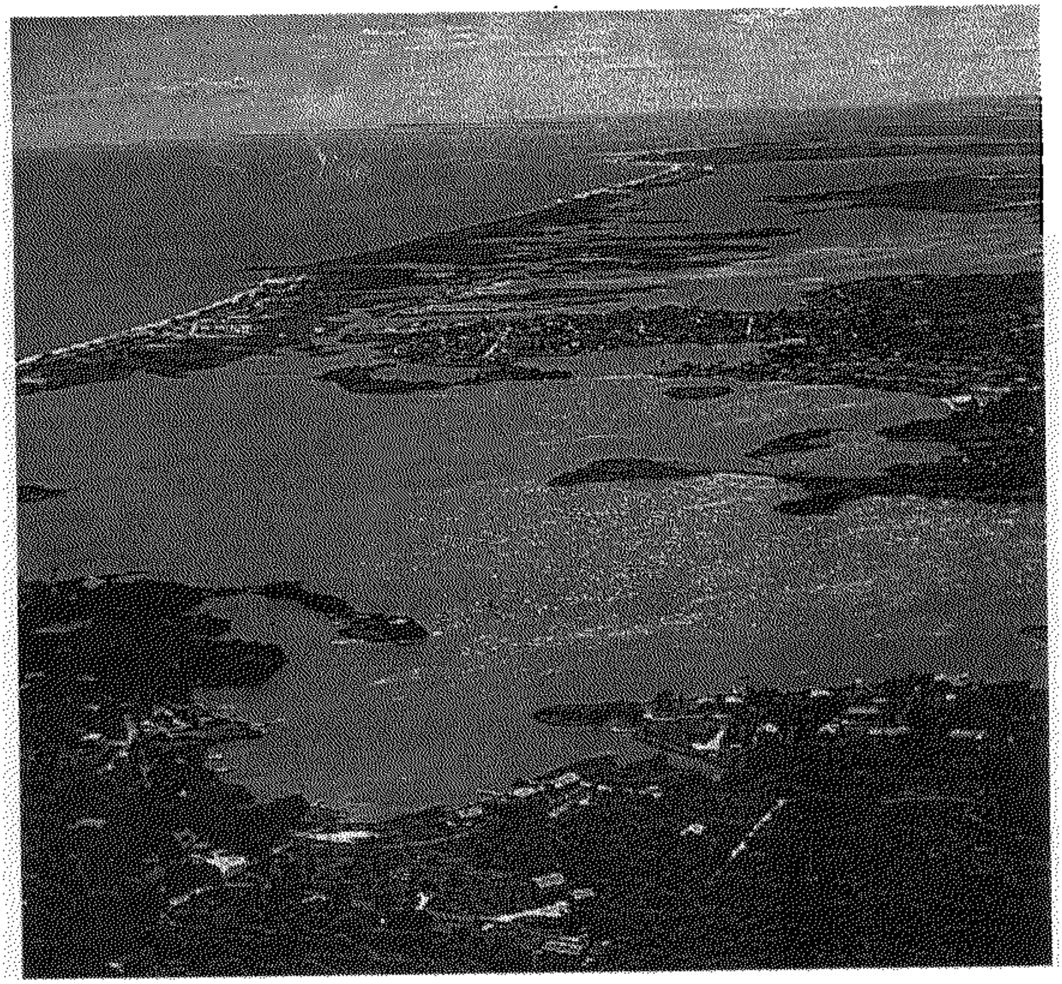
RIU-T-97-004 C3

RHODE ISLAND SALT POND WATER QUALITY

Salt Pond Watchers Monitoring Data

1985-1994



Technical Report
October 1997

By:
Virginia Lee
Laura Ernst

COASTAL RESOURCES CENTER
University of Rhode Island
and
RHODE ISLAND SEA GRANT

RHODE ISLAND
SALT POND WATER QUALITY

Salt Pond Watchers Monitoring Data
1985-1994

Well and Stream Monitoring Data
1994

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Jason Marino

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ACKNOWLEDGMENTS

All of us who enjoy the beauty and the bounty of the salt ponds owe a great debt of gratitude to the salt pond watchers. Their love of the salt ponds and willingness to take action to protect them for the future is inspirational. The dedication, patience and the carefulness of these volunteers has created a credible database for assessing water quality issues of the salt ponds and their watersheds which would not have been possible without them.

