COMMONWEALTH OF MASSACHUSETTS

DUKES COUNTY, SS,

LAND COURT DEPARTMENT
CASE NO. 13 MISC 478175

CHARLES PARKER and VIRGINIA P. DAWSON, RICHARD W. REGAN, MANAGER OF THE REGEN FAMILY STORKS NEST LLC, DOUGLAS and ELIZABETH LIMAN, BARBARA GOLDMUNTZ (LIFE ESTATE), and BARBARA HUNTER FOSTER, TRUSTEE OF PACER II NOMINEE TRUST, Plaintiffs, vs. CHRIS MURPHY, FRANK LORUSSO, WENDY WELDON, RUSSELL MALONEY, ALLISON BURGER, TODD CHRISTY and ALLEN HEALY, as they are members of the Town of Chilmark Zoning Board of Appeals and the TOWN OF CHILMARK, acting by and through its Board of Selectmen, Defendants.	APPENDIX TO DEFENDANTS' RESPONSE TO PLAINTIFFS' CONCISE STATEMENT OF MATERIAL FACTS AND STATEMENT OF ADDITIONAL FACTS

The defendants, Chris Murphy, Frank Lorusso, Wendy Weldon, Russell Maloney, Allison Burger, Todd Christy and Allen Healy, as they are members of the Town of Chilmark Zoning Board of Appeals (the "ZBA"), and the Town of Chilmark (the "Town"), acting by and through its Board of Selectmen (collectively, with the ZBA, the "municipal parties") hereby file this Appendix to their Response to Plaintiffs' Concise Statement of Material Facts and Statement of Additional Facts.

Exhibit A: Affidavit of Matthew E. Poole.

Exhibit B: Affidavit of Arthur G. Gaines, Jr.

Exhibit C: Affidavit of Charles Benbrook

CHRIS MURPHY, ET AL.

By their attorneys,

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Dated: November 21, 2013

4716-004\Appendix to Defs Concise State Facts.doc

CERTIFICATE OF SERVICE

I, Michael A. Goldsmith, hereby certify that I have this 21st day of November, 2013, caused a copy of the within Appendix to Defendants' Response to Plaintiffs' Concise Statement of Material Facts and Statement of Additional Facts, to be served on the plaintiffs, by mailing a copy of the same, first class mail, postage pre-paid, to:

Amy E. Kwesell, Esq.
Rubin & Rudman, LLP
50 Rowes Wharf
Boston, MA 02110

Michael A. Goldsmith

A

COMMONWEALTH OF MASSACHUSETTS

DUKES COUNTY, SS,

LAND COURT DEPARTMENT
CASE NO. 13 MISC 478175

CHARLES PARKER and VIRGINIA P. DAWSON, RICHARD W. REGAN, MANAGER OF THE REGEN FAMILY STORKS NEST LLC, DOUGLAS and ELIZABETH LIMAN, BARBARA GOLDMUNTZ (LIFE ESTATE), and BARBARA HUNTER FOSTER, TRUSTEE OF PACER II NOMINEE TRUST,

Plaintiffs,

vs.

CHRIS MURPHY, FRANK LORUSSO, WENDY WELDON, RUSSELL MALONEY, ALLISON BURGER, TODD CHRISTY and ALLEN HEALY, as they are members of the Town of Chilmark Zoning Board of Appeals and the TOWN OF CHILMARK, acting by and through its Board of Selectmen,

Defendants.

AFFIDAVIT OF MATTHEW E. POOLE

I, Matthew E. Poole, hereby state as follows:

1. I am presently an elected member of the Chilmark Board of Health. I also served as an elected member during a separate period from 1992 to 2007.

2. I am employed as the Board of Health Agent for the Town of Edgartown. I have held that position since 1997.

3. In both capacities, I am charged with reviewing and acting on permits for private drinking water wells, as well as enforcing, or supervising the enforcement of, any laws or regulations enacted to protect the safety of potable water obtained from private wells.

4. The Town of Chilmark does not have a public water supply. Accordingly, all residences, businesses, and governmental buildings obtain potable water from private wells. A permit from the Board of Health is required to install a well.

5. The Town of Chilmark also does not have a public sewer system. All wastewater generated by residences, businesses, and governmental buildings is treated by on-site septic systems. The Chilmark Board of Health is also the local approving authority for construction of and upgrades to on-site septic systems in the Town, and plans filed in connection with applications for new systems or upgrades are required to show drinking water wells within several hundred feet of the system.

6. I am familiar with the area in the Town of Chilmark known as Squibnocket Pond ("the Pond") where the plaintiffs in this matter are seeking to apply the herbicide commonly known as "Rodeo" in an effort to control the growth of phragmites. More specifically, and based on the Order of Conditions issued by the Chilmark Conservation Commission authorizing the plaintiffs' use of Rodeo, I understand that they wish to use Rodeo on the phragmites growing in or around the Pond on land identified on the Chilmark Assessors Map 35 as Lots 1.28, 21, 27, 32, 38 and 39.

7. Phragmites exist in numerous locations around the Pond other than on the plaintiffs' properties identified in the prior paragraph, and the phragmites on their properties comprise only a small percentage of the phragmites growing around the Pond.

8. I reviewed, or caused to be reviewed, the records and files of the Chilmark Board of Health regarding both wells and septic systems in the vicinity of the parcels of land identified in paragraph 6.

9. Based on that research, and by using the Assessors' Maps, I have determined that there are

approximately seventy-four (74) private wells within .5 miles of the parcels on which the plaintiffs seek authority to apply Rodeo to phragmites.

10. Portions of the phragmites growing around and on the borders of the Pond stand in its waters, which ebb and flow with the tide. Some of the plants standing in the water are likely to become fully submerged at high tide.

11. According to the United States Census Bureau, the Town has a total area of 100.4 square miles of which 19.1 square miles is land and 81.3 square miles is water. According to studies by the Martha's Vineyard Commission, the Pond is 603 acres in area, which is approximately .95 square miles. Approximately half of Squibnocket Pond is located in the Town of Aquinnah. The Pond and the surrounding area in the Squibnocket Overlay District, therefore, encompasses approximately one percent (1%) of the Town's total area.

12. According to the website of the Executive Office of Environmental Affairs, the Commonwealth's Pesticide Program is a part of the Division of Crop & Pest Services of the Department of Agricultural Resources, which carries out the day to day responsibilities of regulating pesticides in the Commonwealth of Massachusetts. The Pesticide Program also acts as support staff for the Pesticide Board and Pesticide Board Subcommittee, and retains information on the proper use of all registered pesticides.

13. The Pesticide Program contains a link, http://www.mass.gov/eea/docs/agr/pesticides/aquatic/glyphosate.pdf, for information concerning the use of Glyphosate, the active ingredient in "Rodeo". A copy of the Appendix on Glyphosate found at that link is attached hereto as Exhibit "A".

14. The summary section of the Pesticide Program's criteria and information on Glyphosate provides that "[i]t is not applied to submersed or mostly submersed vegetation. . . . [and] there are restrictions on the application of glyphosate within 0.5 mile upstream of potable water intakes . . . . (Monsanto, 1990)."

15. The current specimen label for "Rodeo" (attached hereto as Exhibit "B") contains the following information for the use of Rodeo in "Aquatic and Other Noncrop Sites":

> "**Rodeo does not control plants which are completely submerged or have a majority of their foliage under water.**" (at page 5); and

> "**NOTE:** Do not apply this product directly to water within ½ mile upstream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within ½ mile of an active potable water intake in a standing body of water such as lake, pond, reservoir. . . ." (at page 6).

Signed under the pains and penalties of perjury.

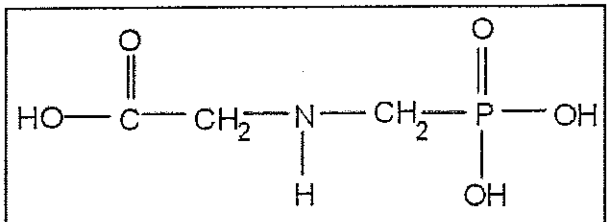
Matthew E. Poole

Dated: November 20, 2013

4716-004/Poole Affidavit Final.doc

EXHIBIT A

III.4 GLYPHOSATE



GLYPHOSATE

SUMMARY

Glyphosate ((N-phosphonomethyl)glycine) is a broad-spectrum herbicide used to control emersed aquatic grasses, broadleaf weeds and brush. It is not applied to submersed or mostly submersed vegetation. Glyphosate is not subject to hydrolysis or photolysis and is not expected to degrade by either route. It is not volatile. In natural waters, glyphosate dissipates in about 1.5-14 days. Breakdown of glyphosate in the aquatic environment occurs mostly through microbial degradation. Glyphosate is also rapidly inactivated by adsorption to soil. Its tendency to bioconcentrate in fish is very low. There are no restrictions on the use of glyphosate-treated water for irrigation, recreation, or domestic purposes. However, there are restrictions on the application of glyphosate within 0.5 mile upstream of potable water intakes and on the retreatment of an area within 24 hours (Monsanto, 1990). Available information indicates that glyphosate is of relatively low toxicity to mammals and aquatic organisms.

The Environmental Protection Agency (EPA) first registered glyphosate for use in 1974. The glyphosate registration was reviewed under EPA 1988 amendments to FIFRA (Federal Insecticide, Fungicide and Rodenticide Act). In 1993, the EPA issued a Reregistration Eligibility Decision (RED) on glyphosate along with a large number of products containing glyphosate as an active ingredient (USEPA, 1994).

REGISTERED PRODUCTS IN MASSACHUSETTS

The current list of aquatic herbicides containing glyphosate that are registered in Massachusetts can be accessed at http://www.state.ma.us/dfa/pesticides/water/Aquatic/Herbicides.htm on the Massachusetts Department of Agricultural Resources (DAR) Aquatic Pesticide Website. The DAR updates this list regularly with changes. In addition, the DAR can be contacted directly at (617) 626-1700 for more specific questions regarding these products.

GLYPHOSATE USES AND APPLICATION

Glyphosate can be used to control emergent aquatic weeds in freshwater lakes, ponds, reservoirs, canals, rivers, estuaries, seeps, irrigation and drainage ditches, wastewater treatment facilities and wildlife habitat restoration and management areas (McLaren/Hart, 1995).

Application of glyphosate may be made using a variety of methods. Broadcast sprays (either ground-rig or aerial) can be used for broad spectrum control over large areas. Handgun and backpack sprayers can be used for more localized application of the herbicide when the spray needs to be targeted away from desirable species. Wiper trunk injection, cut stem/cut stump and tree injection techniques can also be used for more localized control. The more selective methods are only practical for treating relatively small areas (McLaren/Hart, 1995).

The most effective time of application for most perennial and rhizome-bearing species (cattails, phragmites, etc.) is after the plant enters the reproductive stages of growth (ie., generally late August to October) (Kantrud, 1992 as cited in McLaren/Hart, 1995). In general, application should be made in times of low stress (e.g., drought, disease, nutrient depletion, infestation, etc.) and maximum translocation.

Glyphosate is effective for use on floating and emergent aquatic plants but not on submerged aquatic plants because it is diluted below an effective concentration in the treated water. In floating weeds, the effectiveness is reduced if wave action washes the product off before it can penetrate plant foliage (McLaren/Hart, 1995).

The application rate of glyphosate varies depending on the target species, the application method and the specific formulation used. The maximum rates are used for the most resistant target species or for high target weed infestations. Product labels should be consulted for recommended application rates and use restrictions (e.g., not to apply within specified distance from potable water sources).

The addition of a non-ionic surfactant is recommended to promote adhesion, spreading and penetration of the spray droplets through the plant cuticle on the leaves and to maximize absorption and effectiveness of treatment (WSDOE, 1992).

For specific information on recommended application rates for a particular product, the product label should be consulted. The USEPA Office of Pesticide Programs (OPP) has a link to a database of product pesticide labels at http://www.epa.gov/pesticides/pestlabels/.

MECHANISM OF ACTION

Glyphosate penetrates the plant leaf cuticle shortly after contact and begins a cell by cell migration to the phloem, from which it is transported throughout the plants. The herbicidal action usually occurs within 7 days and up to 30 for woody plants (McLaren/Hart, 1995; Monsanto, 1990.)

Glyphosate's primary herbicidal mode of action is to block the synthesis of aromatic amino acids and the metabolism of phenolic compounds by disrupting the plant's shikimic acid metabolic pathway, leading to the inability of the plant to synthesize protein and produce new plant tissue. This is the only herbicide known to interfere with this particular pathway (McLaren/Hart, 1995). A secondary mode of action affects the photosynthetic process, synthesis, respiration and synthesis of nucleic acids by interacting with a complex series of enzymes which control synthesis of important molecules such as chlorophyll. The results of these interactions are a decrease in the rate of photosynthesis, an increase in respiration rate and a series of cellular changes (i.e., formation of granular bodies, deterioration of oil bodies, the endoplasmic reticulum and ribosomes and the vacuolation of the cytoplasm) leading to death (McLaren/Hart, 1995).

Table III.4-1. List of Aquatic Plants Controlled by Glyphosate

Alder	*Alnus* spp.
Ash	*Fraxinus* spp.
Barnyardgrass	*Echinochloa crus-galli*
Birch	*Betula* spp.
Cattail	*Typha* spp.
Cordgrass	*Spartina* spp.
Dogwood	*Cornus* spp.
Elder	*Sambucus* spp.
Elm	*Ulmus* spp.
Flatsedge, Chufa	*Cyperus esculentus*
Fleabane	*Erigeron* spp.
Foxtail	*Setaria* spp.
Foxtail, Carolina	*Alopecurus carolinianus*
Hemlock, Poison	*Conium maculatum*
Honeysuckle	*Lonicera* spp.
Hornbeam, American	*Caprinus caroliniana*
Lettuce, prickly	*Lactuca serriola*
Maple, red	*Acer rubrum*
Milkweed	*Asclepias* spp.
Monkey-flower, Common	*Mimulus guttatus*
Nutgrass	*Cyperus rotundus*
Oak, pin	*Ouercus palustris*
Panicum	*Panicum* spp.
Phragmites	*Phragmites* spp.
Poison Ivy	*Rhus radicans*
Poplar	*Populus* spp.
Purple Loosestrife	*Lythrum salicaria*
Salt cedar	*Tamarix* spp.
Saltbush, sea myrtle	*Baccharis halimifolia*
Smartweed, Pennsylvania	*Polygonium pennsylvanicum*
Smartweed, swamp	*Polygonum coccineum*
Spikerush	*Eleocharis* spp.
Sumac, poison	*Rhus vernix*
Sycamore	*Platanus occidentalis*
Tules, common	*Scirpus acutus*
Willow	*Salix* spp.
Waterhyacinth	*Eichornia crassipes*
Water-lettuce	*Pistia stratiotes*

McLaren/Hart, 1995

ENVIRONMENTAL FATE/TRANSPORT

The major fate process affecting glyphosate persistence in aquatic environments is biodegradation. Microorganisms in soil, water and sediment biodegrade glyphosate under both aerobic and anaerobic conditions (Reinert and Rodgers, 1987; McLaren/Hart, 1995). The main biodegradation product in soil and sediments is aminomethylphosphonic acid (AMPA). Other minor metabolites, including Nmethylaminomethylphosphonic acid, N,N-dimethylaminomethylphosphonic acid, hydroxymethylphosphonic acid and two unidentified metabolites. Residue levels of glyphosate and AMPA in the aquatic environment are low and dissipate rapidly over time (McLaren/Hart, 1995).

Absorption to sediment is another major contributor to the aquatic dissipation of glyphosate. The average half-life of glyphosate in soil is 60 days. In natural waters, dissipation half-lives of glyphosate range from 1.5-14 days. The dissipation half-life of glyphosate in waters not associated with sediments is much longer, (i.e., 7-10 weeks). In the presence of sediments, under either aerobic or anaerobic conditions, dissipation half-lives for glyphosate range from 6.5-21 days (McLaren/Hart, 1995; WSDOE, 1992; Reinert and Rodgers, 1987).

Glyphosate is an acid and bonds to soil with ionic interactions. It has a negligible vapor pressure and is nonvolatile. Glyphosate contains no photolyzable or hydrolyzable groups and is not expected to degrade in these ways (WSSA, 1983 as cited in Reinert and Rodgers, 1987).

The bioconcentration factor (BCF) for glyphosate in fish is low (Westerdahl and Getsinger, 1988 as cited in WSDOE, 1992). Glyphosate residuals are not typically found in fish because there is no affinity between the glyphosate molecule and (the typically lipophilic) fish tissue. Any glyphosate will pass unchanged through the mouth or gills of the fish, remaining either in solution or adsorbed to suspended particulates (McLaren/Hart, 1995). Exposure of experimental fish for 10-14 days to glyphosate concentrations 3 to 4 times the recommended levels resulted in BCF values of 0.2-0.3, which are considered insignificant (Brandt, 1984 as cited in WSDOE, 1992). Information submitted by the manufacturer of this compound also supports the finding of BCF values no higher than 0.3 (Monsanto, 1990 as cited in McLaren/Hart, 1995).

PHARMACOKINETICS

Rat studies indicate that oral doses of glyphosate are rapidly but poorly absorbed by rats, with female rats absorbing more than males (McLaren/Hart, 1995; USEPA, 1992). The glyphosate that is absorbed is rapidly excreted as unmetabolized glyphosate, with 90% of the absorbed dose being excreted within 48 hours (McLaren/Hart, 1995). Peak levels of glyphosate in the blood and bone marrow of rats dosed intraperitoneally occurred within 30 minutes. The concentration of glyphosate in blood had a half-life of one hour but remained relatively constant in bone marrow, with a half-life of 7.6 hours for males and 4.2 hours for females. Following intravenous doses of glyphosate administered to mice, 30-36% of the compound was eliminated unchanged in the urine and the rest in the feces. Traces (0.04%) of aminomethylphosphonic acid (AMPA) were found to be the only metabolites in the feces. Studies conducted with glyphosate administered in feed to chickens, cows and swine suggest that glyphosate does not accumulate in animal tissues during periods of oral exposure (USEPA, 1992). A series of residue and metabolism studies have shown that glyphosate is poorly absorbed across the gastrointestinal tract and there is minimal tissue retention and rapid elimination of residues in birds and fish in addition to mammals (Monsanto, 1993).

HEALTH EFFECTS

Avian:

A number of acute toxicity studies of technical grade glyphosate were conducted on ducks and quail Five-day LC50 values were >3,850 mg/l for each or, practically nontoxic (Monsanto, 1988 and USEPA, 1986 as cited in WSDOE, 1992; AQUIRE, 1995).

