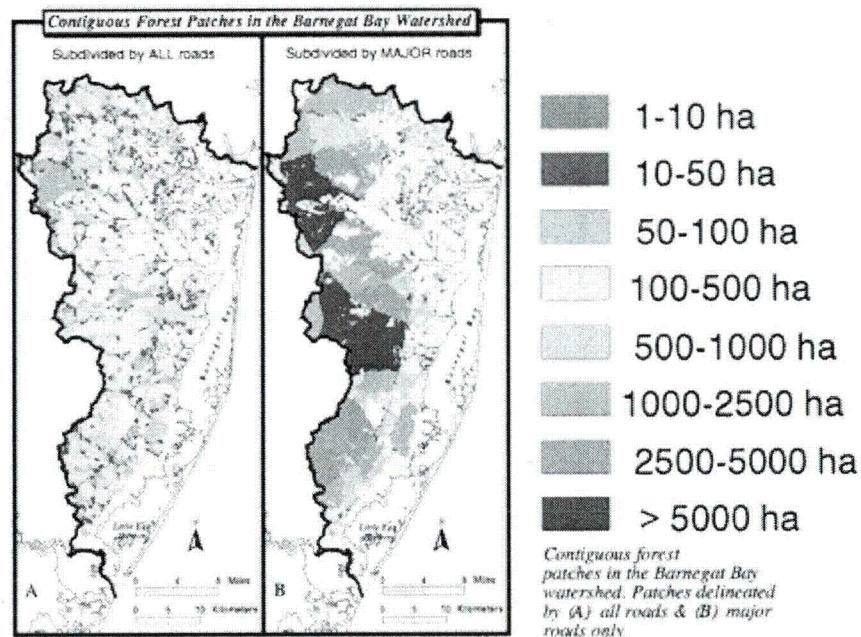
**FOREST LOSS AND FRAGMENTATION**

Barnegat Bay's watershed is part of the larger New Jersey Pinelands, a region dominated by upland pine-oak forests and mixed hardwood-pine-cedar forested wetlands. The conservation of large tracts of contiguous Pinelands habitat and the minimization of fragmentation are issues of concern.

Human development has the direct impact of removing existing natural habitats as well as fragmenting the habitat that remains into smaller pieces. Development and heavily travelled road corridors often serve as barriers or hazards to wildlife movement, facilitate exotic/noxious plant invasions and alter 'natural' disturbance regimes.

- **There has been an approximate loss of 13,700 hectares, or 20%, of upland forest to development between 1972 and 1995.**
- **The loss of wetland forest has been much less at 1,875 hectares, or approximately 6%.**

Contiguous forest areas (i.e. not divided by roads) were delineated by CRSSA to further examine the issue of forest fragmentation. Paved roads and existing developments were used as a boundary to delineate the individual patches of contiguous forest habitat. The forests of the eastern half of the Barnegat Bay watershed are severely fragmented, contrasting very strongly with the largely unfragmented forests of the upper watershed regions. The Barnegat Bay watershed contains several individual forest tracts of large size that are of statewide significance.



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5. Riparian Corridors ►



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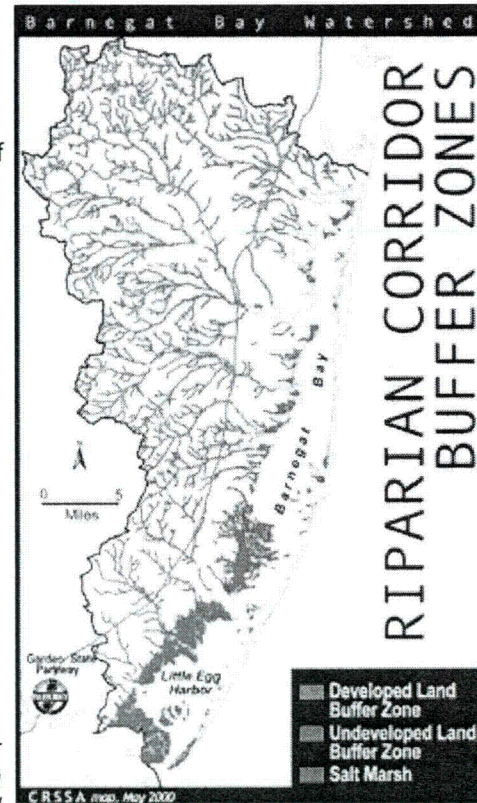
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**RIPARIAN CORRIDORS**