We are also grateful to the many University of Rhode Island graduate students who helped coordinate the sampling program, ran the laboratory analyses, checked the data entry, and assisted with the annual training events: Paula Kullberg, Paul Fofonoff, Anna Thompson, Bob Vaillancourt, Elena Martin, Dave Avery, Nicholas Wolff, James Fraher, Joe Topos, Nancy Craig, Julia McMahon, Margarita Castro, Ellen Gorman, Rick Hein, Bridget Holohan, Courtney Stirling, and Yaqin Li. The efforts of several URI Graduate School of Oceanography staff were also essential: Betty Buckley, Stephen Granger and Alan Desbonnet.

Funding for the salt pond watchers has been provided by Rhode Island Sea Grant, the Lindbergh Foundation, the IBM Corporation, the Kimball Foundation, the Rhode Island Foundation, the Shelter Harbor Conservation Association and the Washington Trust Company. The Rhode Island Department of Health and the Federal Food and Drug Administration also made in kind contributions of free lab analysis for bacteria samples.

We salute the energy and leadership of Suzanne Nardone, volunteer data manager and editor of the Salt Pond Newsletter as well as John Baer, founder of the Salt Pond Coalition and David Monk, present president.

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Metadata for Salt Pond Water Quality Data

Map Data

1. Maps were developed using data from the RI Geographic Information System. Location of sampling stations on the map are approximations of actual locations used in collection of water column samples.

Bacteria Data

Raw Data

1. This data file contains all raw data for the Salt Pond Watchers sampling period 1985-1994
2. Data columns in the spreadsheet are as follows:
   •POND - Code for pond name (Point Judith, Potter, Cards, Trustom, Green Hill, Ninigret, Quonochontaug, Winnapaug, Maschaug).
   •AREA - Area of the pond in which the sample was taken.
   •OLDST - Station number used in past, but is not currently in use. Station number was changed at one point in time to better coordinate with the Rhode Island Dept. of Environmental Management station number for their water quality sampling stations. Old Station Numbers are not shown on maps of the lagoon.
   - NEWST - Station Number in current use. Location of these sampling stations is provided on the map
   - T/P - Designation for the sampling station located in a tributary stream (T) or in the actual lagoon (P)
   - DATE - Date on which the sample was taken
   - FECAL (MPN) - Concentration of fecal coliform bacteria measured in the sample taken on the given date. Data are given in Most Probable Number per 100 ml of sample (MPN/100ml). Analysis according to that provided in "Standard Methods For the Examination of Water and Wastewater, 8th Edition."
   - TOTAL (MPN) - Concentration of total coliform bacteria measured in the sample taken on the given date. Data are given in Most Probable Number per 100 ml of sample (MPN/100ml). Analysis according to that provided in "Standard Methods For the Examination of Water and Wastewater, 8th Edition."
   - WATERFOWL DISTANCE, FT. (NUMBER) - Number of waterfowl noted by the observer during the time of sample collection. Data are provided in approximated distance from the observer to the waterfowl - DISTANCE, FT. - and number of waterfowl observed at that approximate distance (NUMBER).

Water Quality Data

Raw Data

1. This data file contains all the raw data for the Salt Pond Watchers sampling period 1985 – 1994
2. Data columns in the spreadsheet are as follows:
   - POND - Code for pond name (Point Judith, Potter, Cards, Trustom, Green Hill, Ninigret, Quonochontaug, Winnapaug, Maschaug).
   - SITE - Labeled as ON or OFF. ON refers to taking the sample from the designated station on the pond. OFF refers to taking the sample from shore or dock during times of ice cover or otherwise when the designated sampling station could not be sampled.
   - T/P - Designation for the sampling station being located in a tributary stream (T) or in the actual lagoon (P)
   - STATION - Station number identification. These station numbers correspond to those given on the map for Green Hill Pond
   - DATE - Date on which the sample was taken
   - TEMP (°C) - Temperature of the water at the surface in degrees Celsius
   - SDOX (mg/l) - Measure of dissolved oxygen concentration in surface waters (approximately 1 foot below the surface) and reported in milligrams oxygen per liter of water (mg/l = ppm). For method of sampling and analysis, see Protocols in Appendix A.
   - BDOX (mg/l) - Measure of dissolved oxygen concentration in bottom waters and reported in milligrams oxygen per liter of water (mg/l = ppm). For method of sampling and analysis, see Protocols in Appendix A
   - SALT (ppt) - Measure of the salinity of the surface waters of the pond and reported in parts per thousand (grams salt per liter of water).). For method of sampling and analysis, see Protocols in Appendix A.
   - N (μM/l) - Measure of nitrate in surface waters of the pond and reported in units of micro-moles per liter of water.). For method of sampling and analysis, see Protocols in Appendix A.
   - P (μM/l) - Measure of phosphate in surface waters of the pond and reported in micro-moles per liter of water.). For method of sampling and analysis, see Protocols in Appendix A.
   - CHLA (μg/l) - Measure of chlorophyll-a content in surface waters of the pond and reported in units of micro-grams per liter of water.). For method of sampling and analysis, see Protocols in Appendix A.
   - SECCHI (m) - Depth of water to which a standard sized secchi disc is visible by an onboard observer and reported in units of meters below the surface of the pond. For method of sampling and analysis, see Protocols in Appendix A.
   - DEPTH (m) - Depth of the pond at the location where the water quality samples were taken, and reported in meters below the surface of the pond. For method of sampling and analysis, see Protocols in Appendix A.