Mammalian:

Acute:

There is very little information in the published literature on the acute toxic health effects of glyphosate. Glyphosate has very low mammalian acute oral or dermal toxicity (McLaren/Hart, 1995). Acute toxicity studies for a commercial formulation of glyphosate have produced oral LD50 values for Rodeo of 4,873 and 5,600 mg/kg in rats and 1,568 mg/kg in mice (USEPA, 1992). A dermal LD50 value of greater than 5,000 mg/kg (i.e., practically nontoxic) was reported for rabbits (USEPA, 1992). For technical glyphosate, an oral LD50 in the rat and a dermal LD50 in the rabbit were found to be greater than 5,000 mg/kg. The most prominent effect following glyphosate poisoning was reported to be hyperemia (i.e., an excess of blood) of the lungs, with severe stress, accelerated breathing, elevated temperature, occasional convulsive movements and rigor preceding death. A commercial formulation of glyphosate was found to be practically nonirritating to rabbit eye and skin whereas technical glyphosate was severely irritating to rabbit eye but practically nonirritating to rabbit skin (McLaren/Hart, 1995). Glyphosate was found to be a cumulative irritant in guinea pigs (USEPA, 1992). The EPA concluded that glyphosate is slightly irritating to skin and is not a dermal sensitizer (USEPA, 1993a).

Subchronic/Chronic:

Results of subchronic and chronic laboratory studies also indicate that glyphosate is not very toxic. In 90-day feeding studies conducted with rats at doses up to 1,000 mg/kg, no changes as compared with controls in body weight, behavior, mortality, hematology, blood chemistry, or urinalysis were noted. In dogs administered up to 60 mg/kg, a similar lack of changes was noted (USEPA, 1992). A 26-month chronic feeding study in which rats were administered doses of up to 31.5 mg/kg/day (males) and 34 mg/kg/day (females) produced no significant effects on body weight, organ weight, organ/body weight ratios or hematologic and clinical chemistry parameters (USEPA, 1992). In a 24-month chronic study in which rats were administered glyphosate at 2,000, 8,000 and 20,000 ppm for 24 months, a significant decrease in body weight in high-dose females was noted. The No Observed Adverse Effect Level (NOAEL) for glyphosate in this study is 8,000 ppm (McLaren/Hart, 1995). In a one-year dog feeding study, there was an apparent decrease in absolute and relative pituitary weights with no accompanying histopathologic changes. A NOAEL of greater than 500 was reported from this study (Monsanto, 1985 as cited in USEPA, 1992).

Developmental/Reproductive:

In a three generation reproductive study in which male and female rats were administered dietary concentrations of glyphosate corresponding to 0, 3, 10 and 30 mg/kg/day, there were no treatment-related systemic or reproductive effects noted in adults. One group of third generation male pups whose parents were exposed to the highest dose (30 mg/kg/day) showed an increase in the incidence of unilateral renal tubular dilation. The No Observed Adverse Effect Level (NOAEL) for glyphosate in this study is 10 mg/kg/day and the Low Observed Adverse Effect Level (LOAEL) is 30 mg/kg/day (Bio/dynamics, Inc., 1981a as cited in USEPA, 1992). In a subsequent two-generation reproductive study in rats, rats were administered glyphosate in the diet at levels up to 30,000 ppm (about 1,500 mg/kg/day). The only effects noted were very frequent soft stools in the F_0 and F_1 males and females, decreased food consumption and body weight gain of the F_0 and F_1 males and females during the growth (premating) period and decreased body weight gain of the F_{1a}, F_{2a} and F_{2b} male and female pups during the second and third weeks of lactation. Focal tubular dilation of the kidneys, observed in the previous study, was not observed in this study at any level. As a result, the EPA concluded that the presence of this effect in the three-generation study was a spurious rather than glyphosate-related effect (USEPA, 1993a). Rabbits treated with 350 mg/kg/day during days 6-27 of gestation produced signs of maternal toxicity but did not exhibit developmental toxicity.

Mutagenicity:

Glyphosate was not found to be mutagenic in eight strains of bacteria and yeast evaluated in microbial test systems and in Chinese hamster ovary cells (USEPA, 1988; USEPA, 1993b). In addition, glyphosate also produced negative results for chromosomal aberrations in mouse dominant lethal test, the *in vivo* cytogenetics assay, the *Bacillus subtilis* rec assay and in the rat hepatocyte DNA repair assay. High concentrations of glyphosate have produced sister chromatid exchange in human lymphocytes *in vitro* (USEPA, 1992). However, the information from this study has been shown to be possibly erroneous (Slapikoff, 1983; Brusick, 1983).

Carcinogenicity:

No clear-cut dose-response relationship has been established between glyphosate exposure and tumor formation. In one study, male and female rats were administered glyphosate in the diet at doses up to 31.5 and 34.0 mg/kg/day, respectively, for 26 months. No increase in tumor formation was noted (Bio/dynamics, Inc., 1981b as cited in USEPA, 1992). In a 24-month chronic feeding study in mice exposed to levels up to 30,000 ppm glyphosate, no excess of tumors was noted. However, the EPA has classified this study as a chronic toxicity study rather than a cancer study because the study does not meet the specific guidelines for a cancer study established by EPA (USEPA, 1986 as cited in USEPA, 1992). Another cancer study, in which rats were fed glyphosate at concentrations of 2,000, 8,000 and 20,000 ppm for 24 months revealed an increased incidence of adenomas (i.e., benign tumors) of the pancreas, thyroid and liver. Although no dose-response relationship was established and the tumors did not progress from adenomas to carcinomas (malignant tumors), the EPA has recommended that the carcinogenic effects of glyphosate be addressed by a peer review committee (USEPA, 1992). In an 18-month carcinogenicity study, mice were fed diets containing 1, 150, 750 or 4500 mg/kg/day of glyphosate. No effects were observed in the low and mid-dose groups. Effects noted in the high-dose group included decreased body weight gain in males and females, various liver and kidney effects as well as slightly increased incidence of renal tubular adenomas, a rare tumor, in males. The EPA concluded that occurrence of these adenomas was spontaneous rather than compound-induced because the incidence of renal tubular adenomas in males was not statistically significant when compared with the concurrent controls. After extensive evaluation, an independent group of pathologists and biometricians concurred with this conclusion. Therefore, glyphosate was not considered to be carcinogenic in this study.

In 1988, an EPA Science Advisory Panel labeled glyphosate as a D carcinogen under the old EPA cancer classification system, indicating that it is "not classifiable as to human carcinogenicity" based on a lack of statistical significance and uncertainty as to a treatment-related effect (Doyle, 1996; USEPA, 1993b). Under the new EPA cancer classification system using descriptors, a designation of D corresponds to the descriptor, "Data are inadequate for an assessment of human carcinogenic potential". On June 26, 1991, the EPA Office of Pesticide Programs (OPP) labeled glyphosate an E carcinogen (again, based on the old EPA cancer classification system) based on a lack of convincing evidence of carcinogenicity in adequate studies with two animal species, rat and mouse. An E classification is EPA's most favorable category and is given to compounds for which there is "evidence of noncarcinogenicity in humans" (McLaren/Hart, 1995). The EPA Integrated Risk Information System (IRIS) database still lists the 1988 D cancer classification. However, the most recent EPA classification is the OPP 1991 designation of E. Under the new EPA cancer classification system, a designation of E corresponds to the descriptor, "not likely to be carcinogenic to humans".

Available Toxicity Criteria:

The EPA has developed several Drinking Water Health Advisories for glyphosate. Health Advisories are defined as concentrations of a substance in drinking water estimated to have negligible deleterious effects in humans, when ingested for a specified period of time. These values include a ten-day health advisory for a child of 20 mg/l as well as a lifetime health advisory of 1 mg/l for a child and 4 mg/l for a 70-kg adult (USEPA, 1988).

The EPA has also developed a Maximum Contaminant Level Goal (MCLG) for drinking water and has promulgated this value as a Maximum Contaminant Level (MCL) standard (USEPA, 1993b; USEPA, 1995). Massachusetts has adopted this value as a drinking water standard, known as a Massachusetts Maximum Contaminant Level (MMCL).

In addition, the EPA Carcinogen Risk Assessment Verification Endeavor (CRAVE) RfD/RfC workgroup has developed an oral Reference Dose (RfD) of 0.1 mg/kg/day for glyphosate based on the three-generation rat reproduction study conducted by Monsanto cited earlier. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 1993b). The EPA Office of Pesticide Programs (OPP) has developed an RfD of 2.0 mg/kg/day. The World Health Organization (WHO) has developed an RfD of 1.75 mg/kg/day (USEPA, 1995b).

ECOLOGICAL TOXICITY

Aquatic Organisms:

Glyphosate has very low toxicity in aquatic fish and invertebrates. A range of 96-hr LC50 values identified for fish exposed to a formulation of glyphosate were reported to be greater than 1,000 mg/l for a number of species including carp, rainbow trout, bluegill, sunfish and harlequin fish (WSDOE, 1992 as cited in McLaren/Hart, 1995). Another source cites an LC50 greater than 10,000 mg/l for carp. Values over 1,000 mg/l are considered an insignificant hazard (Christensen, 1976 as cited in McLaren/Hart, 1995). Reported 96-hour LC50s for technical grade glyphosate include values ranging from 86 mg/l for rainbow trout to 168 mg/l for harlequin fish. Reported LC50s for technical glyphosate for other invertebrate species include values ranging from >10 mg/l for American oyster larvae to 934 mg/l for a fiddler crab, with the LC50s for *Daphnia magna*, honeybee, shrimp and *Chironomus plumosus* falling in between (WSDOE, 1992; McKee, pers. comm., 1996). A value greater than 10 is considered only slightly toxic (Christensen, 1976 as cited in McLaren/Hart, 1995). The EPA AQUIRE database lists reported LC50s for unspecified forms of "glyphosate" ranging from a 4-hr LC50 value of 1.3 mg/l for rainbow trout to a 4-hr LC50 value of 25,605 mg/l for goldfish (EPA, 1995).

Plants:

Since glyphosate is a broad spectrum herbicide, it is effective on a large number of annual and perennial grasses, broadleaf weeds, sedges, rushes and woody plants as well as ditchbank or shoreline aquatic weeds. Glyphosate is not effective on plants that are completely submerged or which have most of their foliage under water (Monsanto, 1981 as cited in WSDOE, 1992). Because of its widespread effects, glyphosate may affect non-target plants. As with all herbicides, use of glyphosate should be coordinated as part of an overall management plan to control vegetation in an organized manner. Such a plan is particularly important when the objective is the control of large areas of vegetation such as phragmites, cattails or purple loosestrife due to the potential for simultaneous die-off. This die-off could result in oxygen depletion due to rapid decomposition of organic matter, resulting in widespread nonspecific destruction of plant life in addition to fish kills and the proliferation of microfauna and flora which are harmful to waterfowl (WSDOE, 1992 as cited in McLaren/Hart, 1995).

Table III.4-2. Properties of Glyphosate

CAS #:	1071-83-6
Synonyms	isopropylamine salt; n-(phosphonomethyl)glycine
Molecular formula	$C_3H_8NO_5P$
Molecular weight	169.1
Physical properties	solid, white, odorless
Melting point	200°C
Density	0.5 gm/cc for pure chemical
Vapor pressure	negligible
Photolysis half-life	stable
Hydrolysis half-life	stable
Biodegradation half-life	60 days (soil)
Dissipation half-life	1.5-14 days
K_{ow}	5.6×10^{-4}
K_{oc}	High
BCF	Low
Water Solubility	1.2×10^{4}

(WSSA, 1983; Aquatic Plant Identification and Herbicide Use Guide, 1988)

Glyphosate References

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EXHIBIT B

Specimen Label

Dow AgroSciences

Rodeo®

Herbicide

For aquatic weed and brush control. For control of annual and perennial weeds and woody plants in and around aquatic and other noncrop sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression.

Avoid contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees, because severe injury or destruction may result.

Active Ingredient(s):	
glyphosate†: N-(phosphonomethyl)glycine, isopropylamine salt	53.8%
Inert Ingredients	46.2%
Total Ingredients	100.0%

†Contains 5.4 pounds per gallon glyphosate, isopropylamine salt (4 pounds per gallon glyphosate acid).

EPA Reg. No. 62719-324

Keep Out of Reach of Children

CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Harmful If Inhaled

Avoid breathing spray mist. Remove contaminated clothing and wash before reuse. Wash thoroughly with soap and water after handling.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks.

Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid

If Inhaled: Remove individual to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

Environmental Hazards

Do not contaminate water when disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of leak or spill, soak up and remove to a landfill.

Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

Do not mix, store or apply this product or spray solutions of this product in galvanized steel or unlined steel (except stainless steel) containers or spray tanks. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas, which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

Notice: Read the entire label. Use only according to label directions. **Before buying or using this product, read "Warranty Disclaimer" and "Limitation of Remedies" elsewhere on this label.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

This is an end-use product. Dow AgroSciences does not intend and has not registered it for reformulation. See individual container label for repackaging limitations.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical resistant gloves made of any waterproof material
- Shoes plus socks

Storage and Disposal

Do not contaminate water, food, feed or seed by storage or disposal.
Storage: Store above 10°F (-12°C) to keep product from crystallizing. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using.
Pesticide Disposal: Wastes resulting from use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state or local procedures.
Container Disposal: Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed. Do not reuse this container. Triple rinse (or equivalent). Then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

General Information
(How this product works)

This product herbicide is a water-soluble liquid which mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants. Rodeo is intended for control of annual and perennial weeds and woody plants in and around aquatic and other noncrop sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression.

The active ingredient in Rodeo moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days, 7 days or more on most perennial weeds, and 30 days or more on most woody plants. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects include gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of Rodeo and surfactant within the recommended range when vegetation is heavy or dense.

Do not treat weeds, brush or trees under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced control of target vegetation may also occur if foliage is heavily covered with dust at the time of treatment.

Reduced control may result when applications are made to woody plants or weeds following site disturbance or plant top growth removal from grazing, mowing, logging or mechanical brush control. For best results, delay treatment of such areas until resprouting and foliar growth has restored the target vegetation to the recommended stage of growth for optimum herbicidal exposure and control.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may wash the product off the foliage and a repeat treatment may be required.

Rodeo does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

ATTENTION: Avoid drift. Extreme care must be used when applying this product to prevent injury to desirable plants and crops.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. **Avoid applying at excessive speed or pressure.**

Mixing and Application Instructions

Clean sprayer and parts immediately after using this product by thoroughly flushing with water and dispose of rinsate according to labeled use or disposal instructions.

Apply these spray solutions in properly maintained and calibrated equipment capable of delivering desired volumes. Hand-gun applications should be properly directed to avoid spraying desirable plants. Note: reduced results may occur if water containing soil is used, such as water from ponds and unlined ditches.

Mixing

Rodeo mixes readily with water. Mix spray solutions of this product as follows:

1. Fill the mixing or spray tank with the required amount of water while adding the required amount of this product (see "Directions for Use" and "Weeds Controlled" sections of this label).
2. Near the end of the filling process, add the required surfactant and mix well. Remove hose from tank immediately after filling to avoid siphoning back into the water source.

Note: If tank mixing with Garlon* 3A herbicide, ensure that Garlon 3A is well mixed with at least 75 percent of the total spray volume before adding Rodeo to the spray tank to avoid incompatibility.

During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, place the filling hose below the surface of the spray solution (only during filling), terminate by-pass and return lines at the bottom of the tank, and, if needed, use an approved anti-foam or defoaming agent.

Keep by-pass line on or near bottom of tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh. Carefully select correct nozzle to avoid spraying a fine mist. For best results with conventional ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

IMPORTANT: When using this product, unless otherwise specified, mix 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. Use a nonionic surfactant labeled for use with herbicides.
The surfactant must contain 50 percent or more active ingredient.

Always read and follow the manufacturer's surfactant label recommendations for best results.

These surfactants should not be used in excess of 1 quart per acre when making **broadcast** applications.

Carefully observe all cautionary statements and other information appearing in the surfactant label.

Colorants or marking dyes approved for use with herbicides may be added to spray mixtures of this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilutions. Use colorants or dyes according to the manufacturer's label recommendations.

Application Equipment and Techniques

ATTENTION: AVOID DRIFT. EXTREME CARE MUST BE EXERCISED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift, or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to crops, plants, or other areas on which the treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

Note: Use of this product in a manner not consistent with this label may result in injury to persons, animals, or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions. The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications, public health uses or to applications using dry formulations.

1. The distance of the outer most nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following **Aerial Drift Reduction Advisory Information:**

Importance of Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversion section of this label).

Controlling Droplet Size: Volume-Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows product larger droplets.

Pressure-Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.

Number of nozzles-Use the minimum number of nozzles that provide uniform coverage.

Nozzle Orientation-Orienting nozzles so that the spray is released backwards, parallel to the airstream will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.

Nozzle Type-Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.

Boom Length-For some use patterns, reducing the effective boom length to less than ¾ of the wingspan or rotor length may further reduce drift without reducing swath width.

Application-Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

Swath Adjustment: When applications are made with a cross-wind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

Wind: Drift potential is lowest between wind speeds of 2-10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. Note: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a temperature inversion, because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a connected cloud (under low wind conditions) indicates an inversion, while smoke that moves upwards and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Aerial Equipment

For aerial application of this product in California, refer to Federal supplemental label for Rodeo herbicide entitled "For Aerial Application in California Only". In California, aerial application may be made in aquatic sites and noncrop areas, including aquatic sites present in noncrop areas that are part of the intended treatment.

For control of weed or brush species listed in this label using aerial application equipment: For aerial broadcast application, unless otherwise specified, apply the rates of Rodeo and surfactant recommended for broadcast application in a spray volume of 3 to 20 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. Aerial applications of this product may only be made as specifically recommended in this label.

AVOID DRIFT. **Do not apply during inversion conditions, when winds are gusty or under any other condition which will allow drift. Drift may cause damage to any vegetation contacted to which treatment is not intended. To prevent injury to adjacent desirable vegetation, appropriate buffer zones must be maintained.**

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing in the additive label. The use of a drift control agent for conifer and herbaceous release applications may result in conifer injury and is not recommended.

Ensure uniform application. To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Thoroughly wash aircraft, especially landing gear, after each day of spraying to remove residues of this product accumulated during spraying or from spills. **Prolonged exposure of this product to uncoated steel surfaces may result in corrosion and possible failure of the part. Landing gear are most susceptible.** The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion.