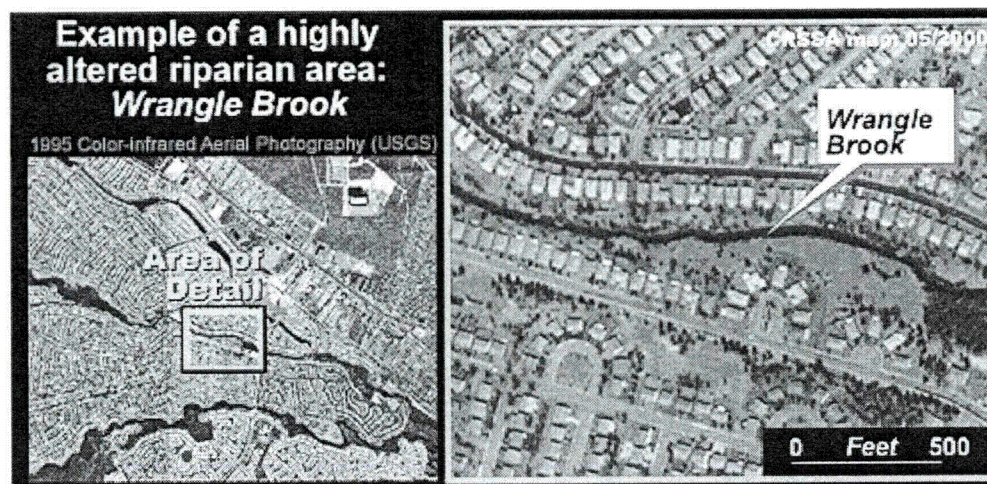
In the sandy soils of the Barnegat Bay watershed, there is a tight linkage between the water quality of the shallow groundwater aquifers and the region's water supply. Human development in the Barnegat Bay watershed has negative impacts on groundwater and instream water quality.

Conversely, riparian corridors left in natural vegetation help reduce the impairment of adjacent stream ecosystems and serve as vital habitat for both upland and wetland dependent species. These riparian zones serve as important corridors for fish and wildlife movement and dispersal, linking the coastal Bay and interior NJ Pinelands habitats.

*A 180 meter wide riparian corridor (90 meter buffer from each stream bank) was delineated for all mapped streams and rivers by CRSSA.*



- 20% of the watershed's riparian zone is in altered land uses (i.e. developed, cultivated/grassland, or bare land).
- Some sub-watersheds' riparian corridors are greater than 50% altered.



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6. [Shoreline Buffer Loss and Alteration](#) ►



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**SHORELINE BUFFER LOSS AND ALTERATION**

Near-shore development impacts habitat value of the bay/upland ecotone by directly displacing native plant vegetation communities that may serve as feeding, nesting and migrating habitat. Human development along with its associated impervious surfaces and horticultural practices exacerbates runoff, sedimentation and nonpoint source pollution. Bulkheading impacts shallow water habitats and eliminates shoreline beach habitat important for shorebirds and terrapin turtles.

For this segment of the habitat loss study, CRSSA analyzed the amount of development with a 150 meter buffer zone from the bay and/or bordering salt marshes (see map below).



**Assorted Bay Shorebirds**  
Photo by R. Zappacosta

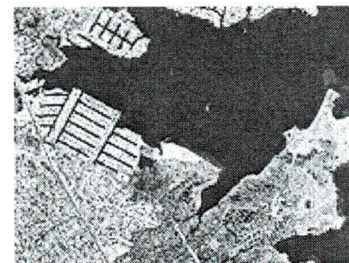
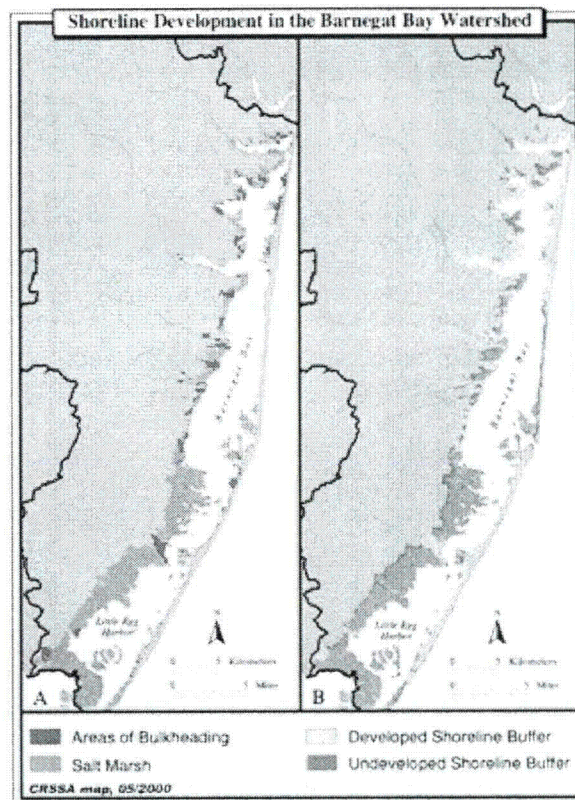
*Shorebirds use shoreline beach habitats to feed, rest and nest*