Rhode Island Salt Ponds
Water Quality Technical Report

INTRODUCTION

This technical report represents a summary of the data collected over a ten year period from 1985-1994 in the salt ponds of southern Rhode Island (Figure 1). It also incorporates data on well and stream monitoring conducted in 1980 by the University of Rhode Island (URI) Graduate School of Oceanography and in 1995 by Laura Ernst, as part of her Master's thesis in the URI Marine Affairs Department, rainfall data from the URI Plant Sciences Department, College of Resource Development, Kingston RI and groundwater data from the U.S. Geological Survey.

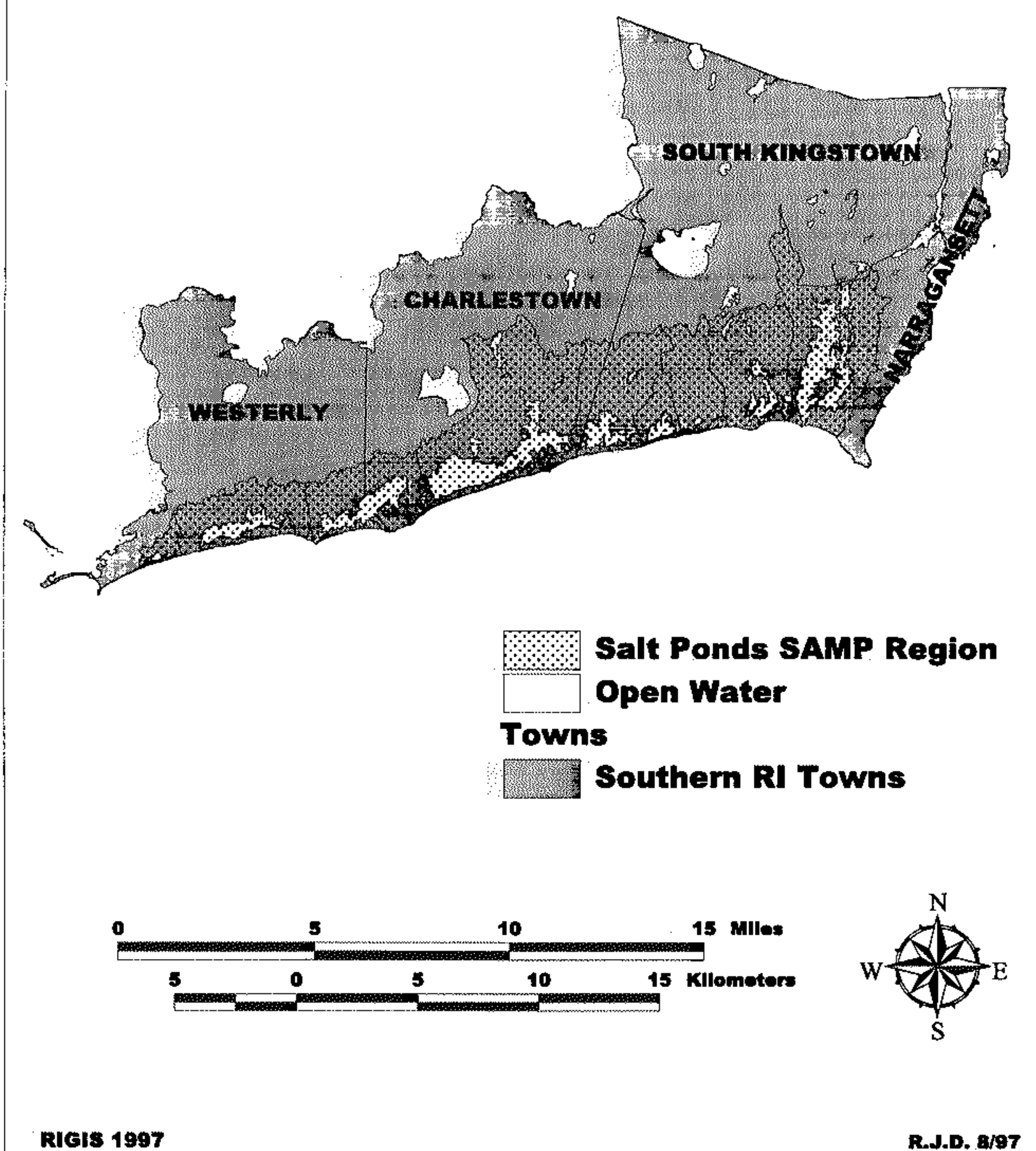
The coastal lagoons of southern Rhode Island locally known as salt ponds, vary in size from 40 acres to over 1700 acres (Table 1). Because the salt ponds are relatively shallow, sunlight reaches the bottom where seagrass beds, seaweeds, and microscopic aquatic plants can grow, creating highly productive estuarine systems. The salt ponds provide critical nursery areas for fin and shellfish, including nearshore flounder, and they provide important resting spots for migratory birds along the Atlantic flyway. They play an important role in the cycling of land based sources of nutrients and the movement of sediments along the barrier beach system. Some of the salt ponds are connected to Block Island Sound (Figure 1) through permanent breachways or inlets through the barriers, providing enhanced ocean access for recreational boating and fishing. Overall, the salt ponds are a significant scenic and aesthetic resource, vital to the region's tourism economy and essential for the quality of life of local residents.