Ground Broadcast Equipment

For control of weed or brush species listed in this label using conventional boom equipment: For ground broadcast application, unless otherwise specified, apply the rates of Rodeo and surfactant recommended for broadcast application in a spray volume of 3 to 30 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. As density of vegetation increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select correct nozzle to avoid spraying a fine mist. For best results with ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

Hand-Held and High-Volume Equipment

(Use Coarse Sprays Only)

For control of weeds listed in this label using knapsack sprayers or high-volume spraying equipment utilizing handguns or other suitable nozzle arrangements:

High volume sprays: Prepare a **3/4 to 2 percent solution** of this product in water, add a nonionic surfactant and apply to foliage of vegetation to be controlled. For specific rates of application and instructions for control of various annual and perennial weeds, see the "Weeds Controlled" section in this label.

Applications should be made on a spray-to-wet basis. Spray coverage should be uniform and complete. Do not spray to point of runoff.

Low volume directed sprays: Rodeo may be used as a **5 to 8 percent solution** in low-volume directed sprays for spot treatment of trees and brush. This treatment method is most effective in areas where there is a low density of undesirable trees or brush. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zig-zag motion. Ensure that at least 50 percent of the leaves are contacted by the spray solution. For flat fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. Small, open-branched trees need only be treated from one side. If the foliage is thick or there are multiple root sprouts, applications must be made from several sides to ensure adequate spray coverage.

Prepare the desired volume of spray solution by mixing the amount of this product in water, shown in the following table:

Spray Solution

Desired	Amount of Rodeo						
Volume	3/4%	1%	1 1/4%	1 1/2%	2%	5%	8%
1 gal	1 fl oz	1 1/3 fl oz	1 2/3 fl oz	2 fl oz	2 2/3 fl oz	6 1/2 fl oz	10 1/4 fl oz
25 gal	1 1/2 pt	1 qt	1 1/4 qt	1 1/2 qt	2 qt	5 qt	2 gal
100 gal	3 qt	1 gal	1 1/4 gal	1 1/2 gal	2 gal	5 gal	8 gal

2 tablespoons = 1 fluid ounce

For use in knapsack sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill the knapsack sprayer with the mixed solution and add the correct amount of surfactant.

Wiper Applications

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 33 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "Weed Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results

Aquatic and Other Noncrop Sites

Apply Rodeo as directed and under conditions described to control or partially control weeds and woody plants listed in the "Weeds Controlled" section in industrial, recreational and public areas or other similar aquatic or terrestrial sites on this label.

Aquatic Sites

Rodeo may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas, and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

- **Rodeo does not control plants which are completely submerged or have a majority of their foliage under water.**
- There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.
- Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

- **NOTE:** Do not apply this product directly to water within 1/2 mile upstream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made **only** in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.
- For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.
- Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.
- Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.
- When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

Other Noncrop Sites

Rodeo may be used to control the listed weeds in the following terrestrial noncrop sites and/or in aquatic sites within these areas:

Habitat Restoration & Management Areas
Highways & Roadsides
Industrial Plant Sites
Petroleum Tank Farms
Pipeline, Power, Telephone & Utility Rights-of-Way
Pumping Installations
Railroads
Similar Sites

Cut Stump Application

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. **Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting.** Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will **control, partially control or suppress** most woody brush and tree species, some of which are listed below:

Common Name	Scientific Name
Alder	*Alnus spp.*
Coyote brush †	*Baccharis consanguinea*
Dogwood †	*Cornus spp.*
Eucalyptus	*Eucalyptus spp.*
Hickory †	*Carya spp.*
Madrone	*Arbutus menziesii*
Maple †	*Acer spp.*
Oak	*Quercus spp.*
Poplar †	*Populus spp.*
Reed, giant	*Arundo donax*
Salt cedar	*Tamarix spp.*
Sweet gum †	*Liquidambar styraciflua*
Sycamore †	*Platanus occidentalis*
Tan oak	*Lithocarpus densiflorus*
Willow	*Salix spp.*

† Rodeo is not approved for this use on these species in the state of California.

Wildlife Habitat Restoration and Management Areas

Rodeo is recommended for the restoration and/or maintenance of native habitat and in wildlife management areas.

Habitat Restoration and Maintenance: When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract waterfowl, and for similar broad-spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants.

Wildlife Food Plots: Rodeo may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reinfest the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tilling to allow for maximum effectiveness.

Injection and Frill Applications

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment will control the following woody species:

Common Name	Scientific Name
Oak	*Quercus spp.*
Poplar	*Populus spp.*
Sweet gum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*

This treatment will suppress the following woody species:

Common Name	Scientific Name
Black gum †	*Nyssa sylvatica*
Dogwood	*Cornus spp.*
Hickory	*Carya spp.*
Maple, red	*Acer rubrum*

† Rodeo is not approved for this use on this species in the state of California.

Release of Bermudagrass or Bahiagrass on Noncrop Sites

Release Of Dormant Bermudagrass and Bahiagrass

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6-leaf stage.

Weeds Controlled

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

Weeds Controlled or Suppressed †

Note: C = Controlled; S = Suppressed

	Rate of Rodeo (Fluid Ounces Per Acre)					
Weed Species	**6**	**9**	**12**	**18**	**24**	**48**
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop *Trifolium campestre*	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

† These rates apply only to sites where an established competitive turf is present.

Release of Actively Growing Bermudagrass

NOTE: Use only on sites where bahiagrass or bermudagrass are desired for ground cover and some temporary injury or yellowing of the grasses can be tolerated.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass	Johnsongrass †
Dallisgrass	Trumpetcreeper ††
Fescue (tall)	Vaseygrass

† Johnsongrass is controlled at the higher rate.
†† Suppression at the higher rate only.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

Bahiagrass Seedhead and Vegetative Suppression

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

Annual Grass Growth Suppression

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

Weeds Controlled

Annual Weeds

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

Broadcast Application Rates: Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application Rates: Use a 3/4 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled.

When applied as directed, Rodeo plus nonionic surfactant will control the following annual weeds:

Common Name	Scientific Name
Balsamapple †	*Momordica charantia*
Barley	*Hordeum vulgare*
Barnyardgrass	*Echinochloa crus-galli*
Bassia, fivehook	*Bassia hyssopifolia*
Bluegrass, annual	*Poa annua*
Bluegrass, bulbous	*Poa bulbosa*
Brome	*Bromus spp.*
Buttercup	*Ranunculus spp.*
Cheat	*Bromus secalinus*
Chickweed, mouseear	*Cerastium vulgatum*
Cocklebur	*Xanthium strumarium*
Corn, volunteer	*Zea mays*
Crabgrass	*Digitaria spp.*
Dwarfdandelion	*Krigia cespitosa*
Falseflax, smallseed	*Camelina microcarpa*
Fiddleneck	*Amsinckia spp.*
Flaxleaf fleabane	*Conyza bonariensis*
Fleabane	*Erigeron spp.*
Foxtail	*Setaria spp.*
Foxtail, Carolina	*Alopecurus carolinianus*
Groundsel, common	*Senecio vulgaris*
Horseweed/Marestail	*Conyza canadensis*
Kochia	*Kochia scoparia*
Lambsquarters, common	*Chenopodium album*
Lettuce, prickly	*Lactuca serriola*
Morningglory	*Ipomoea spp.*
Mustard, blue	*Chorispora tenella*
Mustard, tansy	*Descurainia pinnata*
Mustard, tumble	*Sisymbrium altissimum*
Mustard, wild	*Sinapis arvensis*
Oats, wild	*Avena fatua*
Panicum	*Panicum spp.*
Pennycress, field	*Thlaspi arvense*
Pigweed, redroot	*Amaranthus retroflexus*
Pigweed, smooth	*Amaranthus hybridus*
Ragweed, common	*Ambrosia artemisiifolia*
Ragweed, giant	*Ambrosia trifida*
Rocket, London	*Sisymbrium irio*
Rye	*Secale cereale*
Ryegrass, Italian ††	*Lolium multiflorum*
Sandbur, field	*Cenchrus spp.*
Shattercane	*Sorghum bicolor*
Shepherd's-purse	*Capsella bursa-pastoris*
Signalgrass, broadleaf	*Brachiaria platyphylla*
Smartweed, Pennsylvania	*Polygonum pensylvanicum*
Sowthistle, annual	*Sonchus oleraceus*

Spanishneedles ††	*Bidens bipinnata*
Stinkgrass	*Eragrostis cilianensis*
Sunflower	*Helianthus annuus*
Thistle, Russian	*Salsola kali*
Spurry, umbrella	*Holosteum umbellatum*
Velvetleaf	*Abutilon theophrasti*
Wheat	*Triticum aestivum*
Witchgrass	*Panicum capillare*

†Apply with hand-held equipment only.
††Apply 3 pints of this product per acre.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

Perennial Weeds

Apply Rodeo to control most vigorously growing perennial weeds. Unless otherwise directed, apply when target plants are actively growing and most have reached early head or early bud stage of growth. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

NOTE: If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

Specific Weed Control Recommendations: For perennial weeds, apply the recommended rate plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. See the "General Information", "Directions for Use" and "Mixing and Application" sections in this label for specific uses and application instructions.

When applied as directed, Rodeo plus nonionic surfactant will control the following perennial weeds: (Numbers in parentheses "(-)" following common name of a listed weed species refer to "Specific Perennial Weed Control Recommendations" for that weed which follow the species listing.)

Common Name	Scientific Name
Alfalfa (31)	*Medicago sativa*
Alligatorweed † (1)	*Alternanthera philoxeroides*
Anise/Fennel (31)	*Foeniculum vulgare*
Artichoke, Jerusalem (31)	*Helianthus tuberosus*
Bahiagrass (31)	*Paspalum notatum*
Bermudagrass (2)	*Cynodon dactylon*
Bindweed, field (3)	*Convolvulus arvensis*
Bluegrass, Kentucky (12)	*Poa pratensis*
Blueweed, Texas (3)	*Helianthus ciliaris*
Brackenfern (4)	*Pteridium spp.*
Bromegrass, smooth (12)	*Bromus inermis*
Canarygrass, reed (12)	*Phalaris arundinacea*
Cattail (5)	*Typha spp.*
Clover, red (31)	*Trifolium pratense*
Clover, white (31)	*Trifolium repens*
Cogongrass (6)	*Imperata clylindrica*
Cordgrass (7)	*Spartina spp.*
Cutgrass, giant † (8)	*Zizaniopsis miliacea*
Dallisgrass (31)	*Paspalum dilatatum*
Dandelion (31)	*Taraxacum officinale*
Dock, curly (31)	*Rumex crispus*
Dogbane, hemp (9)	*Apocynum cannabinum*
Fescue (31)	*Festuca spp.*
Fescue, tall (10)	*Festuca arundinacea*
Guineagrass (11)	*Panicum maximum*
Hemlock, poison (31)	*Conium maculatum*
Horsenettle (31)	*Solanum carolinense*
Horseradish (9)	*Armoracia rusticana*
Ice Plant (22)	*Mesembryanthemum crystallinum*
Johnsongrass (12)	*Sorghum halepense*
Kikuyugrass (21)	*Pennisetum clandestinum*
Knapweed (9)	*Centaurea repens*
Lantana (13)	*Lantana camara*
Lespedeza, common (31)	*Lespedeza striata*
Lespedeza, sericea (31)	*Lespedeza cuneata*
Loosestrife, purple (14)	*Lythrum salicaria*
Lotus, American (15)	*Nelumbo lutea*
Maidencane (16)	*Panicum hematomon*
Milkweed (17)	*Asclepias spp.*
Muhly, wirestem (21)	*Muhlenbergia frondosa*
Mullein, common (31)	*Verbascum thapsus*
Napiergrass (31)	*Pennisetum purpureum*
Nightshade, silverleaf (3)	*Solanum elaeagnifolium*
Nutsedge, purple (18)	*Cyperus rotundus*
Nutsedge, yellow (18)	*Cyperus esculentus*
Orchardgrass (12)	*Dactylis glomerata*
Pampasgrass (19)	*Cortaderia jubata*
Paragrass (16)	*Brachiaria mutica*
Phragmites†† (20)	*Phragmites spp.*
Quackgrass (21)	*Agropyron repens*
Reed, giant (22)	*Arundo donax*
Ryegrass, perennial (12)	*Lolium perenne*
Smartweed, swamp (31)	*Polygonum coccineum*
Spatterdock (23)	*Nuphar luteum*
Starthistle, yellow (31)	*Centaurea solstitialis*
Sweet potato, wild † (24)	*Ipomoea pandurata*
Thistle, artichoke (25)	*Cynara cardunculus*
Thistle, Canada (25)	*Cirsium arvense*
Timothy (12)	*Phleum pratense*
Torpedograss † (26)	*Panicum repens*
Tules, common (27)	*Scirpus acutus*
Vaseygrass (31)	*Paspalum urvillei*
Velvetgrass (31)	*Holcus spp.*
Waterhyacinth (28)	*Eichornia crassipes*
Waterlettuce (29)	*Pistia stratiotes*
Waterprimrose (30)	*Ludwigia spp.*
Wheatgrass, western (12)	*Agropyron smithii*

†Partial control.
††Partial control in southeastern states. See "Specific Weed Control Recommendations" below.

Specific Perennial Weed Control Recommendations:

1. **Alligatorweed:** Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.
2. **Bermudagrass:** Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seedheads appear.
3. **Bindweed, field / Silverleaf Nightshade / Texas Blueweed:** Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.
4. **Brackenfern:** Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.
5. **Cattail:** Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.
6. **Cogongrass:** Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.
7. **Cordgrass:** Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.
8. **Cutgrass, giant:** Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7 to 10-leaf stage prior to retreatment.
9. **Dogbane, hemp / Knapweed / Horseradish:** Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.
10. **Fescue, tall:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.
11. **Guineagrass:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.
12. **Johnsongrass / Bluegrass, Kentucky / Bromegrass, smooth / Canarygrass, reed / Orchardgrass / Ryegrass, perennial / Timothy / Wheatgrass, western:** Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.
13. **Lantana:** Apply this product as a 3/4 to 1 percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.
14. **Loosestrife, purple:** Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.
15. **Lotus, American:** Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.
16. **Maidencane / Paragrass:** Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7 to 10-leaf stage prior to retreatment.
17. **Milkweed, common:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.
18. **Nutsedge: purple, yellow:** Apply 4 1/2 pints of this product per acre as a broadcast spray, or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.
19. **Pampasgrass:** Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.
20. **Phragmites:** For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer of fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.
21. **Quackgrass / Kikuyugrass / Muhly, wirestern:** Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3 to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.
22. **Reed, giant / Ice plant:** For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

23. **Spatterdock:** Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.
24. **Sweet potato, wild:** Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.
25. **Thistle, Canada / artichoke:** Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.
26. **Torpedograss:** Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.
27. **Tules, common:** Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.
28. **Waterhyacinth:** Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.
29. **Waterlettuce:** For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.
30. **Waterprimrose:** Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.
31. **Other perennial weeds listed above:** Apply 4 1/2 to 7 1/2 pints of Rodeo per acre as a broadcast spray or apply as a 3/4 to 1 1/2 percent solution with hand-held equipment.

Woody Brush and Trees

NOTE: If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Application Rates and Timing
When applied as a 5 to 8 percent solution as a directed application as described in the "Hand-Held and High-Volume Equipment" section, this product will control or partially control all wood brush and tree species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Specific Brush or Tree Control Recommendations: Numbers in parentheses "(-)" following the common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" which follow the species listing. See this section for specific application rates and timing for listed species.

For woody brush and trees, apply the recommended rate plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions. **When applied as directed, Rodeo plus nonionic surfactant will control the following woody brush plants and trees:** (Numbers in parentheses "(-)" following common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" for that species which follow the species listing.)

Common Name	Scientific Name
Alder (1)	*Alnus spp.*
Ash † (20)	*Fraxinus spp.*
Aspen, quaking (2)	*Populus tremuloides*
Bearclover, Bearmat (20)	*Chamaebatia foliolosa*
Birch (3)	*Betula spp.*
Blackberry (1)	*Rubus spp.*
Broom, French (4)	*Cytisus monspessulanus*
Broom, Scotch (4)	*Cytisus scoparius*
Buckwheat, California † (5)	*Eriogonum fasciculatum*
Cascara † (20)	*Rhamnus purshiana*
Catsclaw † (6)	*Acacia greggi*
Ceanothus (20)	*Ceanothus spp.*
Chamise (17)	*Adenostoma fasciculatum*
Cherry, bitter (7)	*Prunus emarginata*
Cherry, black (7)	*Prunus serotina*
Cherry, pin (7)	*Prunus pensylvanica*
Coyote brush (8)	*Baccharis consanguinea*
Creeper, Virginia † (20)	*Parthenocissus quinquefolia*
Dewberry (1)	*Rubus trivialis*
Dogwood (9)	*Cornus spp.*
Elderberry (3)	*Sambucus spp.*
Elm † (20)	*Ulmus spp.*
Eucalyptus, bluegum (10)	*Eucalyptus globulus*
Hasardia † (5)	*Haplopappus squamosus*
Hawthorn (2)	*Crataegus spp.*
Hazel (3)	*Corylus spp.*
Hickory (9)	*Carya spp.*
Holly, Florida (11) (Brazilian peppertree)	*Schinus terebinthifolius*
Honeysuckle (1)	*Lonicera spp.*
Hornbeam, American (20)	*Carpinus caroliniana*
Kudzu (12)	*Pueraria lobata*
Locust, black † (20)	*Robinia pseudoacacia*
Manzanita (20)	*Arctostaphylos spp.*

Maple, red † (13)	*Acer rubrum*
Maple, sugar (14)	*Acer saccharum*
Maple, vine † (20)	*Acer circinatum*
Monkey flower † (5)	*Mimulus guttatus*
Oak, black † (20)	*Quercus velutina*
Oak, northern pin (14)	*Quercus palustris*
Oak, post (1)	*Quercus stellata*
Oak, red (14)	*Quercus rubra*
Oak, southern red (7)	*Quercus falcata*
Oak, white † (20)	*Quercus alba*
Persimmon † (20)	*Diospyros spp.*
Poison-ivy (15)	*Rhus radicans*
Poison-oak (15)	*Rhus toxicodendron*
Poplar, yellow † (20)	*Liriodendron tulipifera*
Prunus (7)	*Prunus spp.*
Raspberry (1)	*Rubus spp.*
Redbud, eastern (20)	*Cercis canadensis*
Rose, multiflora (16)	*Rosa multiflora*
Russian-olive (20)	*Elaeagnus angustifolia*
Sage: black (17), white	*Salvia spp.*
Sagebrush, California (17)	*Artemisia californica*
Salmonberry (3)	*Rubus spectabilis*
Salt cedar † (9)	*Tamarix spp.*
Saltbush, sea myrtle (18)	*Baccharis halimifolia*
Sassafras (20)	*Sassafras albidum*
Sourwood † (20)	*Oxydendrum arboreum*
Sumac, poison † (20)	*Rhus vernix*
Sumac, smooth † (20)	*Rhus glabra*
Sumac, winged † (20)	*Rhus copallina*
Sweetgum (7)	*Liquidambar styraciflua*
Swordfern † (20)	*Polystichum munitum*
Tallowtree, Chinese (17)	*Sapium sebiferum*
Thimbleberry (3)	*Rubus parviflorus*
Tobacco, tree † (5)	*Nicotiana glauca*
Trumpetcreeper (2)	*Campsis radicans*
Waxmyrtle, southern † (11)	*Myrica cerifera*
Willow (19)	*Salix spp.*

† Partial control (See below for control or partial control instructions.)