**Diamondback Terrapin**  
Photo by R. Zappacosta

*Terrapins need access to shoreline beach habitats to lay their eggs*

- 45% of Barnegat Bay's shoreline is impacted by bulkheading
- 71% (10,729 acres) of Barnegat Bay's shoreline buffer zone is presently developed and/or altered, leaving only 29% (4,406 acres) in natural land cover



Note the contrast between the highly developed shoreline of Silver Bay (left side of air-photo) and the undeveloped shore of Cattus Island Park.

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7. Salt Marsh Alteration ►



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**SALT MARSH LOSS AND ALTERATION**

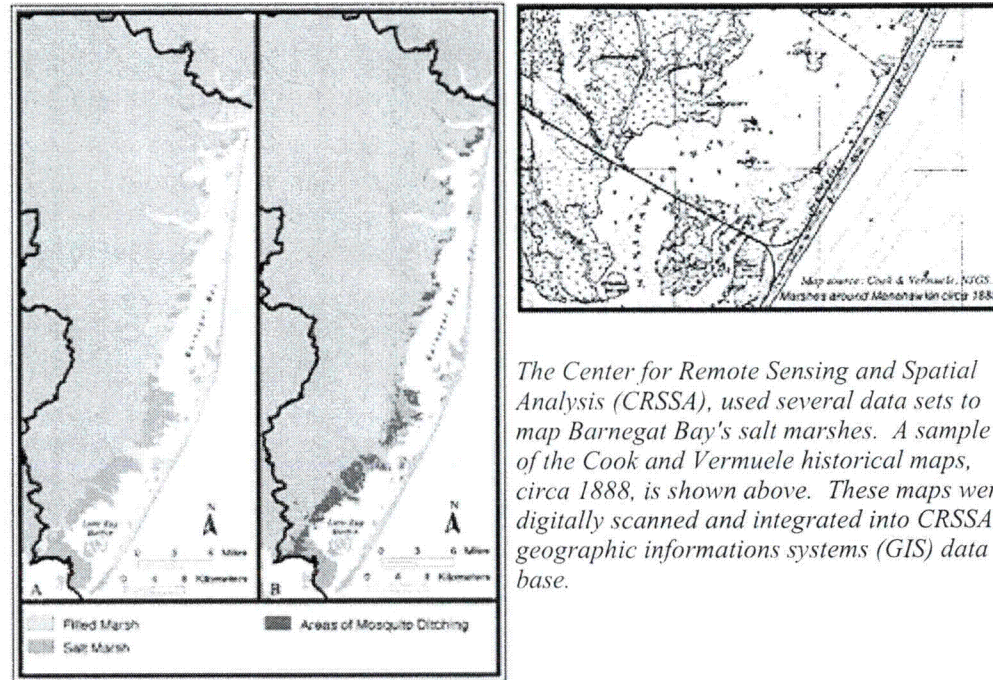
- **Over 28% of Barnegat Bay's marshes have been lost to development.**



Left: Bird's eye of Sheepshead Meadows  
Above: Great Blue Heron, Top Right: Marsh Veg.  
(photos: JCNERR)

Salt marshes serve as important feeding, nesting and refuge for a host of fish and wildlife species. In addition to outright loss through dredging and infilling, salt marshes in Barnegat Bay have undergone extensive modification by various mosquito control measures. Parallel ditching to drain surface water (mosquito breeding habitat) was first conducted in New Jersey in 1906. Historic maps circa 1888 were compared with land cover maps from 1972, 1984 and 1995 to monitor the loss of salt marsh area.