Table 1. Physical Characteristics of the Salt Ponds.

	Point Judith	Potter	Cards	Trustom	Green Hill	Ninigret	Quonochontag	Winnapaug	Machaug
Area (acres)	1530	329	43	160	431	1711	732	446	49
Avg. Depth (ft)	6	2	1.5	1.5	2.5	4	6	5	7
Avg. Salinity	29	27	4	5	19	24	29	28	7
Watershed Area (acres)	3536	3311	1820	794	3039	6025	2307	2294	347
Groundwater Vol. (m^3/yr)	$2.5x10^7$	$5.0x10^6$	$2.2x10^6$	$1.1x10^6$	$6.8x10^6$	$1.5x10^7$	*	*	*

The increasing suburban sprawl that began shortly after the Second World War became a public issue by the 1970s when local residents expressed their concerns

Salt Pond Region



about uncontrolled development and deteriorating conditions in the salt ponds. In 1979 a major five year multi-disciplinary research effort was launched with funding from the Rhode Island Sea Grant Program, the National Oceanic and Atmospheric Administration Office of Coastal Zone Management, the Environmental Protection Agency, and the local towns. The salt pond project was designed to clarify many of the major issues and natural processes that are characteristic of the salt ponds, including impacts to the habitat and water quality from nitrogen and bacterial contamination. Volunteer pond watchers contributed to many aspects of the research project by keeping waterfowl counts and taking field measurements that helped define the nature of the water quality as well as the recreational fishery problems. A Special Area Management Plan (SAMP) for the Salt Pond Region was adopted in 1984, updated in 1997, and is being implemented by the Rhode Island Coastal Resources Management Council (CMRC). The SAMP is a watershed based management tool which among other things, depends on land use regulations, nitrogen removal technologies, vegetated buffer management and nonpoint source controls to maintain and restore water quality.

The Salt Pond Watchers

Volunteers, known as the "Salt Pond Watchers" began an annual monitoring program in 1985 with funding from the Rhode Island Sea Grant Program under the direction of Virginia Lee of the URI Coastal Resources Center. As stewards of the salt ponds, the Salt Pond Watchers are invaluable. Their long-term inventory is a basis for understanding the changes in the ecology and the cumulative impacts of development on the coastal ecosystem. The Salt Pond Watchers also help to gauge the success of the SAMP in managing water quality in the salt ponds.