Specific Brush or Tree Control Recommendations:

1. **Alder / Blackberry / Dewberry / Honeysuckle / Oak, Post / Raspberry:** For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.
2. **Aspen, Quaking / Hawthorn / Trumpetcreeper:** For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.
3. **Birch / Elderberry / Hazel / Salmonberry / Thimbleberry:** For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.
4. **Broom, French / Broom, Scotch:** For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.
5. **Buckwheat, California / Hasardia / Monkey flower / Tobacco, tree:** For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
6. **Catsclaw:** For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
7. **Cherry, bitter / Cherry, black / Cherry, pin / Oak, southern red / Sweetgum / Prunus:** For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.
8. **Coyote brush:** For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
9. **Dogwood / Hickory / Salt cedar:** For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.
10. **Eucalyptus, bluegum:** For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6 to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.
11. **Holly, Florida / Waxmyrtle, southern:** For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.
12. **Kudzu:** For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.
13. **Maple, red:** For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.
14. **Maple, sugar / Oak: northern pin / Oak, red:** For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
15. **Poison-ivy / Poison-oak:** For control, apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.
16. **Rose, multiflora:** For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.
17. **Sage, black / Sagebrush, California / Chamise / Tallowtree, Chinese:** For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
18. **Saltbush, sea myrtle:** For control, apply this product as a 1 percent solution with hand-held equipment.
19. **Willow:** For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment.
20. **Other woody brush and trees listed above:** For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Crop injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or
(2) Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer above and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

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Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

Label Code: D02-148-002
Replaces Label: D02-148-001

EPA-accepted 05/15/2002

Revisions:

1. Update of specific uses allowed in the state of California.

B

COMMONWEALTH OF MASSACHUSETTS

DUKES COUNTY, SS,

LAND COURT DEPARTMENT
CASE NO. 13 MISC 478175

CHARLES PARKER and VIRGINIA P. DAWSON, RICHARD W. REGAN, MANAGER OF THE REGEN FAMILY STORKS NEST LLC, DOUGLAS and ELIZABETH LIMAN, BARBARA GOLDMUNTZ (LIFE ESTATE), and BARBARA HUNTER FOSTER, TRUSTEE OF PACER II NOMINEE TRUST,

Plaintiffs,

vs.

CHRIS MURPHY, FRANK LORUSSO, WENDY WELDON, RUSSELL MALONEY, ALLISON BURGER, TODD CHRISTY and ALLEN HEALY, as they are members of the Town of Chilmark Zoning Board of Appeals and the TOWN OF CHILMARK, acting by and through its Board of Selectmen,

Defendants.

AFFIDAVIT OF
ARTHUR G. GAINES, JR.

I, Arthur G. Gaines, Jr., hereby depose and state as follows:

1. I hold the position of Oceanographer Emeritus at the Marine Policy Center, which is a department of the Woods Hole Oceanographic Institution ("WHOI") located in Woods Hole, Massachusetts. My curriculum vitae is attached hereto as

Exhibit "A", which includes a list of my professional publications.

2. WHOI is an institution dedicated to research and education to advance society's understanding of the ocean and its interaction with the earth's system. I have been affiliated with WHOI since 1979.

3. I hold a Ph.D. in Oceanography from the University of Rhode Island, and a Bachelor of Science in biology and geology from Cornell University.

4. My professional career has been dedicated to conducting and supporting research on coastal lands and sea, which involves planning, management, and policy making through more effective use of marine science and technology. My work includes the exploration of mechanisms for cooperative efforts between academia, government and industry in accomplishing this goal, and assessing the generic relevance and applicability of United States coastal management experience in an international context. My specific area of research includes analyzing coastal ponds and embayments to determine what makes those water bodies a suitable habitat for shellfish, finfish and plant life.

5. I was a member of the Coastal Resource Advisory Board of the Commonwealth of Massachusetts for ten years and have served as its Chairman for two years. I have published numerous technical and other reports relative to coastal resource issues.

For a complete listing of my publications and my professional activities and membership, please see my curriculum vitae. A number of my publications pertain to the health of coastal ponds and embayments in southeastern Massachusetts, and how changes to those water bodies impact shellfish, finfish and plant life.

6. I have studied various ponds and waterbodies on Martha's Vineyard, including Squibnocket Pond, Sengekontacket Pond, the Edgartown Harbor coastal complex, which includes Cape Pogue Bay; Edgartown Great Pond; the Lagoon Pond; and the Mink Meadows coastal embayment. I have issued various reports about these studies.

7. I make this affidavit from my own personal and professional knowledge including results drawn from the report I co-authored with a colleague, James M. Broadus, dated December 15, 1989 entitled "Area Wide Planning And Management: Squibnocket Pond Coastal Resources Complex" (a copy of which is appended hereto as Exhibit "B") (the "Squibnocket Study").

8. My co-author of the Squibnocket Study, James M. Broadus, was a resource economist of the highest repute. He was the Director of WHOI's Marine Policy Center. An outline of his experience is attached hereto as Exhibit "C".

9. The purpose of the Squibnocket Study was "to provide technical information to planners and other decision makers in support of their management of the coastal resources associated

with Squibnocket Pond". We delineated the Pond's watershed; analyzed salinity levels; analyzed the shellfish, alewife and aquatic vegetation; and recommended a comprehensive and integrated approach to manage the coastal resources at Squibnocket Pond, including nutrient management.

10. We specifically recommended that measures be put in place to reduce fertilizer applications to surrounding properties, and that upgraded zoning measures be introduced in order to ensure those measures. We also note that Squibnocket Pond is connected to other coastal water bodies, including Menemsha Pond and Menemsha Harbor.

11. Of special significance, we found that the flushing of the Pond is very restricted, far more so that other coastal ponds on Martha's Vineyard. For this reason, materials entering the Pond tend to remain there for at least several months, rather than being removed by flushing mechanisms we have identified in other coastal ponds.

12. Our study led the Chilmark planners to propose the provision in the Chilmark Zoning By-laws now identified in Section 12.6(H), which was adopted by the Chilmark voters in 1990, less than a year after our study. The zoning provision precludes the use of chemical fertilizers, herbicides, fungicides, pesticides and chemical septic system cleaners within 500 feet of Squibnocket Pond.

13. In my opinion, Section 12.6(H) of the Chilmark Zoning By-law is an appropriate, site specific and necessary planning provision designed to protect this fragile coastal great pond. Squibnocket Pond is simply too fragile to risk the use of the substances regulated by Section 12.6(H) of the Chilmark Zoning By-law.

Arthur G Gaines Jr

Arthur G. Gaines, Jr.

Dated: November 18, 2013

COMMONWEALTH OF MASSACHUSETTS

County of Barnstable, ss.

On this 18th day of November, 2013, before me, the undersigned notary public, personally appeared Arthur G. Gaines, Jr., proved to me through satisfactory evidence of identification, which was **(circle one)** personal knowledge of identity of the principal/passport or drivers license bearing photographic image of principal/other ——, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose.

Ellen Murphy Bailey

Notary Public

My commission expires: 10 Oct. 2019

4716-004\Gaines Affidavit.doc

EXHIBIT A

ARTHUR G. GAINES, Jr.
Resumé
November 2013

Career Research goals:

To conduct research that improves coastal planning and management through more effective use of marine science and technology; to explore mechanisms for cooperative efforts between academia, government and industry in accomplishing this goal; to assess the relevance and applicability of the U.S. coastal management experience in an international context.

Education:

1964	B.S.	Cornell University - Biology, geology
1975	Ph.D.	University of Rhode Island - Oceanography Dissertation: "Papers on the geomorphology, hydrography, and geochemistry of the Pettaquamscutt River Estuary"

Employment:

2000- Present	Oceanographer Emeritus, Marine Policy Center, Woods Hole Oceanographic Institution
1997-present	Principal, Coast & Harbor Institute, Woods Hole, MA
1987-2000	Research Specialist, Marine Policy Center, Woods Hole Oceanographic Institution
1979-1987	Marine Science Advisor, Sea Grant Program, Woods Hole Oceanographic Institution
1977-1979	Staff Scientist, Sea Education Association, Woods Hole, MA
1975-1977	Assistant Master, Atlantic College, Wales, U.K. Taught classes in chemistry and marine science. Research with the British Institute for Marine Environmental Research (IMER)

Research Programs:

2007-Present	Principal investigator, The Woodneck Beach coastal complex. Reports on the coastal processes, nutrient balance, and tidal flushing of a Cape Cod estuary-marsh system.
2002-Present	Principal Investigator, The Southgate Coastal Reserve. Multidisciplinary research at St. Croix, USVI, sponsored by the St. Croix Environmental Association, issuing 10 major reports and numerous additional papers on the history, geology, biology, hydrology, water quality and management of the Southgate Coastal Reserve.
1986-1998	Principal Investigator, Environmental systems analyses on the coastal ponds of Martha's Vineyard: Lagoon Pond; Squibnocket Pond; the Edgartown Harbor coastal complex (including Cape Poge Pond); Edgartown Great Pond; Sengekontacket Pond; and Mink Meadow embayment.

1988-1995	Program Manager, "U.S. ECDIS Testbed Project." A national program to evaluate and introduce advanced technology to the bridge of ships for enhanced marine environmental security and maritime safety.
1987-1995	Program Coordinator, "A National Marine Electronics Agenda". A project to identify new environmental monitoring technologies and to analyze the economics, structure and function of the U.S. industries producing these technologies. The project involved academic researchers at three institutions; a 50-member, private sector Marine Instrumentation Panel advisory council; and a state-level public/private partnership program.
1989-1991	Team member, "Environmental Security and the World Oceans". With collaboration of colleagues from our Center and from the [former] Soviet Union, this project addressed global environmental problems and the question of appropriate measures to provide "environmental security" from actions of irresponsible states.
1982-1987	Team member, "Coastal and marine management in the Galapagos Islands."
1980-1982	Team member, "Systems analysis of the Town Cove Estuary, Orleans, MA"
1987	Co-chair, Conference on "Scientific Research and the Galápagos Marine Resources Reserve" In response to our Center's multi-year project on coastal management in the Galápagos Islands, the President of Ecuador created a 70,000 square kilometer "Galápagos Marine Resources Reserve." The 1987 NSF-sponsored conference served as a capstone to the research project and brought together many Ecuadorian organizations with interest in the Galápagos.

Professional Activities:

2000	Chairman, panel on "Convergence of Science and Fishing Expertise". Marine GIS Technology Conference. October 12-13, 2000. FISH EXPO, Providence, R.I.
2000	Participant, U.S. Ports Visioning Session. Meeting with Hon. Rodney E. Slater, Secretary, U.S. Department of Transportation, September 12, 2000, Washington, D.C.
1997	Panel Member, "Wastewater and its effects on coastal bays and estuaries." Nathan Mayhew Seminars of Martha's Vineyard. September 18, 1997. Fanny Blair Hall, Vineyard Haven, MA

1996	Chairman, "The Scientific and Technological Basis for Management of Straddling Stock Fisheries." 20th Annual Seminar: Implementing the 1982 Law of the Sea Convention. Center for Oceans Law and Policy, University of Virginia School of Law. March 15-16, 1996. Annapolis, MD
1995	Chairman, "Environmental impacts of warfare: A natural science perspective." Conference on "The Protection of the Environment During Armed Conflict and Other Military Operations". U.S. Naval War College International Law Studies Program, September 20-22, 1995. Newport, R.I.
1994	Chairman, "Toward an Effective Protocol on Land-Based Marine Pollution in the Wider Caribbean Region." December 1-2, 1994. University of the West Indies, Barbados.
1986-1994	Member, Board of Directors, The Sounds Conservancy, Inc.
1989-1992	Member, Comprehensive Conservation and Management Plan Advisory Committee, Buzzards Bay Project, USEPA/Mass. Executive Office of Environmental Affairs.
1987-1990	Member, Editorial Board, ESTUARIES, Journal of the Estuarine Research Federation.
1987-1989	Chairman, Coastal Resources Advisory Board, Massachusetts Executive Office of Environmental Affairs (Gubernatorial appointment).
1986-1989	Member, Coastal Resources Advisory Board, Massachusetts Executive Office of Environmental Affairs.
1989	Panel Member, "Narragansett Bay Water Quality: Relationships Between Pathogen Input and Shellfish". June 13, 1989, USEPA Narragansett Bay Project, University of Rhode Island, Narragansett, RI.
1987	Co-chair, Conference on "Scientific Research and the Galápagos Marine Resources Reserve"
1987	Chairman and Panelist, "Residential and Commercial Development of the Coastal Zone", Southeastern Massachusetts University "Seminar Series on Coastal Resources", South Dartmouth, MA.
1987	Coordinator, "To Use the Oceans Wisely", a symposium and 15th anniversary reunion of the Marine Policy Center held in honor of Dr. Paul M. Fye. April 5-7, 1987, Woods Hole, MA.

1987	Coordinator, moderator, and co-chair for NSF-sponsored conference entitled, "Scientific Research and the Galápagos Marine Resources Reserve" held April 20-24, 1987 (co-hosted by INOCAR), Guayaquil, Ecuador.
1986	Moderator and panel member, "Coastal Eutrophication: Causes? Cures?" New England Estuarine Research Society meeting, October 24, 1986, Boston, MA.
1986	Panel member, "Marine Water Quality: The Role of Science in Resource Management." September 20, 1986. Coastweek Conference, Massachusetts CZM, Boston, MA.
1985	Assistant Chairman, MTS/NOAA symposium "Government Ocean Incentives: What's In It For Industry?" June 12, 1985, Waltham, MA.
1985	Speaker. "The Galápagos Islands (Ecuador): The Use of Technical Information in Coastal Planning." Presented at Coastal Zone '85, Baltimore, Maryland, 1985.
1983	Organizer. WHOI Ocean Industry Program conference on "Marine Policy and Economics, and Our Use of the Sea." December 7-8, 1983, Woods Hole, MA.
1982	Chairman and Panelist, "Scientific and Technical Information in Coastal Management." Massachusetts CZM conference on "Local Government and the New Federalism." October 16, 1982, Boston, MA
1982	"Use of Scientific and Technical Information in the Local Decision-making Process." Presented at Conference on Massachusetts Coastal Cities and Towns in the 1980s. Massachusetts CZM, Boston, MA.
1981-83	Participant, U.S. Coast Guard "Marine Industry Day", U.S. Coast Guard Base, Boston, MA.
1980-1983	Member, Editorial Advisory Board, CURRENTS, magazine of the National Marine Educators Association
1974-1975	Chairman, Tri-Town Narrow River Planning Committee South Kingstown, R.I. Directed a watershed planning committee, bringing ecological principles to bear on land-use planning surrounding an estuary.

Teaching and Education Experience:

Adult Education Level:

1989 Faculty member (invited), "A Short Course on Environmental Management and Regional Economic Development", January 21 - February 2, Aqaba, Jordan. Sponsored by Aqaba Region Authority; Royal Scientific Society (Jordan); International Federation of Institutes for Advanced Study.

1984 Lecturer (invited), Cornell Adult University 1984 Caribbean Expedition, January 7-21, one of a staff of five lecturers accompanying a cruise aboard S/Y SEA CLOUD planned for the Trustees of Cornell University 1984.

1969-1971 Lecturer, University of Rhode Island, Division of Extension, Kingston, R.I. General Oceanography (Ocean. 401, 3 Cr.).

College Level:

1991-1995 Member, Ocean Studies Advisory Committee, Maine Maritime Academy, Castine, ME.

1987 Member, Visiting Committee to Evaluate a Proposed Curriculum in Marine Science for Maine Maritime Academy, Castine, Maine.

1986-1987 Member, Advisory Board, Massachusetts Bay Marine Studies Consortium

1980-1984 Member, Advisory Board, Massachusetts Marine Educators

1980-1982 Lecturer, "Into the Ocean World" (3 Cr.) offered by the Inter-institutional Marine Studies Consortium through M.I.T. Sea Grant, Cambridge, MA. A course in oceanography and maritime affairs, sponsored by a consortium of 25 Boston area colleges and universities.

1975 Instructor (summer), Marine Biology (Biology 294, 3 Cr.), University of Connecticut, Noank Laboratory, Noank, CT Lectures, laboratories and fieldwork in a traditional undergraduate college format.

Secondary Level:

1973 Faculty member, Introduction to the Sea, International Ocean Institute, The Royal University of Malta, Malta. Lectures and fieldwork on marine pollution for a special three-week program for students from Mediterranean countries.

1972-1973 Director, Summer Practice School of Oceanology, St. George's School, Newport, R.I. Responsible for all operational aspects of a six-week grant-supported summer program for 35 to 50 high school science students. In 1972 students from this program captured 1% of the Westinghouse Science Talent Awards nationally.

1971 Staff member, Summer Practice School of Oceanology, St. George's School, Newport, R.I. Lectures, laboratories and fieldwork on chemical oceanography and on estuarine studies for an intensive six-week project-oriented course for advanced high school science students.

Selected memberships:

The American Association for the Advancement of Science
Estuarine Research Federation
The New England Estuarine Research Society
The American Society of Limnology and Oceanography
Marine Technology Society
N.E. Section Marine Technology Society
American Society of International Law

Selected Talks and Poster Sessions:

"U.S. Electronic Chart Display and Information System (ECDIS) Test Bed Project: Implementing ECDIS." International Symposium: The Hydrographic Affairs Development Strategy for the Age of ENC in Korea. March 3-5, 1996. Seoul National University, Seoul Korea.

"U.S. Electronic Chart Display and Information System (ECDIS) Test Bed Project: Overview and Update." Conference on Maritime Communications and Control. Institute of Marine Engineers. July 7-8, 1993. London.

"Developing a National Marine Electronics Agenda." Poster session at OCEANS'89, September 1989, Seattle, WA.