- **Most of Barnegat Bay's wetland loss appears to have occurred between 1940 and 1970. Subsequent to the passage of the Coastal Wetlands Law of 1970, 167 hectares, or 1.5%, has been lost to development.**
- **There are 950 kilometers (590 miles) of parallel grid mosquito control ditches affecting approximately two-thirds of Barnegat Bay's marshes.**



*The Center for Remote Sensing and Spatial Analysis (CRSSA), used several data sets to map Barnegat Bay's salt marshes. A sample of the Cook and Vermuele historical maps, circa 1888, is shown above. These maps were digitally scanned and integrated into CRSSA's geographic information systems (GIS) data base.*

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8. Submerged Aquatic Vegetation ►



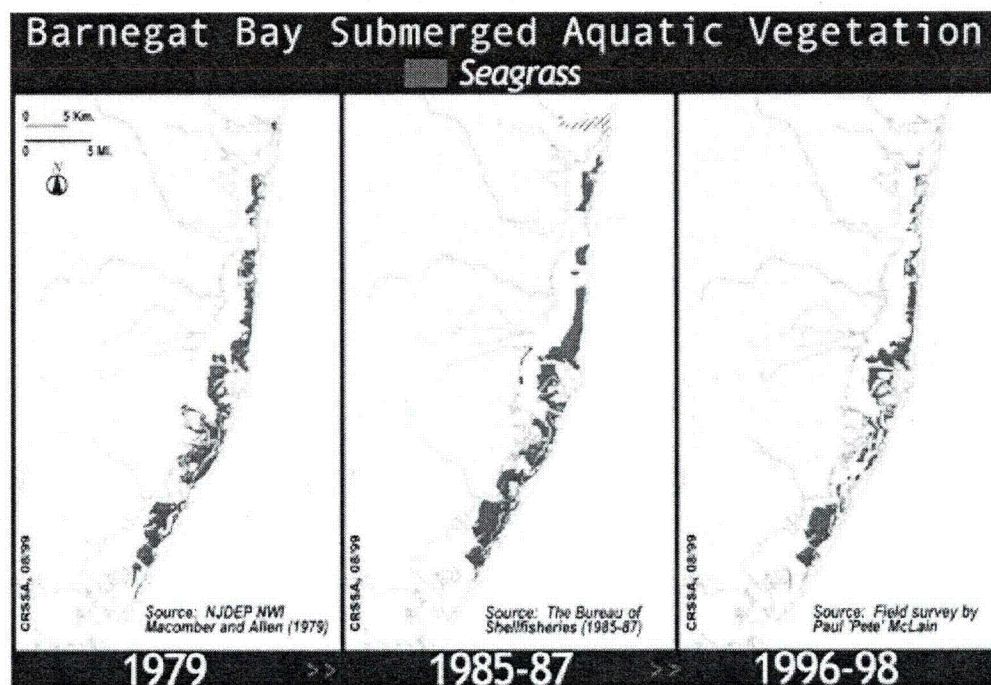
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**SUBMERGED AQUATIC VEGETATION**

Submerged aquatic vegetation (SAV), primarily eelgrass, *Zostera marina* and widgeon grass (*Ruppia maritima*) is an important component of the bay ecosystem, serving as important nursery and refuge habitat for a number of faunal groups. These seagrasses are a sensitive indicator of the bay's overall health.

- **Barnegat Bay contains over 75% of New Jersey's SAV habitat**
- **Comparison of the 1970's and 1980's with the 1990's surveys shows a decrease of nearly 33% in SAV area**



Due to a difference in mapping methods, we must be cautious in directly attributing the decrease in SAV acreage to a large-scale dieback. However, there is reason for



concern over the status of seagrass beds in Barnegat Bay as anecdotal evidence indicates declining health due to decreasing water clarity from algal blooms, wasting disease and infestations of epiphytic algae.

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**GAPS IN CONSERVATION PROTECTION**

To analyze the gaps in conservation protection through the Barnegat Bay watershed, CRSSA superimposed digital maps of public conservation lands on maps of priority wildlife habitat. This "gap" analysis was used to highlight the existing areas of high habitat value which remain unprotected through the watershed study area.

- **90% of Barnegat Bay's salt marshes are presently protected in some form of public conservation ownership**
- **70% of the remaining undeveloped shoreline is in some form of public conservation ownership**
- **Nearly 45% of interior forest habitat is in some form of conservation ownership**
- **50% of Barnegat Bay's islands are in some form of public conservation ownership**

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**SUMMARY**

Barnegat Bay and its upland watershed represent a rich diversity of coastal and pinelands habitats. While significantly altered by human land use activities, many of these habitats are still intact functioning natural communities. Through government legislation and regulation, some of the most destructive past practices, such as dredging and filling coastal salt and freshwater marshes, have been largely eliminated. However, development and the consequent loss of upland forests proceeds apace.

To minimize the environmental impacts of future development, shoreline buffer areas, bay islands and riparian corridors should receive enhanced protection. To maintain the integrity of the pinelands ecosystem, development should be steered away from large tracts of unfragmented pinelands habitat.