The salt pond watchers (Table 2) are local community members, from all walks of life who are trained, field tested, and laboratory checked at the URI Graduate School of Oceanography. Twenty-three volunteers started out in 1985 monitoring 22 bacteria and water chemistry stations every other week, from May through October, in seven of the south shore salt ponds. By 1989 they had expanded to include the entire region, and a program was started in the Great Salt Pond on Block Island in 1990. By 1987 there were 33 Salt Pond Watchers monitoring 67 bacteria and 29 water chemistry stations. Today there are 14 volunteers and 37 bacteria stations. The Salt Pond Watchers made weather observations, measured depth, water temperature, rainfall, salinity, turbidity (secchi disk), dissolved oxygen, collected samples for analysis of coliform bacteria (total and fecal), nutrients (nitrates and phosphates), phytoplankton (chlorophyll a), and eelgrass wasting disease. The Salt Pond Watcher data has been incorporated into the Rhode Island State of the State's waters and biannual reports to the Environmental Protection Agency. It is also provides a basis for revising the state's construction standards for on-site sewage disposal systems. Today the towns are using the data to develop policies for wastewater management districts designed to decrease nonpoint source pollution loads.

Table 2. Salt Pond Watchers, 1985 - 1997.

Henry Van Ackerman	Bill Henry	Pete Schipper
James Allen	Ellie Heyder	Eric Schoonover
Don Allyn	Charles Hickox	Ben Spector
Craig Anthony	Harry Holland	Everett St. George
John Baer	Galen Howard	Nick Starinovich
Bob Ballou	Ed Hunter	Elaine Stedman
Donn Barclay	Bart Hurley	Alan Stedman
George Biesel	Jay Kamm	C. Strickland
Chris Blansfield	Bill Kilcup	Alain Sweeney
Zena Bliss	Barbara Kilcup	Jack Tobin
Ed Bliven	Anne Kimball	Ross Toney
Ken Boll	Ernie Kingman	Ned Tuttle
Jack Bradley	J. Krukowski	Lou Valois
John Brotherhood	Karl Kurth	Mike VanVranken
Miriam Brennan	Faith Labossier	Vincent Vigna
Gilbert Burdick	John Lamb	George Vinal
Philip Carpenter	Laura Lamb	Walter Wall
Judy Chappell	John Lanik	Nancy Wetherell
V. Chappell	Lars Larson	Robert Wetherell
Kathleen Connelly	Virginia Larson	Mark Winslow
Christopher Damon	Roger Laughlan	Dick Wood
Steve DeMetrick	S. Lea	
Tim Dillingham	Van Lee	
Bea Doyle	Frank LeVasseur	
Ray Dowd	Chris Littlefield	
Ruth Emers	Bessie McGonagle	
Bill Eschenfelder	Dave Monk	
Lynn Faireweather	Cy Morgan	
Brian Fortz	William Morton	
Roger Freeman	Sue Nardone	
Ibby Freeman	Joan Nelson	
Brian Fritz	Bill Orme	
Jeff Gardner	Earle Perkins	
Marge Gaunt	Ray Phelan	
Jeff Gledhil	Joe Picano	
George Griffin	Merridith Platt	
Clem Griscom	Robert Pratt	
John Haden	Margie Pratt	
Al Hale	Anne Preuss	
Dorothy Hausmann	John Rahm	
Henry Hausmann	Fay Rand	
Steve Haydock	Toni Salisbury	
Lang Hemenway	Vic Samoles	

MONITORING METHODS

The Salt Pond Watcher volunteers were required to attend training sessions as part of their introduction to water quality sampling. The Field Sampling Manual, Laboratory Protocol Manual and Data Management Protocol developed by URI for the salt pond volunteers are enclosed in Appendix A. A series of graduate students acted as coordinators, trainers and data analyzers for the volunteers.

As part of the monitoring program, chlorophyll measurements are made by filtrating water through a fine filter and then wrapping and freezing the filter until it is read; water clarity measurements are taken by secchi disk from a boat or off a dock; water temperature is read from a laboratory calibrated thermometer suspended 6 inches below the water surface for at least two minutes; nutrient samples are taken through tubing attached to a syringe from 10" below the water surface, and filtered into 50ml bottles, then frozen for analysis at the URI Graduate School of Oceanography; dissolved oxygen measurements are made using a Lamotte kit with which the volunteers perform their own titrations and report them on field sheets; eelgrass wasting disease is monitored using Dr. Fred Short's index: volunteers monitor eelgrass once each growing season by collecting 10 plants near an existing sample station and an eelgrass bed, the plants are then measured for length, width, age, and the percentage of disease covering each leaf; bacteria samples are taken using sterile sample bottles and delivered to the laboratory for analysis within six hours of sampling.