"Pollution at the Coast." Presented at the Nathan Mayhew Seminar Series on "Our Coast in Danger", June 9, 1989. Edgartown, MA.

"The U.S. Mussel Watch Program." Presented on behalf of Dr. John Farrington at a meeting of the International Federation of Institutes for Advanced Study. 1982, Tokyo, Japan.

"Tidal Features of a Flooded Glacial Landscape." Presented at meeting of New England Estuarine Research Society, 1974, Woods Hole, MA.

"Sulfide Production in a New England Estuary." Presented at meeting of American Society of Limnology and Oceanography, 1973, Salt Lake City, Utah.

"Gas Production in Solid Waste in the Marine Environment." Presented at meeting of New England Estuarine Research Society, 1973, Woods Hole, MA.

"Anoxic Water in the Pettaquamscutt River." Presented at meeting of American Society of Limnology and Oceanography, 1971, Kingston, RI.

Publications and Technical Reports

Gaines, A.G. and K. Audenaerde, 2013. Tide and Management at Woodneck Beach [Falmouth, Mass.]. *Winter 2013 Newsletter* of the Sippewissett Association, Falmouth, MA. 3pp.

Gaines, A.G. and E.H. Gladfelter, 2012. Woodneck Beach Study [Falmouth, Mass.]: Coliform Bacteria. *Summer 2012 Newsletter* of the Sippewissett Association, Falmouth, MA. 3 pp.

Gaines, A.G. and E.H. Gladfelter, 2011. Woodneck Beach [Falmouth, Mass.]: Nutrient Results. *Winter 2011 Newsletter* of the Sippewissett Association, Falmouth, MA. 2 pp.

Gaines, A.G. 2007. *Marsh Dieback at Mink Meadows (Tisbury, Mass.).* The Coast & Harbor Institute, Woods Hole, MA. 7 pp.

Gaines, A.G. and E.H. Gladfelter, 2004. *The Southgate Coastal Reserve: A Strategy for Management and Implementation.* SCR Technical Report # 1. Prepared for the St. Croix Environmental Association, Gallows Bay, USVI. The Coast & Harbor Institute, Woods Hole, Mass. 58 pp.

Gaines, A.G., 2004. *The Southgate Watershed: Geology and Hydrology of an Arid Landscape.* SCR Technical Report # 2. Prepared for the St. Croix Environmental Association, Gallows Bay, USVI. The Coast & Harbor Institute, Woods Hole, Mass. 31 pp.

Gaines, A.G. and R.E. Crawford, 2004. *Southgate Pond: Geology and Ecology of a Tropical Coastal Pond.* SCR Technical Report # 4. Prepared for the St. Croix Environmental Association, Gallows Bay, USVI. The Coast & Harbor Institute, Woods Hole, Mass. 72pp.

Gladfelter, E.H. and A.G. Gaines, 2004. *The Southgate Cultural Heritage: Imprint of our Forerunners*. SCR Technical Report # 3. Prepared for the St. Croix Environmental Association, Gallows Bay, USVI. The Coast & Harbor Institute, Woods Hole, Mass. 40 pp.

Gaines, A.G. and S.D. Pratt, 2003. *Oxygen Depletion in Connecticut Estuarine Waters*. Final Research Report. Funded by Long Island Sound License Plate Program, Connecticut Department of Environmental Protection. The Coast & Harbor Institute, Woods Hole, Mass. 87 pp.

Gaines, A.G. and R.L. Fultz, 2002. *Rushy Marsh Pond Restoration Project: Reopening a Connection to the Sea*. Final Report Submitted to The Conservation Division, Town of Barnstable, Barnstable, Massachusetts. The Coast & Harbor institute, Woods Hole, Mass. 82 pp.

Gaines, A.G., 2001. [Book Review] G. E. Weir. An Ocean in Common: American Naval Officers, Scientists, and the Ocean Environment. *Proceedings*. U.S. Naval Institute, October 2001: 114-115.

Gaines, A.G. and R. E. Crawford, 2001. Sediment Mobilization in a Small Commercial Harbor: The Role of Vessel Operations. P. 565-572 (In.) N.J. Shankar, T.A. Cheong and L. Pengzhi (eds). *Proceedings of the International Conference on Port and Maritime R & D and Technology*, 29 - 31 October 2001, Singapore

Pratt, S.D., A.G. Gaines and L. Steere, 2000. *An Environmental Status Report on Edgartown Great Pond: Bottom Dwelling Animals and their habitats [with notes on aquatic and wetland plants]*. Final Report to the Great Pond Foundation, Edgartown, Mass. 50 pp. + Appendices.

Gaines, A.G., 1999. *Nutrient Loading and Management Strategies at Sengekontacket Pond*. Prepared for Friends of Sengekontacket, Edgartown, MA. Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, MA 35 pp.

Gaines, A.G., 1999. *The Great Ponds Center and Environmental Considerations of Edgartown Great Pond.* Prepared for Meeting House Golf Club, Natick, Mass. The Coast & Harbor Institute, Woods Hole, Mass. 58 pp.

Gaines, A.G., E.H. Gladfelter, P. Hoagland and H. Kite-Powell, 1999. *An Earth Sciences Observatory at St. Croix: Economic Analysis for a New Scientific Facility on the U.S. Virgin Islands*. Prepared for the Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina. Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, Mass. 83 pp.

Hoagland, P., A.G. Gaines and M.E. Schumacher. 1999. *AUV applications in Massachusetts Bay: an assessment of current and potential opportunities.* MIT Sea Grant Program, Cambridge, Mass.

Gaines, A.G., 1998. Nutrient Loading Limits of Edgartown Great Pond, Edgartown, Massachusetts. Appendix C (48 pp) [In]. *Edgartown Great Pond: Nutrient Loading and Recommended Management Program.* Martha's Vineyard Commission, Oak Bluffs, Mass. Ca. 175 pp.

Gaines, A.G., 1998. *Cape Poge Bay: A Threatened Sea Grass lagoon.* Final Report. Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, Mass. 67 pp. + appendices.

Gaines, A.G., 1997. *The Impact of Ferry Docking at Vineyard Haven on Suspended Sediments: A Comparison of the* ISLANDER *and the* MARTHA'S VINEYARD. Prepared for the Woods Hole, Martha's Vineyard, and Nantucket Steamship Authority. The Coast & Harbor Institute, Woods Hole, Mass. 19 pp.

Gaines, A.G., 1997. *Sediment Mobilization in Hyannis Inner Harbor: the Role of Harbor Operations.* Prepared for the Woods Hole, Martha's Vineyard, and Nantucket Steamship Authority. The Coast & Harbor Institute, Woods Hole, Mass. 23 pp.

Pratt, S.D. and A.G. Gaines, 1997. *An Environmental Status Report on Edgartown Great Pond: Bottom Habitats and Their Flora and Fauna.* Progress Report I (July 7, 1997). 23 pp.

Gaines, A.G., 1996. The Scientific and Technological Basis for Management of Straddling Stock Fisheries. p. 53-64 (In) M.H. Nordquist (ed.) *20th Annual Seminar: Implementing the 1982 Law of the Sea Convention.* Center for Oceans Law and Policy, University of Virginia School of Law, Charlottesville, Va. 468 pp.

Gaines, A.G., 1996. Environmental impacts of warfare: A natural science perspective. p. 136-147 (In) R. J. Grunawalt, J.E. King and R. S. McClain (eds.) *The Protection of the Environment During Armed Conflict and Other Military Operations.* U.S. Naval War College International Law Studies, Volume 69. 720 pp.

Gaines, A.G., (1996 Korean Translation). U.S. Electronic Chart Display and Information System (ECDIS) Test Bed Project: Overview and Update. *Maritime Communications and Control.* Institute of Marine Engineers, Vol. 105 (2). Marine Management (Holdings) Ltd., London. p. 71-82 (In) International Symposium: The Hydrographic Affairs Development Strategy for the Age of ENC in Korea. March 3-5, 1996, Seoul National University, Seoul, Korea. 97 pp.

Schumacher, M. P. Hoagland and A.G. Gaines, 1996. Land-based marine pollution in the Caribbean: incentives and prospects for an effective regional protocol. *Marine Policy,* Vol. 20 (2): 99-121.

Hoagland, P., M.E. Schumacher and A.G. Gaines, Jr., 1995. Toward an Effective Protocol on Land-Based Marine Pollution in the Wider Caribbean Region. WHOI Technical Report 95-10, Woods Hole Oceanographic Institution, Woods Hole, Mass. 176 pp.

Hoagland, P., M.E. Schumacher and A.G. Gaines, Jr., 1995. Hacia un Protocolo Efectivo sobre Contaminacion Marina de Origen Terrestre en la Region del Gran Caribe. WHOI Technical Report 95-10, Woods Hole Oceanographic Institution, Woods Hole, Mass. 189 pp.

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EXHIBIT B

Squibnocket Pond

Coastal Resources Complex

Martha's Vineyard

Arthur G. Gaines, Jr.

And

James M. Broadus

Areawide Planning and Management: Squibnocket Pond Coastal Resources Complex.

Arthur G. Gaines, Jr. and James M. Broadus
Marine Policy Center
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts

Final Report
February 9, 1990

PREFACE

The purpose of this project is to provide technical information to planners and other decision-makers in support of their management of the coastal resources associated with Squibnocket Pond, a brackish coastal pond on Martha's Vineyard. A second objective is to help separate policy and management issues at Squibnocket into categories or units that are more readily evaluated and addressed. Where possible, alternative options have been identified for treating individual issues.

The term "coastal resources" is used in a broad sense, to mean living and non-living resources (such as fish and land); marketed and non-marketed resources (such as shellfish and clean water); and to include resources of the larger Squibnocket setting which are affected by, and affect, the Pond--roughly defined by its watershed. Our conclusions are limited to that which can be objectively defined and quantified, although we recognize that subjective value judgments are an important part of coastal management. In this report we have not attempted to discuss all of the data presented, but they are nevertheless included for their value as baseline information for future reference, discussion, and decision-making.

For this project we have worked with a Community Panel drawn from Chilmark and Gay Head. The Panel consists of Ms. Berta Welch, Gay head Planning Board; and Mr. Christopher Murphy and Ms. Jennifer Lander, Chilmark Planning Board. Ms. Welch is also a member of the Wampanoag Tribe of Gay Head. The Community Panel helped identify principal issues, provided us with local contacts and references, coordinated meetings and--from public and private sources--raised the necessary funds. Ms. Lander coordinated interactions with the Community Panel. Mr. Russell Walton reviewed the report and provided suggestions for technical and typographical editing.

We are grateful to Mr. and Mrs. William Clark, of Nashaquitsa, who provided access to the Pond; Mr. Russell Smith, Gay Head, who provided data on well water chemistry; and to Ms. Mitzi Pratt, Gay Head, who allowed us to establish an electronic receiver base-station in her house. Mr. Mark Racicot provided data on and access to Squibnocket Ridge, for which we are grateful. During the course of this study we met with Mr. Albert Fisher, Gay Head; Mr. Timothy Simmons, formerly of Sheriff's Meadow Foundation; Mr. Gus Ben David, of Massachusetts Audubon Society; Ms. Susan Whiting, West Tisbury, an authority on birdlife; Ms. Josephine Bruno, of the Martha's Vineyard Garden Club; Mr. Richard Burt, West Tisbury, an authority on archeology; and Mr. Robert Woodruff, of Woodruff & Associates. We thank Ms. Ann C. Allen, Librarian/Archivist, Dukes County Historical Society, for her patience and help with historical maps and documents.

The results of this program fall within the public domain and are subject to the traditional conventions and intellectual property rights of academia. The Woods Hole Oceanographic Institution cannot assume advocacy positions. Final management recommendations and decisions are the responsibility of the Community Panel or other entities to which they report or provide information.

EXECUTIVE SUMMARY

A study of coastal resources management for Squibnocket Pond was conducted from May to December, 1989, based on limited field work and a review of existing information. Squibnocket Pond is a brackish (10 o/oo) coastal pond connected to Menemsha Pond and the sea through a restricted, artificial channel ("Herring Creek"). Flow in the Creek changes direction with tidal periodicity, but exchange is insufficient to cause tidal displacements of surface elevation in the Pond. Variation in surface elevation instead is associated with rain events and, possibly, long period tidal oscillations. Current and salinity measurements in the Creek indicate an average seawater influx of 11,600 m^3/day, an average ebb flux of 26,600 m^3/day and a freshwater input to the Pond of 13,900 m^3/day.

The Pond is well mixed horizontally and vertically, with no evidence of stratification of salinity, nutrients or oxygen. Shellfish (clams, mussels, and oysters) are present but near their lower tolerance limit for salinity. Several indicators suggest the Pond is naturally eutrophic (highly productive): high chlorophyll **a**; high turbidity in the water column; high daytime dissolved oxygen levels; and abundant submerged aquatic vegetation (consisting predominantly of freshwater varieties). The tidal exchange and its pattern suggests materials entering the Pond are trapped inside for a long period of time.

Historical maps indicate the Pond was formerly connected to the sea through a natural inlet; other small, man-made connections have been created at two sites in the past. An artificial inlet through the barrier beach would probably be unstable, like all other inlets on the south shore of Martha's Vineyard, owing to active sand transport. Salinity in the Pond could probably be raised sufficiently for growing shellfish by improving exchange through the existing connection at Herring Creek, although this would not greatly increase flushing of the Pond. The direct salinity and biological response resulting from modest increases in exchange at Herring Creek would probably be in a state of flux for several years, and the biological response cannot be accurately predicted. However, the change would probably be reversible if, in the end, it were considered undesirable. Fecal coliform bacteria measurements suggest parts of the Pond are potentially subject to seasonal closures for shellfishing. This results from ambiguities in existing State regulations that do not distinguish between human and wildlife sources of this indicator. The implication is that management of Squibnocket Pond for shellfishing could be confounded by harvesting closure on the basis of these water quality standards.

Salinity modification to improve shellfishing may be deleterious to the alewife fishery. The alewife run at Squibnocket Pond presently has minor direct economic benefits, but is of significant cultural and historical value. The larger ecological role of alewives needs further evaluation; it is

believed the value of alewives is multiplied through their role as forage for sport fish in the area. Modest and inexpensive management steps are recommended, such as assuring passage of adults by enforcement of harvesting laws, identification and enhancement of spawning areas, and improved record keeping. Assessment of the future potential of this fishery is recommended.

Nitrogen-containing nutrients appear to limit plant growth during some periods of time. Present nitrogen loading to the Pond appears to be mainly conveyed by groundwater. For management purposes, the watershed is divided into three sectors: Nashaquitsa, Squibnocket Ridge, and Black Brook. Nashaquitsa, the most densely developed sector, presently is responsible for greatest nitrogen loading to the Pond (60%); but because of its large area, the Black Brook sector holds greatest loading potential if densely developed. If future land-use in the Squibnocket Ridge and Black Brook sectors increased groundwater nitrogen to the current level of Nashaquitsa, nitrogen loading to Squibnocket Pond would rise by a factor of three. Management of nutrient loading associated with human activities is promising for Squibnocket because of: its limited watershed and abundant wetlands; existing laws and self-imposed restrictions surrounding development; and an uncommon sensitivity and commitment of private landowners here to environmental protection.

The Gay Head Town landfill appears to be located within the Squibnocket watershed. No measurable impact was detected on nutrient concentrations in water samples from along Black Brook, which transects this portion of the watershed. A separate, commercial monitoring study of groundwater at the landfill concludes no significant increase of metals and other substances monitored was detectable. Some of the streams entering Squibnocket Pond, such as Black Brook, contain elevated levels of organic matter (62 ppm carbon) that colors the water dark brown. This is believed to be natural organic material, perhaps released by wetland vegetation and sediments.

Several challenging management concerns bear on the coastal resources of Squibnocket, such as: preservation of assets with largely subjective value (e.g., the coastal vista and wilderness ambience); the relationship and balance between private rights and governmental power in resource management; the use of ignorance of a sensitive resource as a means for protecting it (e.g., for archaeological sites and endangered species); and the balance and politics of shared government jurisdiction in the management and allocation of limited resources.

Our study illustrates the need for and value of a comprehensive and integrated approach in managing coastal resources at Squibnocket; we feel the study provides structure and substance to what is bound to be an ongoing process.

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INTRODUCTION

Background

Coastal lands and resources of the U.S. are under unprecedented pressure for modification and development. Although several levels of government are involved in managing and inventorying resources at the water's edge, many crucial powers reside in local-based entities--local land owners and local government. To a significant extent, many of the nation's most magnificent vistas and sensitive coastal lands have survived only as a result of the private commitment of land owners to preserve them.

Similarly, local governments have played a crucial role through their powers to enforce public health laws and wetland protection laws, through acquisition of open space and provision of public access and, most importantly, through exercise of zoning and real estate taxation powers. In a very real sense, much of the national effort in coastal management can be regarded as the composite of local efforts. In the converse sense, many of the failures of national and state programs can be traced to an inability to treat local-based issues effectively.

The local effort is crucial from another point of view as well. Although large state and Federal programs are funded annually to manage the nation's water quality, shellfish and finfish resources, barrier beaches, and coastal lands, the effort is nowhere near what is needed. The coast of southern New England illustrates dramatically the complexity of harbors, ponds, barrier spits and saltmarshes that make up elements of the nation's shore. The national effort must by its very nature assign highest priority toward addressing the larger coastal seas and sounds and the larger embayments depicted on the national map. But for residents of coastal towns, assets at a much smaller geographic scale determine the quality of life.

Unfortunately, though the size scale of local coastal management is smaller, the technical complexity of the problems is not. Local decision-makers have equal need for information as a basis for their decisions, but often very little support in obtaining this information. It is at the local level that volunteerism merges with the basic responsibility of citizens to participate in governance; and at this level they carry a far greater impact in routine decision-making than at any other.

The Towns of Chilmark and Gay Head are no exceptions to these generalizations, and in fact illustrate many of them well. One purpose of this work is to add our technical background to an ongoing effort on planning and management of coastal assets in this locale--specifically those related to Squibnocket Pond (Fig. 1)--to provide a more solid basis for decisions that are likely to have an impact for generations to come.