While large expanses of upland and wetland habitats are presently protected as publicly owned conservation land, additional open space acquisition and/or easements are justified on a number of grounds:

- 1.) watershed protection to insure high quality inflow to Barnegat Bay
- 2.) protection of habitat for commercially, recreationally and ecologically important flora and fauna
- 3.) open space and enhanced public access for human recreation and aesthetic enjoyment.

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**OBJECTIVE**

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Key Environmental	Concern
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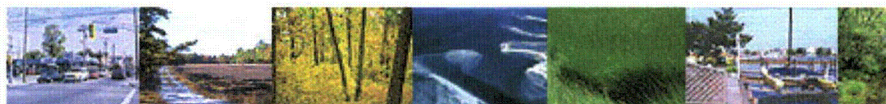
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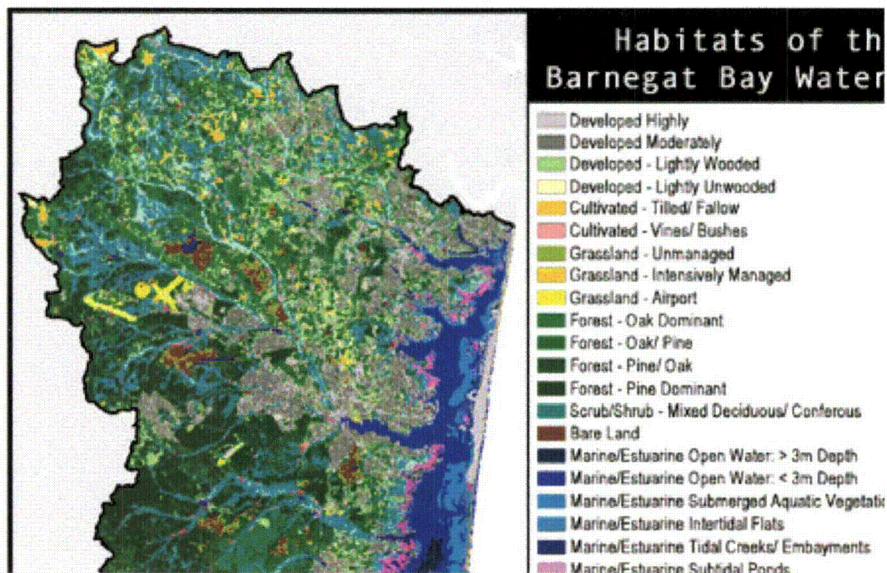
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**3. Watershed Developme**

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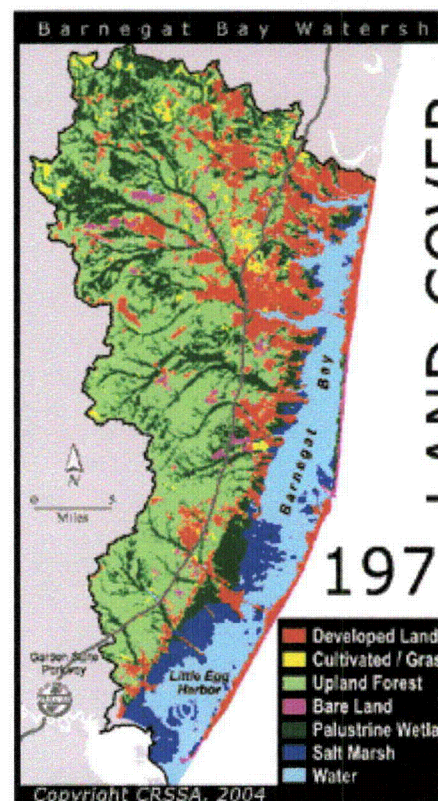
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Animation by the Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA), 2004.

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**[4. Forest Loss and Fragmentation](#)**

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**FOREST LOSS AND FRAGMENTATION**