Laboratory Methods

Nutrients and salinity are analyzed by technicians at Dr. Scott Nixon's laboratory at the URI Graduate School of Oceanography. Chlorophyll was analyzed by graduate students in Dr. Ted Durbin's laboratory at the URI Graduate School of Oceanography. Fecal coliform bacteria were analyzed in laboratories at the Rhode Island Department of Health and the Federal Food and Drug Administration laboratory at Quonset Point. Since 1996, bacteria samples have been analyzed at the URI Microbiology Laboratory located on the Kingston Campus by graduate students from the department. Bacteria samples are collected every two weeks from May to October and kept cool until processing which occurs within six hours of collection to assure sample integrity. Medium is prepared before the samples are collected and placed into test tubes. Another, smaller glass tube is inverted into the medium filled test tube and used to trap the CO_2 emitted by the bacteria. Once filled the test tubes get capped and put into the air incubator at 35°C for 3 hours. Test tubes are placed in a water bath and when they are removed, the presence of gas bubble indicates a positive result. The most probable number of fecal bacteria are determined using a chart in the back of the laboratory protocol (Appendix A).

Sampling Schedules, Seasons and Locations

The Salt pond Watchers began monitoring water quality parameters in 1985 twice a month, from May through October. Since then the frequency of monitoring for most of the water quality parameters has remained constant, although the season has been extended during winter months for special projects such as constricted tidal circulation resulting from the 1987 bridge reconstruction over the inlet to Green Hill Pond. Sampling stations have also changed as data from initial samples indicated hot points for bacterial contamination and nutrients, particularly near the tributaries of the salt ponds, which had high concentrations of bacteria. As volunteers came and went, some stations went unsampled, and other stations were added or moved to accommodate requests from the Rhode Island Department of Environmental Management (DEM).

Some water quality monitoring stations and parameters have proven more reliable and consistent than others for a variety of reasons. The stations in the middle basins of the ponds have more constant readings of nitrogen, dissolved oxygen and water clarity because they are not as affected by the fluctuations in depth from tidal influence and runoff from storm events. Secchi disk measurements are not particularly useful to gauge water clarity in most areas of the ponds because they are so shallow (1-6 feet) and water clarity is good enough to see to the bottom. Bacteria measurements are taken in the tributaries flowing into the salt ponds, but nutrients have only been sampled by the URI as part of stream flux studies to determine total loadings to the salt ponds. Data on eelgrass loss and the presence of wasting disease was a special project for 1993.

SUMMARY

Salt Ponds

Bacteria

The streams and brooks measured by the Salt Pond Watchers indicate high levels of fecal bacteria flowing into several of the ponds: Green Hill Pond, northern Point Judith Pond, and the eastern basin of Ninigret Pond. Since waterfowl are a potential source of fecal bacteria, the Salt Pond Watchers record the presence of waterfowl at each sampling. During the summer season, when the bacteria concentrations are high, the numbers of waterfowl are low or they are not present. This information has been used by DEM to target individual sewage disposal systems as a source of pollution. Bacteria levels in the ponds spike after rainfall events. Fecal coliforms counts have been as high as 4600 MPNs in Green Hill Pond when daily rainfall measured .95 inches. Bacteria trends also indicate that some stations tend to have higher levels in the spring and summer, a special concern since that is when most of the recreational shellfishing effort occurs. Based on these data and their own surveys, DEM has closed upper Point Judith Pond, Green Hill Pond, and the eastern portions of Ninigret Pond to shellfishing.

Nitrogen

Nitrogen data from a winter survey in 1987 first indicated unusually high concentrations of nitrate and nitrite during the winter months as compared to other seasons. The data provided the first evidence of high nitrate loadings to one of the salt ponds resulting from nonpoint sources of pollution. Researchers had predicted the high winter concentrations in the initial multi-disciplinary study because tidal exchange restrictions cause Green Hill Pond to fill up with stream and groundwater flow and the high nutrient loadings they carry. In the spring and summer, nutrient levels are very low, even in ponds with high loadings, because aquatic plants, phytoplankton, algae and submerged grasses draw the available nutrients out of the water column into the plant tissue during their growing season.

Nitrate concentrations in the salt ponds increase corresponding to the number of houses per acre in the adjacent watershed (Figure 2). Because nitrogen is the nutrient most responsible for eutrophication of coastal waters, nitrogen concentrations were monitored by the Salt Pond Watchers.