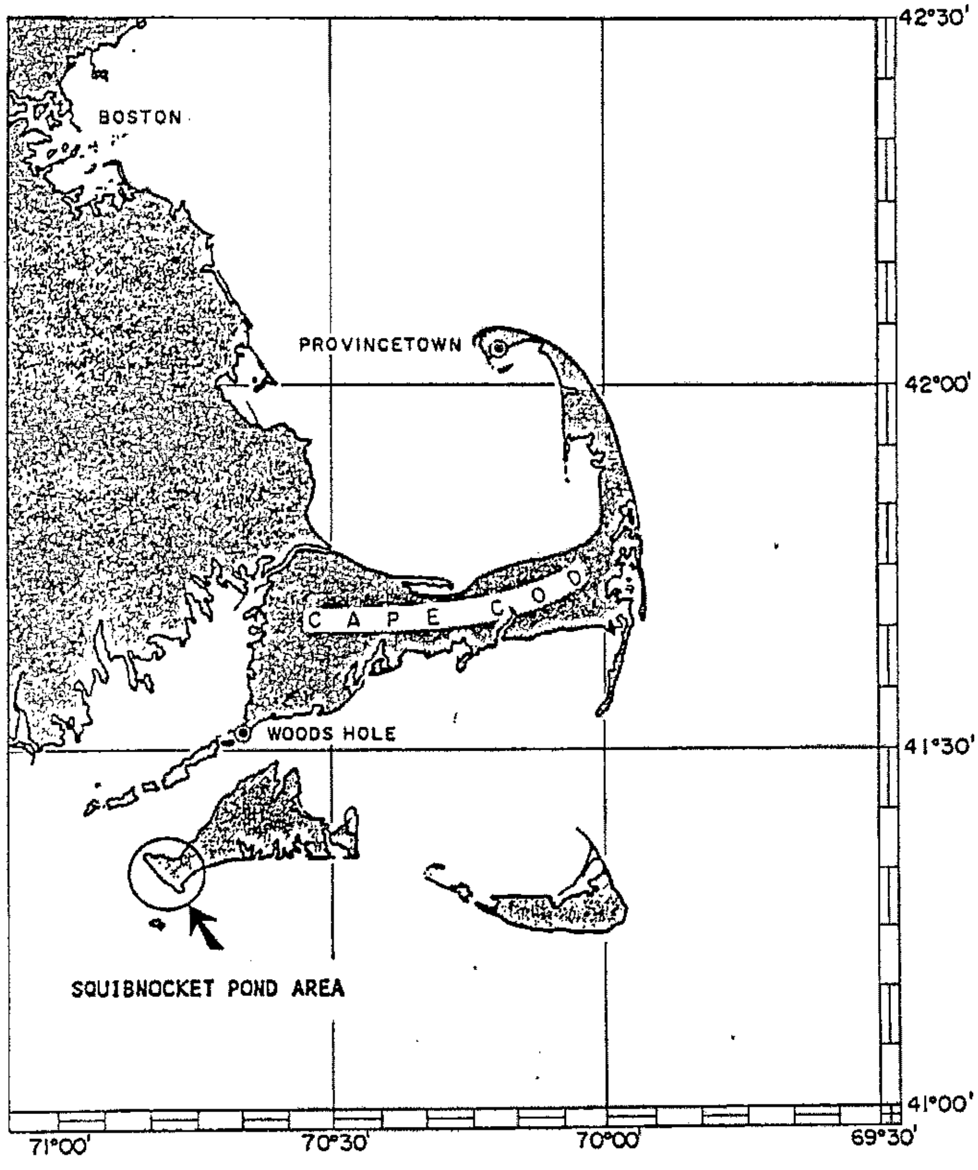

Figure 1. Regional setting for Squibnocket Pond (Martha's Vineyard) Towns of Chilmark and Gay Head, Dukes County, Massachusetts.

Principal Issues

The larger issue involves integrated management of limited coastal resources of Squibnocket Pond (Fig. 2), including land, water, and living and non-living resources. Definition of specific issues has been an ongoing part of the program, and represents one of the central functions of the Community Panel, an advisory group drawn from the two Towns:

o **Water quality of Squibnocket Pond.** Given its remote location and sparsely populated watershed, one might expect low levels of contaminants--is this assumption correct?

o **Sources and potential sources of pollutants**, such as nutrients, metals, fecal bacteria, and, possibly, organic contaminants such as hydrocarbons and pesticides. Possible sources are septic systems, landfills, and highway runoff. In the case of fecal contamination, the role of wildlife needs to be assessed.

o **Status of living coastal resources**, such as the herring run (Alosa pseudoharengus) at Squibnocket, which represents one of the few herring runs in the area subject to organized commercial exploitation. How does present harvest compare with that of the past? How large is the associated flux of materials and what are the implications of modifying it?

o **Artificial breaching of the coastal barrier.** Given the Pond's geometry, surface elevation and fresh water content, what changes might accompany creation of an artificial breachway? On the basis of available information, is an artificial opening to the sea on the south shore likely to be stable?

o **Level of biological activity.** Compared to other water bodies in Martha's Vineyard and southern New England, what is the level of productivity by algae and submerged aquatic vegetation, and how does this effect the diurnal distribution of dissolved oxygen in Squibnocket Pond?

o **Shared legal jurisdiction and institutional considerations.** The coastal area under consideration falls within the Towns of Chilmark and Gay Head, and certain resources fall within the purview of the Wampanoag Tribal Council. What opportunities and obstacles does this shared jurisdiction pose?

o **Preservation of coastal vistas and the wilderness ambience.** What is the value of "wilderness" in megalopolis, how can it be preserved, and what is an equitable and appropriate role for government and for the private sector in this process?

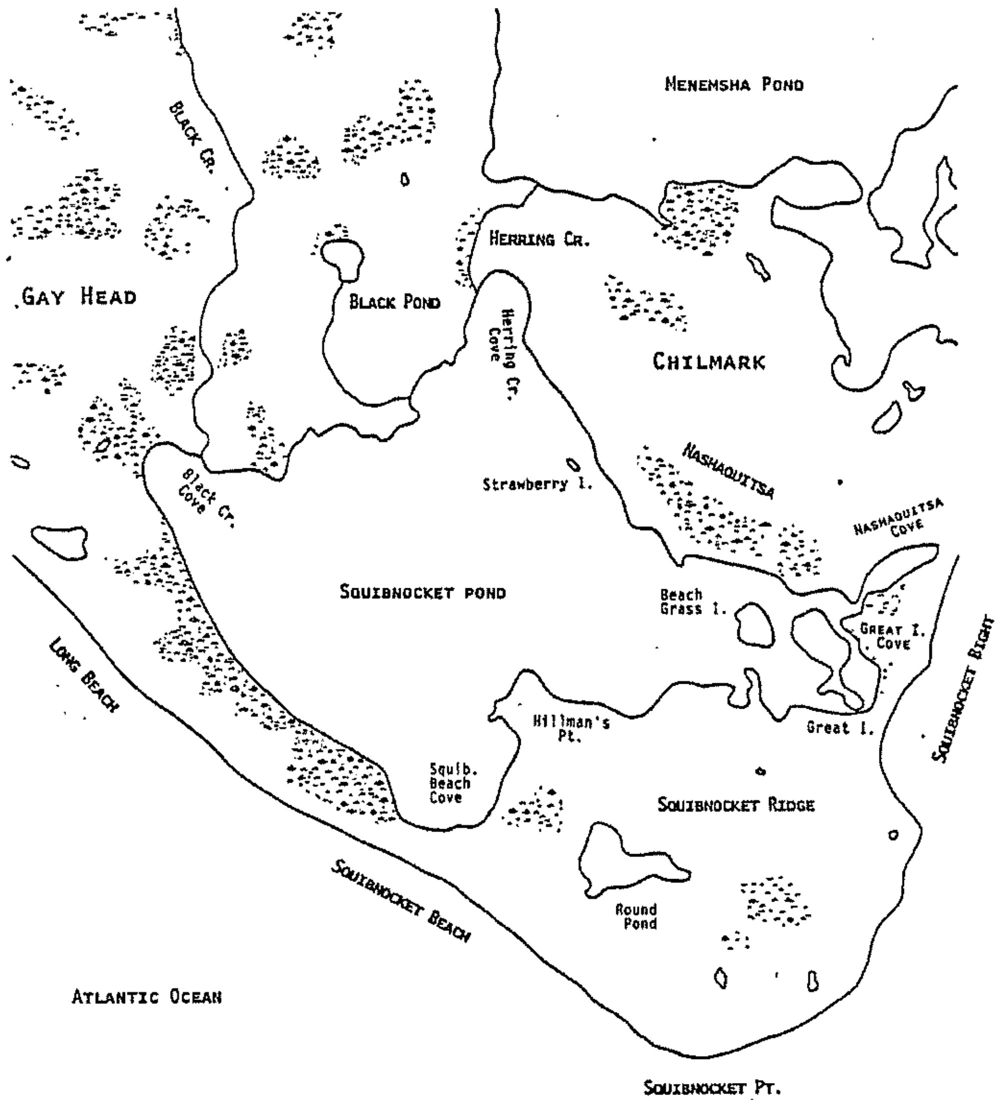

Figure 2. Squibnocket Pond, Towns of Chilmark and Gay Head, Massachusetts.

REVIEW OF EXISTING INFORMATION

Archeological Setting

Squibnocket Pond lies in an important setting regarding native American peoples, from prehistoric populations to the Wampanoag Tribe that currently resides in and shares governance for this area. The shores of the Pond contain many archeological sites, of which two are described in detail by Ritchie (1969). The Hornblower II site, just west of the Herring Creek entrance to Squibnocket Pond is particularly significant. Material excavated from the deepest stratum at this site dates from about 4,300 years before present, and is assigned to the Late Archaic of the Laurentian tradition. It records an early settlement of the southern Massachusetts area. Artifacts within overlying strata define a discrete Archaic manifestation in southern New England, described by Ritchie (1969) as the "Squibnocket Complex". Artifacts defining this complex include projectile points, scrapers, knives and drills; and the site contains a stone hearth, earth oven, potsherds and tools.

Remains of food items include abundant mollusk shells of the hard clam, soft clam, scallop, oyster, boat shell and two species of mussels. A large number of animal bones, mainly of the whitetail deer but including several other familiar species, are interpreted to suggest an emphasis on hunting. Other bones indicate the gray seal and harbor seal were taken, as were fish (e.g., cod, striped bass, bluefish), turtles (box and red-bellied), ducks and other waterfowl and other animals.

Inferences from Historical Maps

Several historical maps of the Squibnocket area are available that provide insight into natural and human activities affecting the Pond, although this kind of evidence must be viewed with caution.

The Breachway

The oldest map examined is the so-called DesBarres map (1776), a surprisingly detailed map suggesting a thorough exploration of Squibnocket Pond--perhaps for its potential as a harbor. This map (Fig. 3, panel A) depicts the Long Beach/Squibnocket Beach barrier with a prominent breachway. No other map found portrays this feature, although the 1831 Dunham map marks the same site, "opening formerly here" (Fig. 4). The location of this former breachway appears to have determined one bound of the division between the two towns. Anecdotal evidence of Vanderhoop (1904), suggests the inlet closed in about 1818.

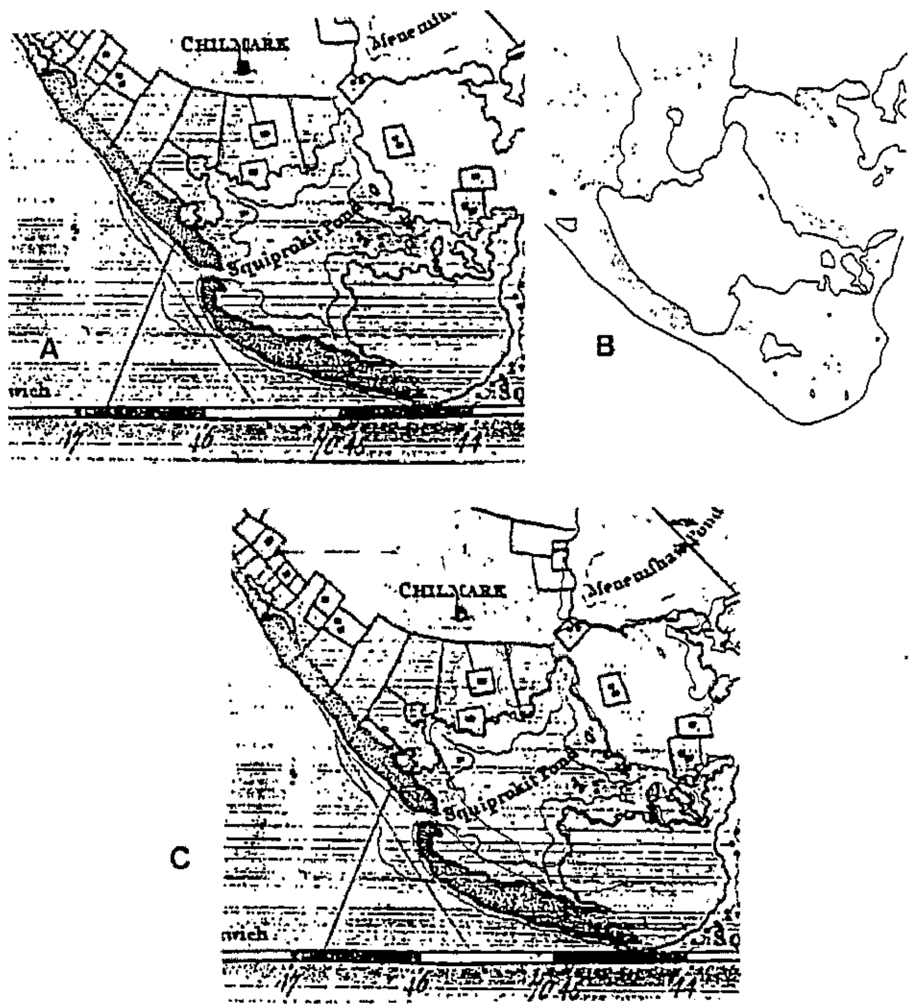

Figure 3. Detail of DesBarres map (1776) showing Squibnocket Pond area, compared with modern (U.S.G.S., 1972). A) DesBarres map; B) modern map; C) both maps overlaid.

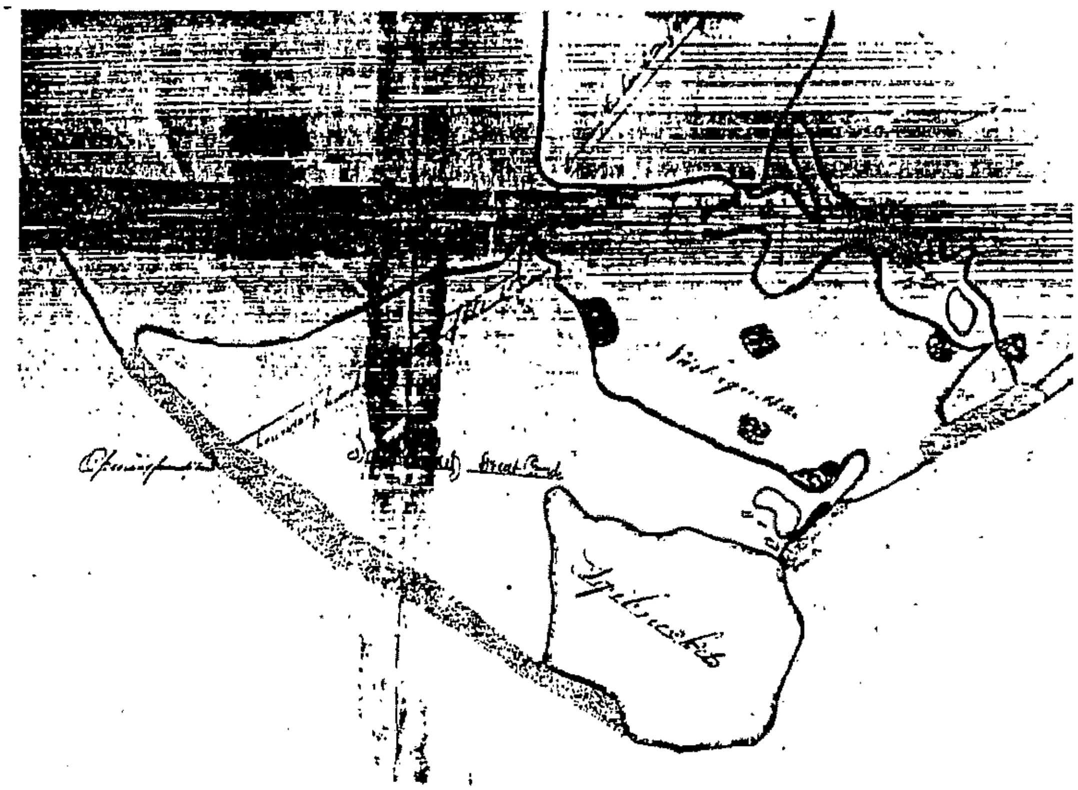

Figure 4. Detail of Dunham map (1831) showing location of former inlet in the barrier beach.

One consequence of an open breachway would be increased exchange between Squibnocket Pond and the sea. Under present conditions, salinity of the Pond water is about 10 o/oo (= 10 parts per thousand), about 1/3 full strength seawater. With an open inlet, salinity conditions may have been similar to those of Menemsha Pond, which has a permanent, structured opening, and which contains water of about 30 o/oo, only slightly more dilute than the coastal sea. While there is no reason to believe the breachway on the exposed beach at Squibnocket was a permanent one, it is likely the Pond had higher salinities during those periods it was open, and that the fauna and flora reflected the changes in environment. Ritchie (1969) believes that changes in composition of mollusk shells in strata of archeological sites around Squibnocket reflects changes associated with breaching events.

Another consequence of an open connection to the sea would be that the Pond surface elevation would be subject to changes forced by the semi-diurnal tide. As discussed below, the present restricted connection through Herring Creek effectively dampens out most of this effect. According to U.S.G.S. (1972) the present [average] surface elevation of Squibnocket Pond is 3 feet (0.91 m) above mean sea level, or about 1.6 feet (0.49 meters) above high tide level. This is probably an overestimate (because the semidiurnal flood tide current at Herring Creek lasts an average of nearly three hours daily), but it is likely that the effect of a free connection to the sea would be to lower the average surface elevation of the Pond, toward mean sea level.

Beach Migration and Erosion

A second salient observation from historical maps is transgression of the barrier spit at Squibnocket. A comparison of the DesBarres map with a modern U.S.G.S. topographic map (U.S.G.S., 1972) suggests a northward migration of the shoreline up to 425 meters (1,400 feet) over 196 years, or 2.2 meters/year (7.1 feet/year) on average (Fig. 3, C). This migration was not accompanied by appreciable narrowing of the mapped spit. Migration of the western limb of the barrier has been much less.

Compared to beach migration, erosion of the ocean coastline near Squibnocket has not been severe. This is probably a result of armoring of the shore by residual glacial boulders as the fine fraction was selectively removed over geological time, as the cliffs receded.