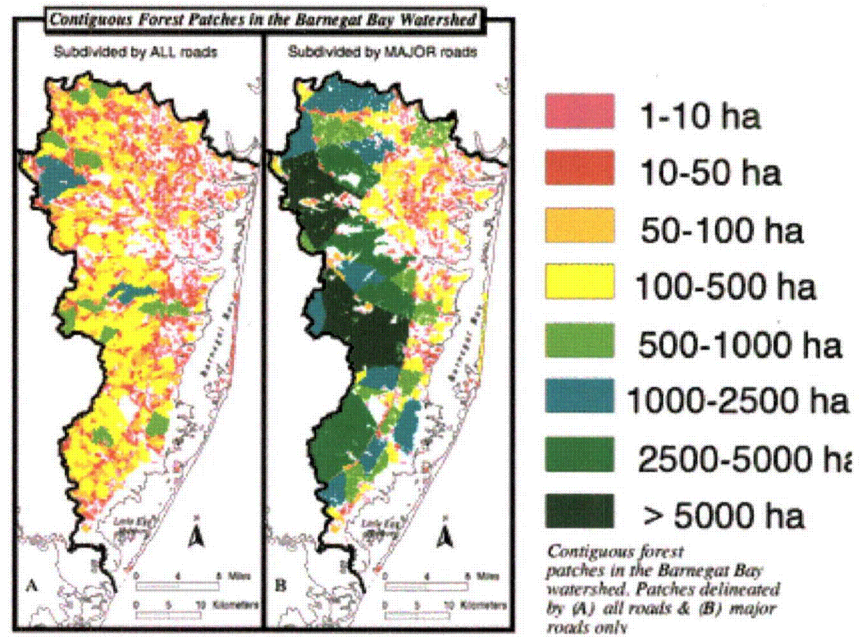
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[5. Riparian Corridor](#)

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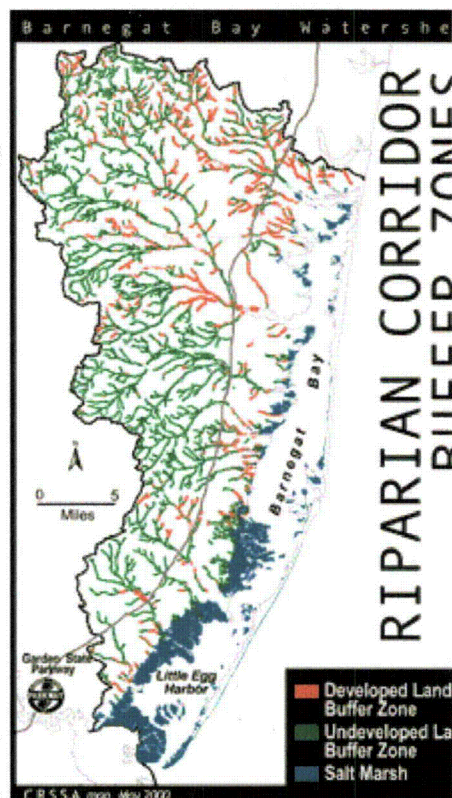
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**RIPARIAN CORRIDORS**

In the sandy soils of the Barnegat Bay watershed, there is a tight linkage between the water quality of the shallow groundwater aquifers and the region's water supply. Human development in the Barnegat Bay watershed has negative impacts on groundwater and instream water quality.

Conversely, riparian corridors left in natural vegetation help reduce the impairment of adjacent stream ecosystems and serve as vital habitat for both upland and wetland dependent species. These riparian zones serve as important corridors for fish and wildlife movement and dispersal, linking the coastal Bay and interior NJ Pinelands habitats.

*A 180 meter wide riparian corridor (90 meter buffer from each stream bank) was delineated for all mapped streams and rivers by CRSSA.*



- 20% of the watershed's riparian zone is in altered land uses (developed, cultivated/grassland, or bare land).
- Some sub-watersheds' riparian corridors are greater than 50 altered.



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[6. Shoreline Buffer Loss and Alteration](#)





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**SHORELINE BUFFER LOSS AND ALTERATION**

Near-shore development impacts habitat value of the bay/upland ecotone by displacing native plant vegetation communities that may serve as feeding, nesting and migrating habitat. Human development along with its associated impervious surfaces and horticultural practices exacerbates runoff, sedimentation and source pollution. Bulkheading impacts shallow water habitats and eliminates shoreline beach habitat important for shorebirds and terrapin turtles. *by direct nesting non point*

For this segment of the habitat loss study, CRSSA analyzed the amount of development with a 150 meter buffer zone from the bay and/or bordering salt marshes (see map below).