Eelgrass

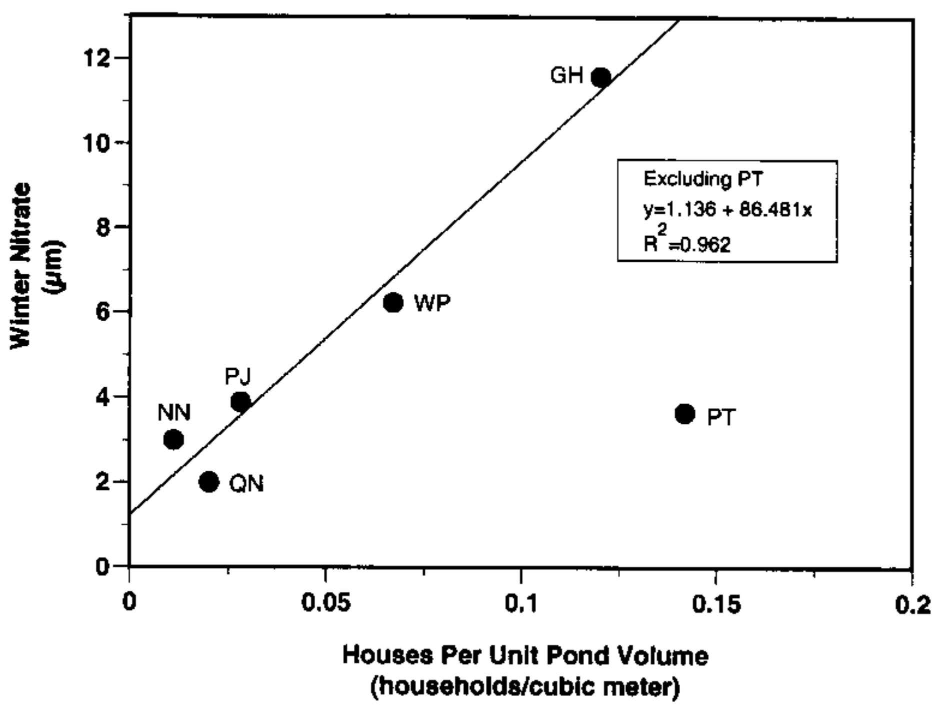
Data for eelgrass loss is sporadic across the ponds. Other researchers have assessed the extent of eelgrass over the years (Thorne-Miller et al. 1983, Short et al. 1996) and in Ninigret Pond a 41% decline between 1960 and 1992 was correlated to housing density increases.

Well and Stream Data

Well and stream data were collected in 1981 by Scott Nixon's laboratory at the URI Graduate School of Oceanography as part of the first salt ponds project to understand the amount of nitrogen loading into the salt ponds from groundwater, stream flow, the atmosphere and offshore. Homeowners in the salt pond watersheds were asked to participate in a sampling project and wells were sampled for nitrogen concentrations. Stream sampling was conducted in the Saugatucket River for Point Judith Pond, Cross Mills Stream for Ninigret Pond, and Teal Pond and Factory Pond Streams in Green Hill Pond. In 1994, some of the same wells and additional wells were sampled as part of a study of the cumulative and secondary impacts of development, wells and streams were sampled for concentrations of nitrate, ammonia, phosphate, and organic nitrogen and phosphate (Appendix B and C). Both well and stream samples were analyzed again at Dr. Scott Nixon's laboratory at the URI Graduate School of Oceanography and the data were used in the revised Salt Pond Region SAMP and the Master's thesis of Laura Ernst, URI Marine Affairs Department.

United States Geological Survey well data is also provided in Appendix B to show the changes in groundwater levels in the salt pond watersheds. Groundwater is the