Herring Creek (Gay Head)

Both the DesBarres map and the Pease map (1866) depict the present Herring Creek as terminating a short distance inland from its mouth at Squibnocket Pond (Fig. 5), suggesting the

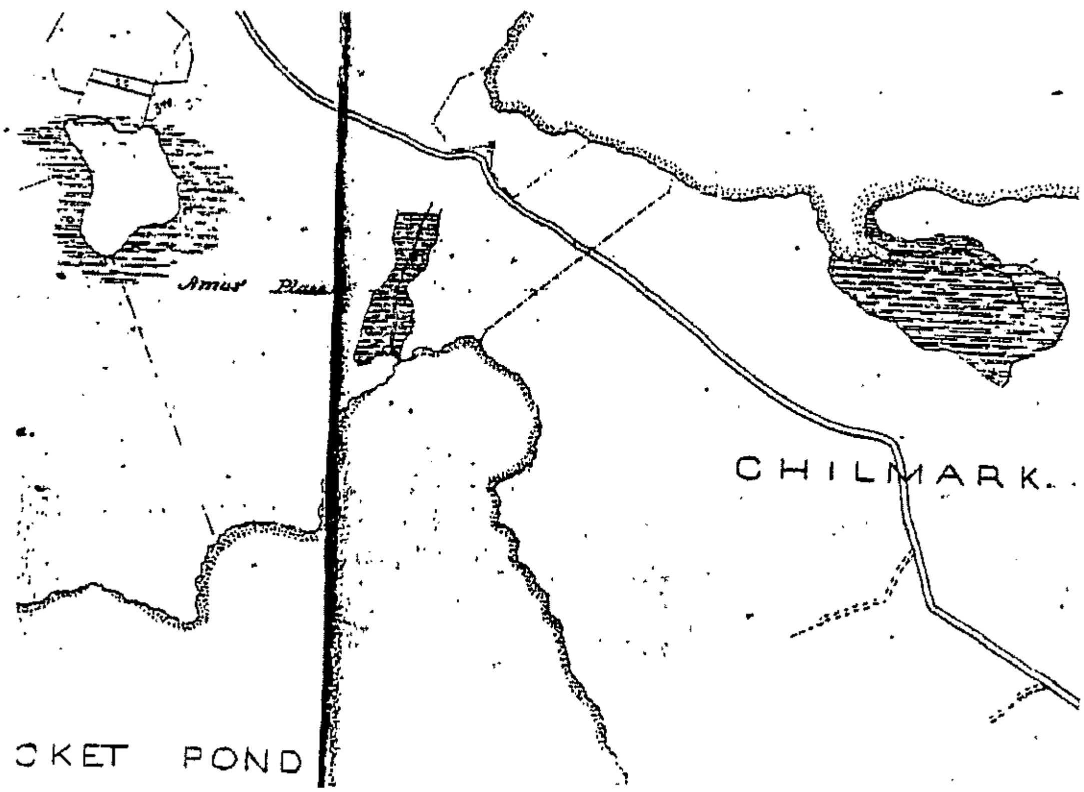

Figure 5. Detail of Pease map (1866) depicting Herring Creek as terminating without connecting to Menemsha Pond.

present connection with Menemsha Pond was established later. This evidence supports anecdotal accounts (e.g., Vanderhoop, 1904) that the Herring Creek connection was created by man. If this is correct, then Herring Creek would originally have been a freshwater stream leading only to Squibnocket, rather than a brackish, tidal creek connecting the two ponds. A potable water source at this location would have served the adjacent Hornblower II prehistoric indian site (Ritchie, 1969).

Unfortunately, the mapped evidence is equivocal. The stream is a minor geographic feature on the scale of mapped features, and its representation is sensitive to predilections and priorities of the map maker. For example, the Walling map of 1855 shows the connection as it exists today, while the Pease map, dated 11 years later, does not.

Because of the importance of this connection between the ponds, additional information was obtained through a direct field examination of Herring Creek. This examination tended to support the view that connection is artificial. Central parts of the Creek pass through deep, apparently artificial trenches through rocky glacial ridges, connecting small natural wetlands in depressions between Squibnocket and Menemsha Ponds. Both ends of Herring Creek have been deepened and are bordered by small rubble jetties.

Our working hypothesis at the moment, therefore, is that the connection between Squibnocket Pond and Herring Creek was artificially created between 1776 and the mid 19th century. According to Belding (1921) many coastal ponds in Massachusetts were modified during the 19th and early 20th centuries in connection with management of the anadramous alewife fishery (see discussion of alewives in Appendix 1). Two examples on Martha's Vineyard are "Herring Creek" connecting Edgartown Great Pond and Katama Bay in Edgartown, and a less well known ditch between Katama Bay and Pocha Pond, across Chappaquiddick Island. We have by no means yet exhausted all lines of evidence to prove the case one way or another for Gay Head Herring Creek, or to specify an exact date for its construction.

The consequences of connecting the two ponds could be quite important. For example, a principal mechanism for natural breaching of a barrier spit is accumulation of freshwater in the closed pond until a storm or other event initiates flow across the beach. This rapidly leads to dramatic excavation of a gut by the ebbing water, in a matter of hours producing a breachway that then remains open for a variable period depending upon wave action and longshore sediment transport on the seaward side. At other sites along the south shore of Martha's Vineyard, breachways thus produced stay open for a period ranging from days to weeks. With creation of a drain between Squibnocket and

Menemsha Ponds, no such head of fresh water could accumulate and the tendency for breaching of the barrier would be reduced.

A second obvious consequence of creating the Herring Creek connection is creation of a herring or alewife run from Menemsha into Squibnocket (see Appendix 1). Prior to excavation of the Creek, the run could only have existed when Squibnocket Pond had a breachway, and then the fish would presumably have migrated into Herring Creek from the Squibnocket Pond side. Harvesting of the fishery would have occurred at the south end of the present Herring Creek, rather than at the north end, as it is currently practiced.

Third, the cutting of Herring Creek provides a stable, though restricted, supply of seawater to Squibnocket. The effect overall probably has been to stabilize the aquatic environment as a low salinity coastal pond; in contrast, intermittent opening to the sea results in wide salinity excursions over time.

A final comment has to do with rising sea level. The best current estimate of local relative sea level rise in recent centuries is about 1 foot/100 years (30 cm/100 years). Therefore, since the earliest available map was produced (1776), sea level at Squibnocket has risen about 2 feet (0.6 meters). While resulting inundation is not evident from the historical maps, sea level rise over the past century could have had a significant impact on flow between Squibnocket and Menemsha (limiting channel depth at the Squibnocket end presently averages 54 cm (1.8 feet).

The Artificial Opening

The 1897 U.S. Coast & Geodetic Survey map (U.S.C.&.G.S., 1897) shows a small connection between Squibnocket Pond and the sea at the east side of Great Island. A detail from a later, more legible edition of this map is shown in Fig. 6. At present there is no connection to the sea at this site, but there are remains of a wooden sluiceway, constructed of heavy planking on pilings forming a double walled structure. This structure runs from the low glacial bluff into the sea. The interior is filled with beach sand and cobbles. On the Pond side, road modifications, natural filling and brush conceal the feature, although stoneworks, perhaps walls of the sluiceway, are evident in the marshy cove margin near Great Island.

Although Belding (1921) refers to an artificial Herring run at Squibnocket (which he distinguishes from "Gay Head Herring Creek"), the photo he gives of this structure (Fig. 7) does not resemble the remains at the site shown on the 1897 map. This photo looks more like a site near the present Chilmark town

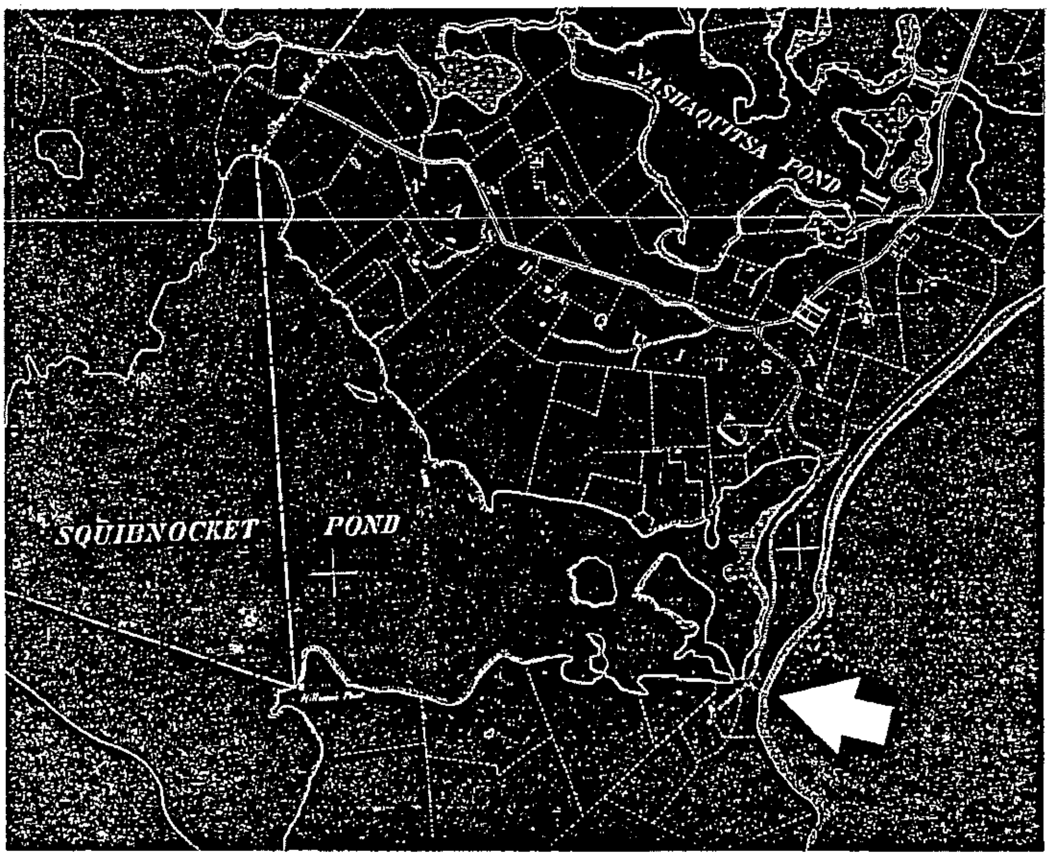

Figure 6. Detail of U.S. Coast & Geodetic map showing the location of an artificial connection to the sea at Great Island. The earliest map in this series showing this feature is dated 1897-98.

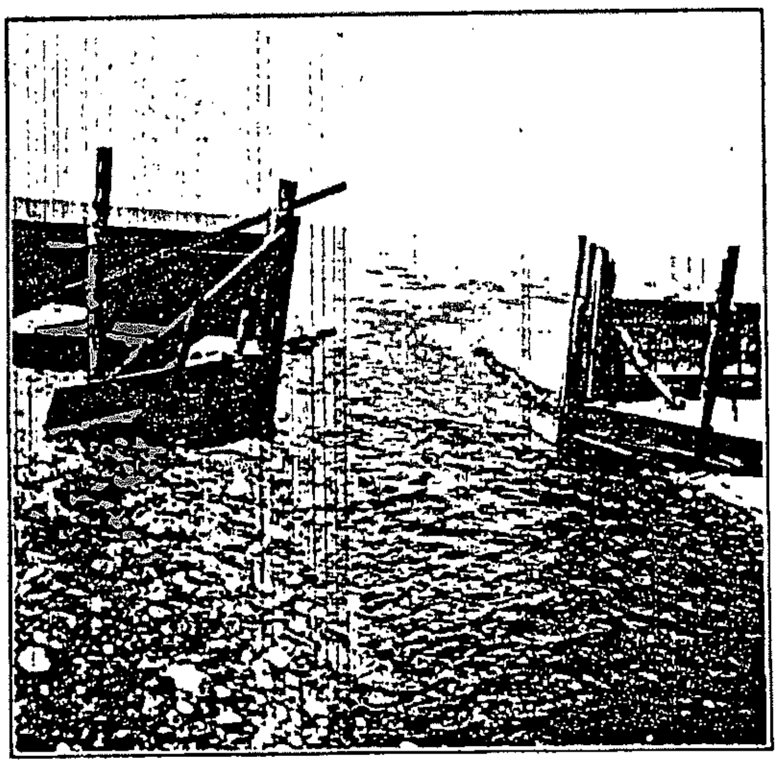

Figure 7. Photo of artificial herring run at Squibnocket, according to Belding (1921). This does not correspond with the site mapped in Fig. 6.

parking area at the extreme east cove of Squibnocket, another promising location for an artificial opening, but one for which there is no map evidence. The wooden pilings standing in the beach at this site are believed to be part of a bulkhead constructed to hold up the bank for a parking area.

Given the dimensions of the sluiceway at Great Island, it is unlikely it provided much exchange compared with a natural breachway. From the scale of this structure, and its primary purpose (i.e., to attract and provide access for alewives) it is possible the structure served mainly to discharge pond water, and that appreciable flood waters did not enter at high tide.

Other Minor Features

The DesBarres (1776) map depicts a number of minor features of interest. All of the small islands presently existing in the eastern coves are recognizable, as is the diminutive Strawberry Island (see Fig. 3, A and C). Desbarres even mapped prominent boulders in the Pond; the solitary boulder portrayed directly above "S" on his map (Fig. 3A) is currently located nearer the present shoreline and is covered with oysters. Given the rise in sea level over the centuries, these boulders may at the time have been inter-tidal, while they are at present totally submerged. The cove shown at the extreme west side of the Pond is currently a wetland.

Lily Pond, the small pond behind the dune near the town line is also portrayed by DesBarres; this seemingly ephemeral feature, a shallow freshwater panne trapped against a small glacial hill by the dune ridge, has existed in this spot for over two centuries.

The Squibnocket Pond Watershed

The watershed and groundwater recharge area of Squibnocket determine and quantity of fresh water entering the Pond; and activities within this area, both natural and human, can affect the composition and quantity of waterborne materials entering this coastal pond. The watershed can be defined from the topography shown on geological maps by connecting topographic highs (Fig 8). The groundwater recharge area is often approximated by the watershed, but can be significantly different. The recharge area is better estimated by drawing lines that are equidistant from zones of discharge, such as the margins of water bodies or stream beds. For the case of Squibnocket Pond, this is not possible because of the complexity of the glacial aquifer and abundant evidence of perching of the water table on impervious beds. Therefore, at Squibnocket until

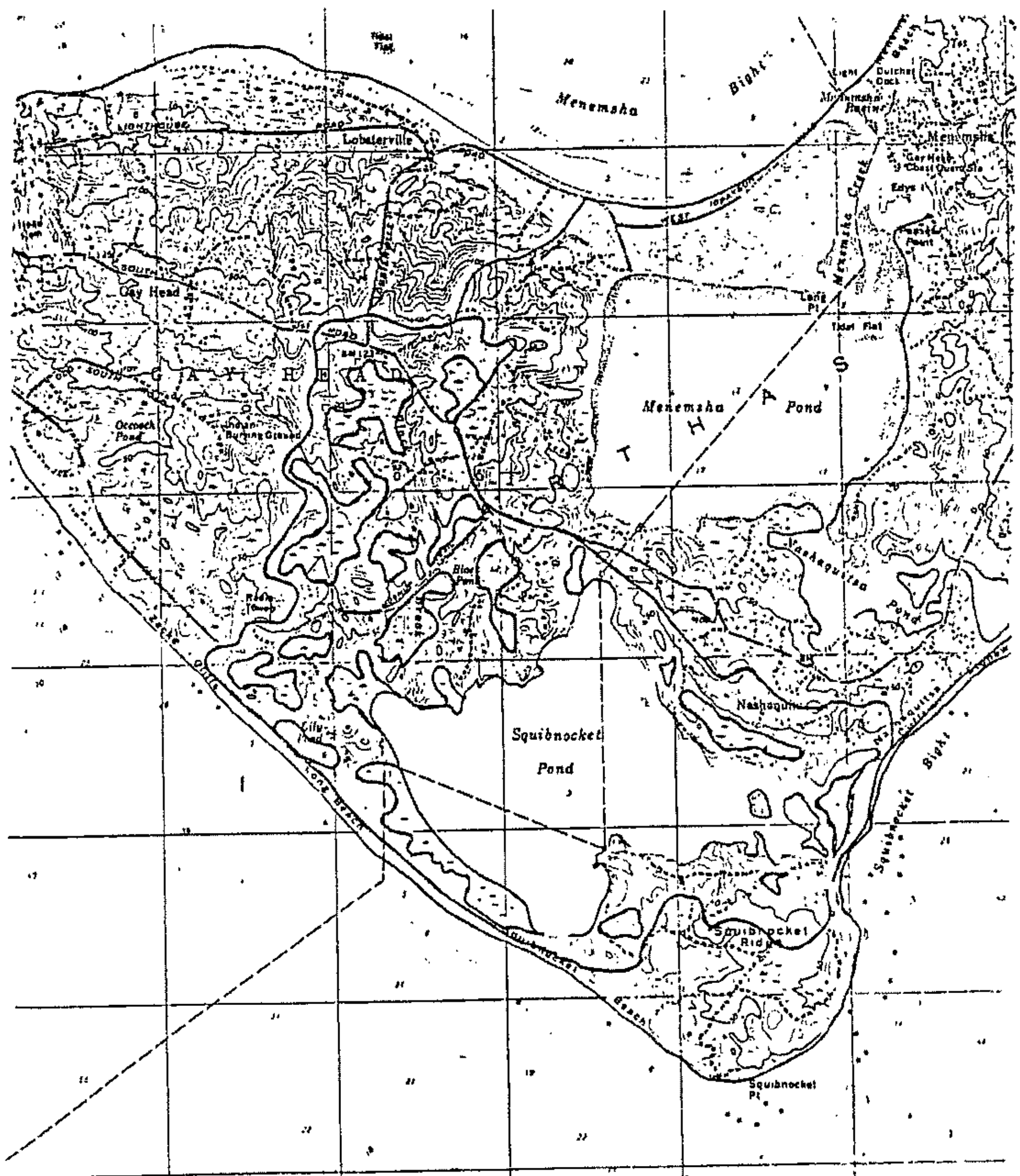

Figure 8. Estimated boundaries of the Squibnocket Pond watershed, on U.S.G.S. 1972 topographic map. Major wetlands are delineated.

better information is available it is assumed the watershed and recharge area are congruent. The watershed and recharge areas for Menemsha Pond, which delivers dissolved and suspended materials to Squibnocket during flood tide through Herring Creek, are a lesser concern. Dissolved materials in freshwater entering Squibnocket by this route are strongly diluted with seawater (to about 3% of original concentration), and bioactive substances could have reacted with the marine life in Menemsha Pond. Very accurate measurements of transport into Squibnocket from Menemsha were made, which will be discussed later.