**Assorted Bay Shorebirds**  
Photo by R. Zampantini

*Shorebirds use shoreline beach habitats to feed, rest and nest*



**Diamondback Terrapin**  
Photo by R. Zampantini

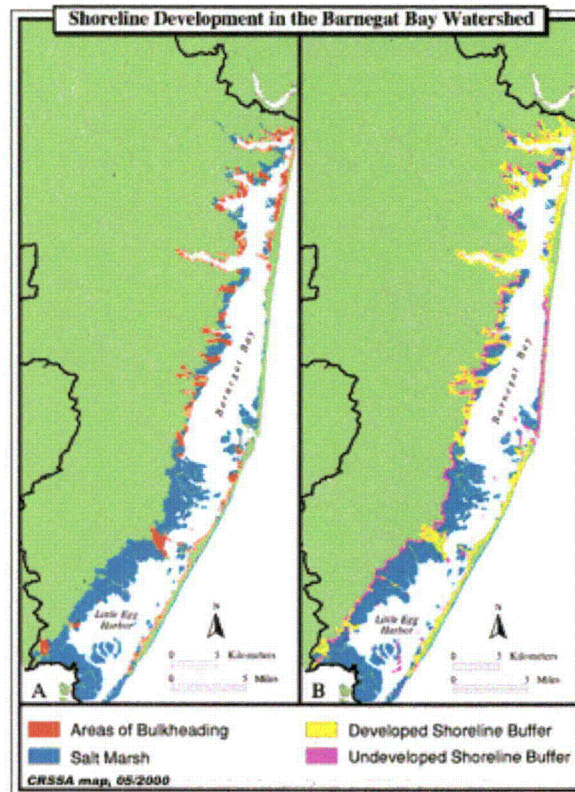
*Terrapins need access to shoreline beach habitats to lay their eggs*

- 45% of Barnegat Bay's shoreline is impacted by bulkheading

- 71% (10,729 acres) of Barnegat Bay's shoreline buffer zone is presently developed and/or altered leaving only 29% (4,406 acres) in natural land cover *of P*



*Note the contrast between the*



developed shoreline of Silver Lake (air-photo) and the undeveloped shore of Cattus Park.

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[7. Salt Marsh Alterat](#)

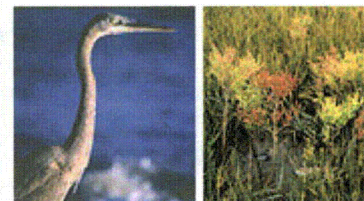


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## SALT MARSH LOSS AND ALTERATION

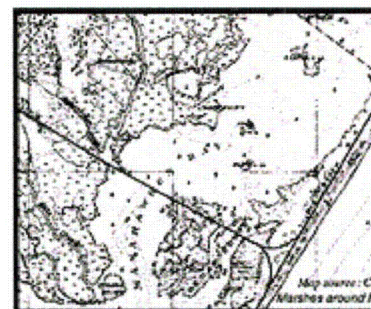
- Over 28% of Barnegat Bay's marshes have been lost to devel



Left: Bird's eye of Sheepshead Meadows  
 Above: Great Blue Heron, Top Right: Ma  
 (photos: JCNERR)

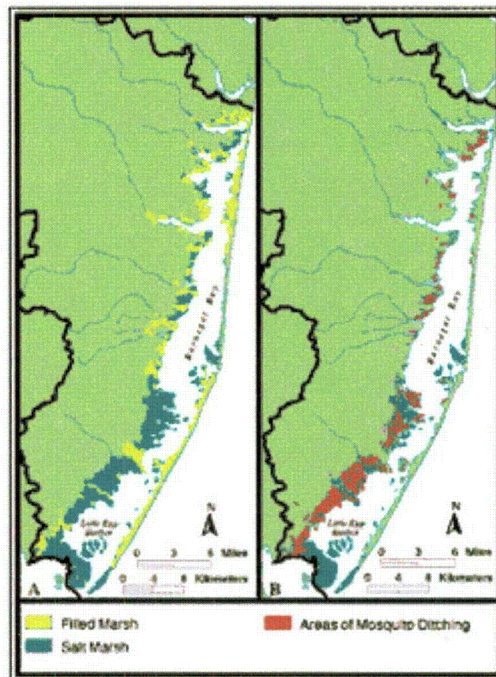
Salt marshes serve as important feeding, nesting and refuge for a host of wildlife species. In addition to outright loss through dredging and infilling, s in Barnegat Bay have undergone extensive modification by various mosqui measures. Parallel ditching to drain surface water (mosquito breeding habit first conducted in New Jersey in 1906. Historic maps circa 1888 were com land cover maps from 1972, 1984 and 1995 to monitor the loss of salt mars

- Most of Barnegat Bay's wetland loss appears to have occurred between 1940 and 1970. Subsequent to the passage of the Coastal Wetlands Law of 1970, 167 hectares, or 1.5%, has been lost to development.
- There are 950 kilometers (590 miles) of parallel grid mosquito control ditches affecting approximately two-thirds of Barnegat Bay's marsh



The Center for Remote Sensing and Analysis (CRSSA), used several data maps of Barnegat Bay's salt marshes. One of the Cook and Vermuele historical maps, circa 1888, is shown above. These maps were digitally scanned and integrated into geographic information systems (GIS) as a base.