Figure 2. Winter Nitrate Concentrations and Housing Density

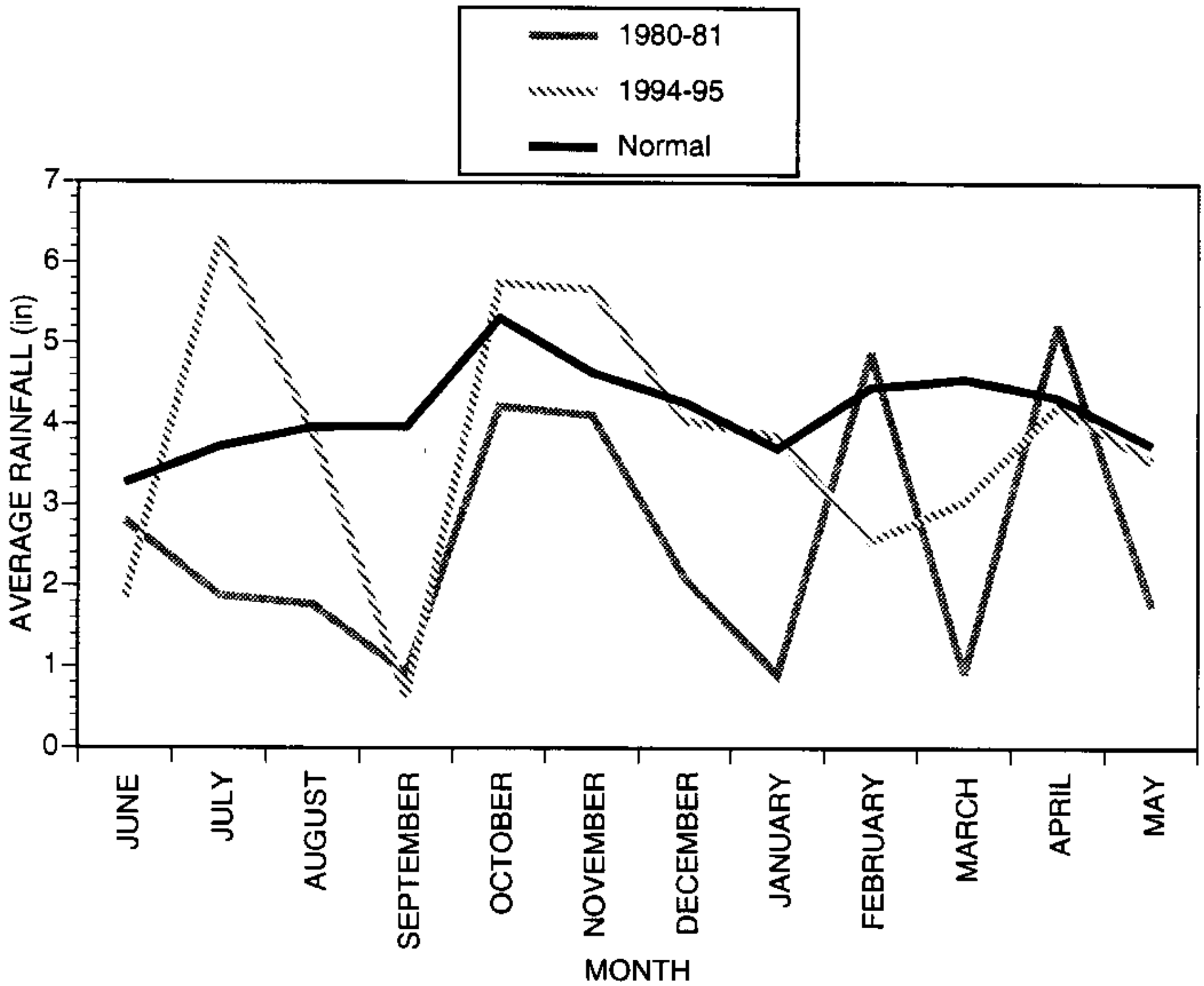


major source of freshwater to the salt ponds and variations in the amount of groundwater also impact the amount of nitrogen loading through groundwater to the salt ponds.

Rainfall

Rainfall data have also been used to estimate the amount of atmospheric deposition of nitrogen on the salt ponds and the amount of overland runoff to the salt ponds from impervious surfaces. Rainfall data are provided in Appendix D for 1985-1994 from the URI Plant Sciences Department at the College of Resource Development, Kingston, RI. Nitrogen concentrations in rainfall were measured by the URI Graduate School of Oceanography in 1981 (.49mg/l) (Nixon et al. 1982) and in 1990 (1.04mg/l) (Fraher 1991). The amount of rainfall to the salt ponds and their tributaries varies from year to year. Large variations in rainfall in the salt pond region as shown in Figure 3 for 1980-81, 1994-95 and the 30 year average rainfall (1961-1990) alters the nitrogen loading from the watershed to the salt ponds and their tributaries.

Figure 3. Rainfall data for 1980-81, 1994-95 and Normal (thirty year average for the period of 1961-1990), based on data from the URI Department of Plant Science, College of Resource Development.



The Salt Pond Watchers Coalition of Rhode Island has received much attention and undergone many changes since its inception in 1985. The volunteer water quality monitoring group has been written up in the Providence Journal, Yankee Magazine, numerous peered reviewed journals and periodicals. Because of the success of the Salt Pond Watchers, interest from the local, state, and federal level resulted in a national citizen monitoring symposium held at the University of Rhode Island in 1988. The Salt Pond Watchers were a model for beginning volunteer water quality monitoring groups all over the nation during the late 1980s. Today, the data they collect are used to make decisions about regulations and management measures which benefit the valuable resources of the salt ponds, and the local communities.

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