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[8. Submerged Aquatic Vegetat](#)

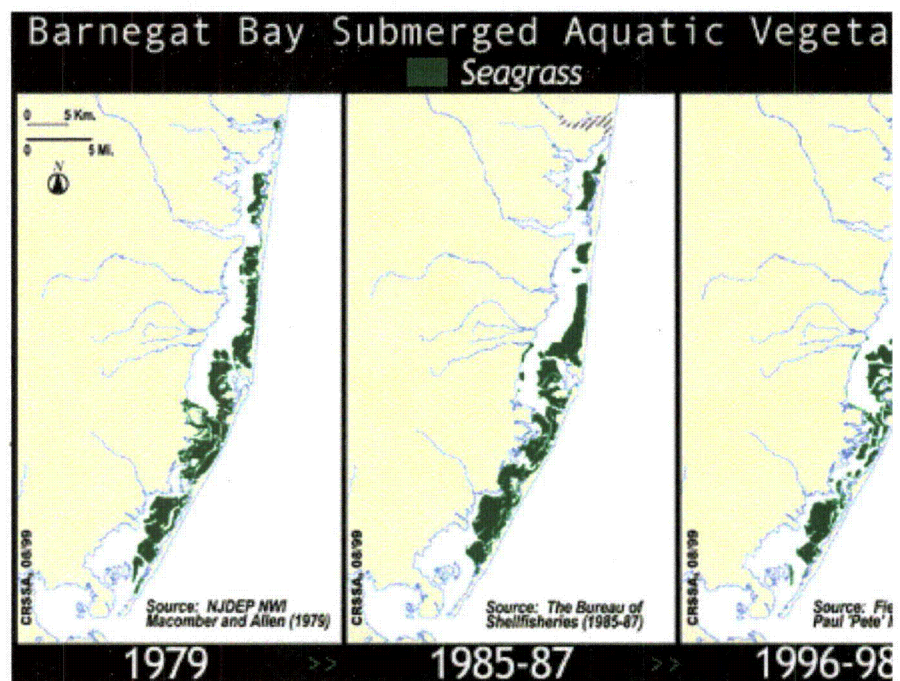
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**SUBMERGED AQUATIC VEGETATION**

Submerged aquatic vegetation (SAV), primarily eelgrass, *Zostera marina* and widgeon grass (*Ruppia maritima*) is an important component of the bay ecosystem serving as important nursery and refuge habitat for a number of faunal groups. These seagrasses are a sensitive indicator of the bay's overall health.

- Barnegat Bay contains over 75% of New Jersey's SAV habitat
- Comparison of the 1970's and 1980's with the 1990's surveys shows a decrease of nearly 33% in SAV area



Due to a difference in mapping methods, we must be cautious in directly attributing the decrease in SAV acreage to a large-scale dieback. However, there is concern over the status of seagrass beds in Barnegat Bay as anecdotal evidence indicates declining health due to decreasing water clarity from algal blooms, disease and infestations of epiphytic algae.

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[9. Gaps in Conservation Protection](#)

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To analyze the gaps in conservation protection through the Barnegat Bay watershed, CRSSA superimposed digital maps of public conservation land: maps of priority wildlife habitat. This "gap" analysis was used to highlight the existing areas of high habitat value which remain unprotected through the watershed study area.

- **90% of Barnegat Bay's salt marshes are presently protected in some form of public conservation ownership**
- **70% of the remaining undeveloped shoreline is in some form of public conservation ownership**
- **Nearly 45% of interior forest habitat is in some form of conservation ownership**
- **50% of Barnegat Bay's islands are in some form of public conservation ownership**

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Barnegat Bay and its upland watershed represent a rich diversity of coastal pinelands habitats. While significantly altered by human land use activities, many of these habitats are still intact functioning natural communities. Through government legislation and regulation, some of the most destructive past practices, such as dredging and filling coastal salt and freshwater marshes have been largely eliminated. However, development and the consequent of upland forests proceeds apace.

To minimize the environmental impacts of future development, shoreline buffers, bay islands and riparian corridors should receive enhanced protection. To maintain the integrity of the pinelands ecosystem, development should be steered away from large tracts of unfragmented pinelands habitat.

While large expanses of upland and wetland habitats are presently protected as publicly owned conservation land, additional open space acquisition and easements are justified on a number of grounds:

- 1.) watershed protection to insure high quality inflow to Barnegat Bay
- 2.) protection of habitat for commercially, recreationally and ecologically important flora and fauna
- 3.) open space and enhanced public access for human recreation and aesthetic enjoyment.

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