The Squibnocket Pond watershed can be divided into four sectors (Table 1), lying on the three lobes of glacial moraine forming a) Gay Head, b) Nashaquitsa and c) Squibnocket Ridge; and on d) the beach/marsh complex formed more recently by coastal marine processes. The characterization of the watershed sectors is an ongoing effort, with numerous public and private participants (see MVC, 1977). The comments offered here are intended to contribute to that effort, but are far from complete.

The three glacial sectors of the watershed together comprise about 80% of the total. Wetlands cover about 310 acres of the watershed (23%), as 19 more-or-less discrete, though often connected units.

Nashaquitsa Sector

This sector, falling within the municipal purview of Chilmark, is the most heavily developed for residential housing. It comprises about 15% of the watershed. According to the Martha's Vineyard Commission, it is also nearest to buildout under present zoning laws. MVC (1977) characterized its use as woodlands, open fields and light residential. Portions of this sector are subject to conservation restrictions, imposed voluntarily by landowners. In one case these restrictions are formalized through agreement with the Trustees of Reservations, a Massachusetts conservation organization. In a second case they are formalized through deed restrictions on building lots grouped under a community association.

Primary public access to Squibnocket Pond (for residents of Chilmark) occurs through this sector at Squibnocket Bight. A less known and used access (for residents of Gay Head) crosses the far western part of Nashaquitsa, near the town line in the Town of Gay Head.

Table 1. Areal characteristics of the Squibnocket Pond watershed (estimated from U.S.G.S., 1972)

Feature	Estimated Area Square Km	Acres
Squibnocket Watershed		
Total area	7.930	1,960
Total terrestrial	5.410	1,340
wetland[a/]	1.240 (23%)	310
non-wetland	4.170 (77%)	1,030
Black Brook sector	2.870 (53% [66.4])[b/]	710
Squibnocket Ridge sector	0.660 (12% [15.3])	160
Nashaquitsa sector	0.790 (15% [18.3])	200
Beach/marsh sector	1.090 (20% [0.0])	270
Total aquatic	2.520	620
Squibnocket Pond	2.510	620
Black Pond	(0.012)[c/]	(3)
Lily Pond	(0.007)[c/]	(2)
Menemsha Watershed		
Total area	11.850	2,930
Total terrestrial	8.680	2,140
Total aquatic	3.200	790
Menemsha Pond	2.710	670
Nashaquitsa Pond	0.360	90
Stonewall Pond	0.130	30

a/ "Wetland" is used here to mean areas shown on the U.S.G.S. topographic map (1972) as wetlands. This is not necessarily the same as the legal term "wetland" as used in Massachusetts law.

b/ Figures in [] represent % of watershed if beach/wetland is disregarded.

c/ These values determined from morphometric estimates.

Kaye (in MVC, 1977), characterizes the hydrology of Nashaquitsa as follows:

> "Variable aquifer. Mostly sandy zones interbedded with clay, complexly folded and tilted. Water table varies from 10 feet to 100 feet in depth. Quality of water good.
>
> "This zone consists largely of a thick gray clay overlain by medium-grained sands that were pushed by a lobe of glacial ice out of the Menemsha Basin and Menemsha Bight and in consequence are much deformed. Ridges are generally underlain by thick clay, intervening valleys by sand. All deposits dip north."

There are no prominent streams entering Squibnocket Pond from this sector, although numerous intermittent seeps are found at the shoreline. A particularly large spring is believed to enter Nashaquitsa Cove, where reduced surface salinity occurred and where freezing is retarded during the winter.

Squibnocket Ridge Sector

Squibnocket Ridge is subject to governance and the zoning laws of Chilmark. It is currently the object of a planning program by the Vineyard Open Land Foundation (VOLF) on behalf of the corporation of owners. A large amount of data on the soils, drainage, wildlife and other characteristics of Squibnocket Ridge are currently being gathered by VOLF, consulting engineers, conservation organizations and their volunteers.

Judging from the U.S.G.S. (1972) topographic map, about half of the landform drains into Squibnocket Pond, comprising about 15% of the Squibnocket Pond watershed. For many years the Ridge was used for cattle and sheep grazing, and for a small number of seasonal residences. MVC (1977) characterizes its use as woodlands and open fields, with some light residential. Kaye (in MVC, 1977), characterizes the hydrology of Squibnocket Ridge (Zone E) as follows:

> "Generally a poor aquifer. In places, shallow water table and limited amounts of groundwater occur in thin sand and gravel and sandy till [that] overlies very compact glacial till. This till, which makes up the main mass of this moraine, yields little if any water."

Only small streams are known to flow into Squibnocket Pond from the Ridge, although numerous seeps and intermittent streams can be found at the shoreline, most of which drain small wetlands.

Black Brook Sector

All of the well delineated streams entering Squibnocket Pond appear to arise in this sector, which comprises about 66% of the watershed. The Black Brook sector is subject to laws and governance of the Town of Gay Head and of the Wampanoag Tribal Council. It is sparsely developed residentially, and was characterized by MVC (1977) as open fields and woodlands. A particularly well known hydrological feature of this sector is "Cook's Spring", located a short distance west of Herring Creek on the south side of South Road. This spring presently issues from a short vertical pipe leading from a buried reservoir tank from which water can be drawn. Anecdotal accounts indicate the mouth of the spring is buried beneath the highway a short distance uphill from the pipe, and is conducted to its present location through crushed gravel and pipe. According to Smith (personal communication) the spring is subject to contamination by runoff during periods of rainfall. The rate of discharge measured in November 1989, during a dry period, was about 13,000 gallons per day (=49 cubic meters/day).

This sector is closely related to Squibnocket Ridge hydrologically and the above description by Kaye (in MVC, 1977) applies here as well.

One of the principal concerns in this sector is the impact on water quality of the Gay Head landfill, situated adjacent to a wetland near the head of Black Brook, near the intersection of Lobsterville Road and South Road (State Highway). Monitoring of the groundwater composition at up- and downgradient wells has been conducted by Saunders Associates (1989) and by Goldberg-Zoino & Associates (1985-87), in accordance with administrative consent orders to the town by the Massachusetts D.E.Q.E. (now the Department of Environmental Protection). Saunders Associates (1989) concludes there is a "...lack of indication of significant water quality degradation within the Gay Head landfill...." However, results of the monitoring program have not been translated into terms of groundwater loading, and require further assessment.

Beach/marsh Sector

The beach/marsh sector consists of the barrier beach and wetland complexes, in places incorporating minor glacial deposits, that connect Squibnocket Ridge to the mainland on both sides, and corresponds roughly with the areas restricted under M.G.L. chapter 130 section 105, as recorded in maps 11 and 44 filed in the Dukes County Courthouse. This sector comprises 20% of the watershed.

Kaye (in MVC, 1977) characterized this sector hydrologically as follows:

> "Very poor aquifer. Beach sands, sand dunes, marshes and artificial fill over marshes and shallow offshore."
>
> "These areas are very vulnerable to salt water intrusion."

FIELD OBSERVATIONS, MEASUREMENTS, AND ESTIMATES

Squibnocket Pond

Origin and Landforms

Squibnocket Pond is part of a coastal landform, representing a quintessential example of the drowned glacial end moraine. In this area, late glacial thrusting by ice produced ridges and valleys in complex sediments consisting of glacial materials and deformed older coastal plain sediment, the best examples of which are exposed in the eroded Gay Head Cliffs, but which also occur, unexposed, at Squibnocket Ridge and elsewhere nearby.

Squibnocket Pond represents an irregular flooded basin, whose shoreline is mainly shaped by the original glacial landforms. It has a surface area of 2.51 square km (620 acres) and a shoreline length of 9.47 km. (values for Menemsha are 2.71 and 8.96, respectively). The bathymetry is not well defined, although one modern map gives rough information (Zapal, 1977 in Walsh et al., 1979). Where the shore lies against glacial material it is mainly steep and studded with cobbles and boulders (in places seeping with groundwater) that can be seen extending underwater to form parts of the Pond bottom. An intertidal zone is generally narrow or absent. Small islands (Great, Beach Grass, and Strawberry), are formed from glacial deposits and their eroded remains. In two places conspicuous boulder clusters are stained white with the excrement of sea and shorebirds. Isolated boulders occur uncharted in the eastern arm of Squibnocket Pond where they rise unexpectedly from the depths to present a hazard to boating. They occur less commonly elsewhere in the Pond as well.

The southwest margin of the Pond is a barrier beach complex, the product of marine processes which have reworked glacial sediment, accompanied by marsh building in the shallow water along much of this Pond margin. Minor sediment reworking on the Pond side has produced a narrow beach along this border of the wetland, to produce an interior wetland captured between two beach deposits.

The orientation of the barrier and an evidently abundant sand supply has resulted in construction of magnificent dunes, the work of strong northwest winter winds. Very few better examples of dune building exist in Massachusetts. Along this margin of the Pond, the shore is sandy and shallow for a considerable distance into the Pond. This provides a diversity of shoreline that gives this pond great interest and natural history value. The Black Creek Cove area is a backshore dune and wetland complex. This feature is the eastern terminus of a larger feature extending to the northwest, where marine deposits have moved against the glacial coast producing, in local terms, a broad, low-lying trough of backshore landforms and wetlands. Occasional small glacial features project out of the sand, or stand with eroded flanks at the shoreline.

Salinity and Temperature

Two spatial surveys of salinity were made in Squibnocket Pond (Figs. 9 and 10). These indicated a surface salinity of about 10 o/oo (1/3 of full strength seawater), with very little variation around the Pond. Two samples collected a few meters offshore in Black Creek Cove on October 26, 1989 measured about 2 o/oo and 3 o/oo, reflecting the influence of freshwater streams entering nearby. The other site showing depression in salinity was Nashaquitsa Cove for which salinity was 6.4 o/oo on August 12. A vertical profile of salinity on September 2 showed no stratification to the bottom.

In connection with electronic monitoring at the mouth of Herring Creek in Squibnocket Pond, salinity was measured at two minute intervals. These measurements indicated very little departure in the salinity of ebbing water from about 10 o/oo, with flood tide producing sharp spikes of about 30 o/oo (see Fig. 19c, p. 39).

Temperature of Squibnocket Pond water (Figs. 11 to 13) followed a typical seasonal pattern for this area, reaching 25 C (77 F) in late July (Fig. 11). Measurements made electronically at 15 minute intervals during October at the mouth of Herring Creek, indicated the diurnal variation of temperature in the Pond was large compared to the effect of flood tide from Menemsha.

Plants and Animals

Unstructured observations on the biota were recorded in the course of our fieldwork. The dominant benthic plants (angiosperms) in Squibnocket are all of freshwater variety. These appear to be thinly distributed in deep water, but occur in much denser concentration in all of the coves. In the eastern coves, rooted freshwater plants were extremely dense during the

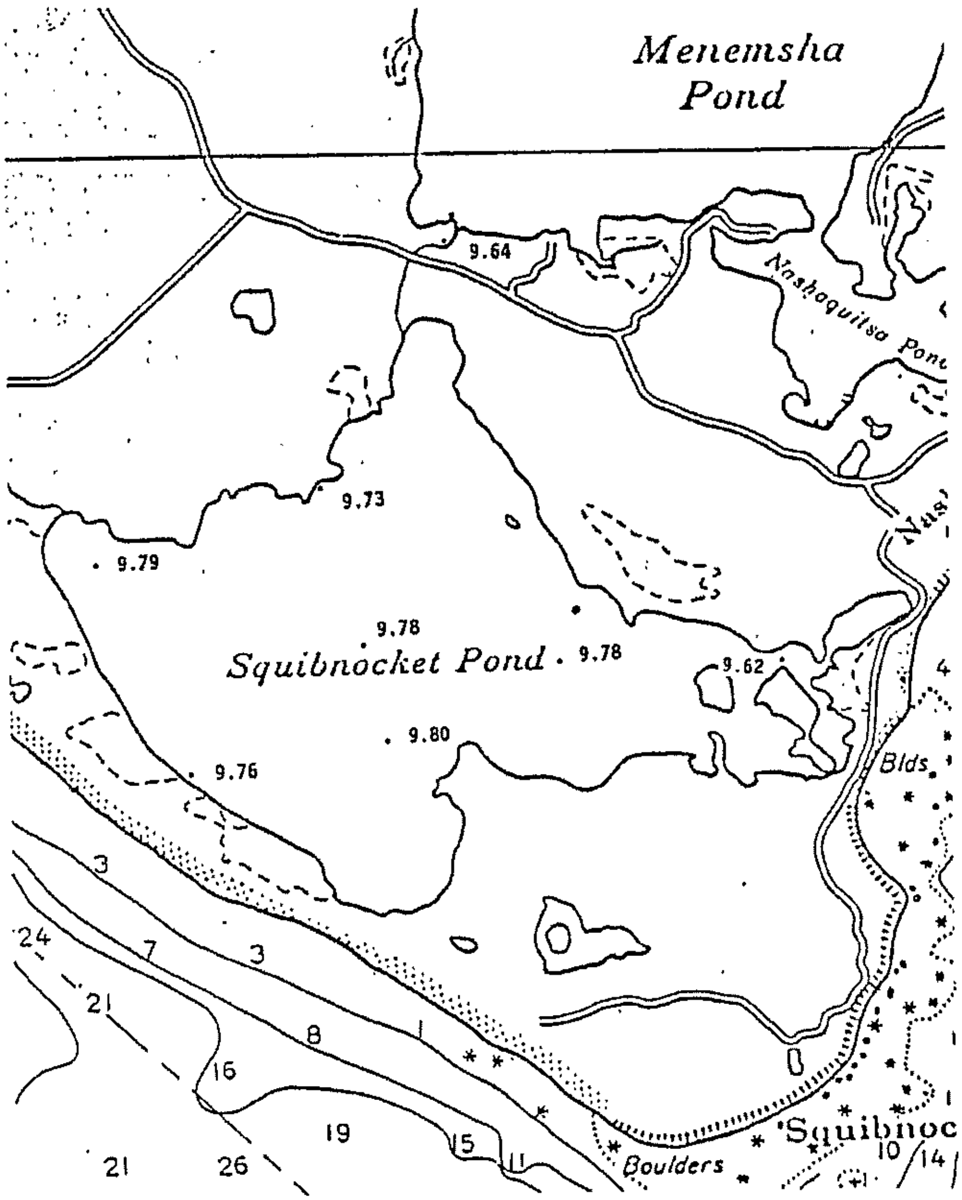

Figure 9. Surface salinities for Squibnocket Pond, May 29, 1989 (values accurate to 0.01 o/oo)

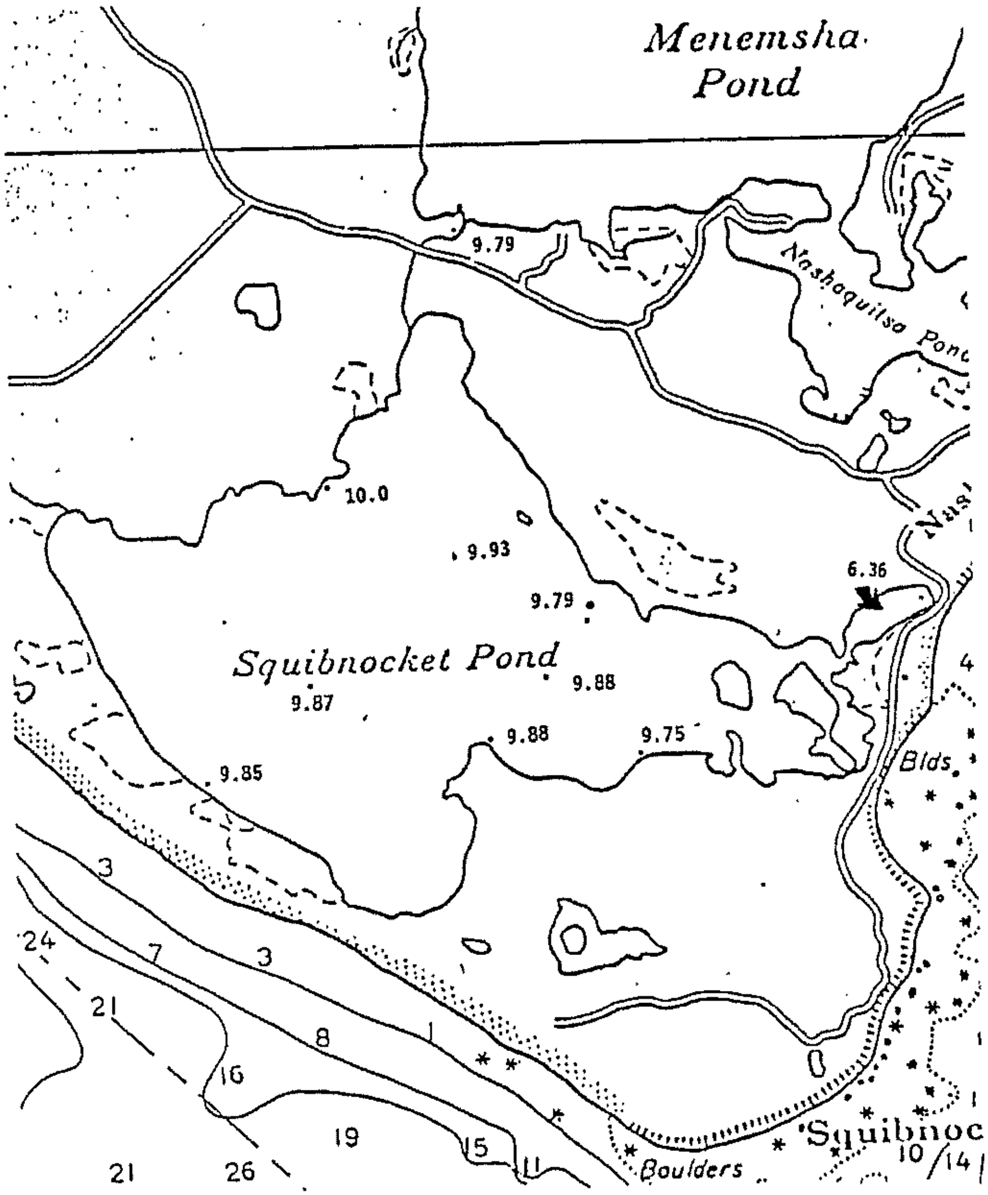

Figure 10. Surface salinities for Squibnocket Pond, August 12, 1989 (values accurate to 0.01 o/oo)

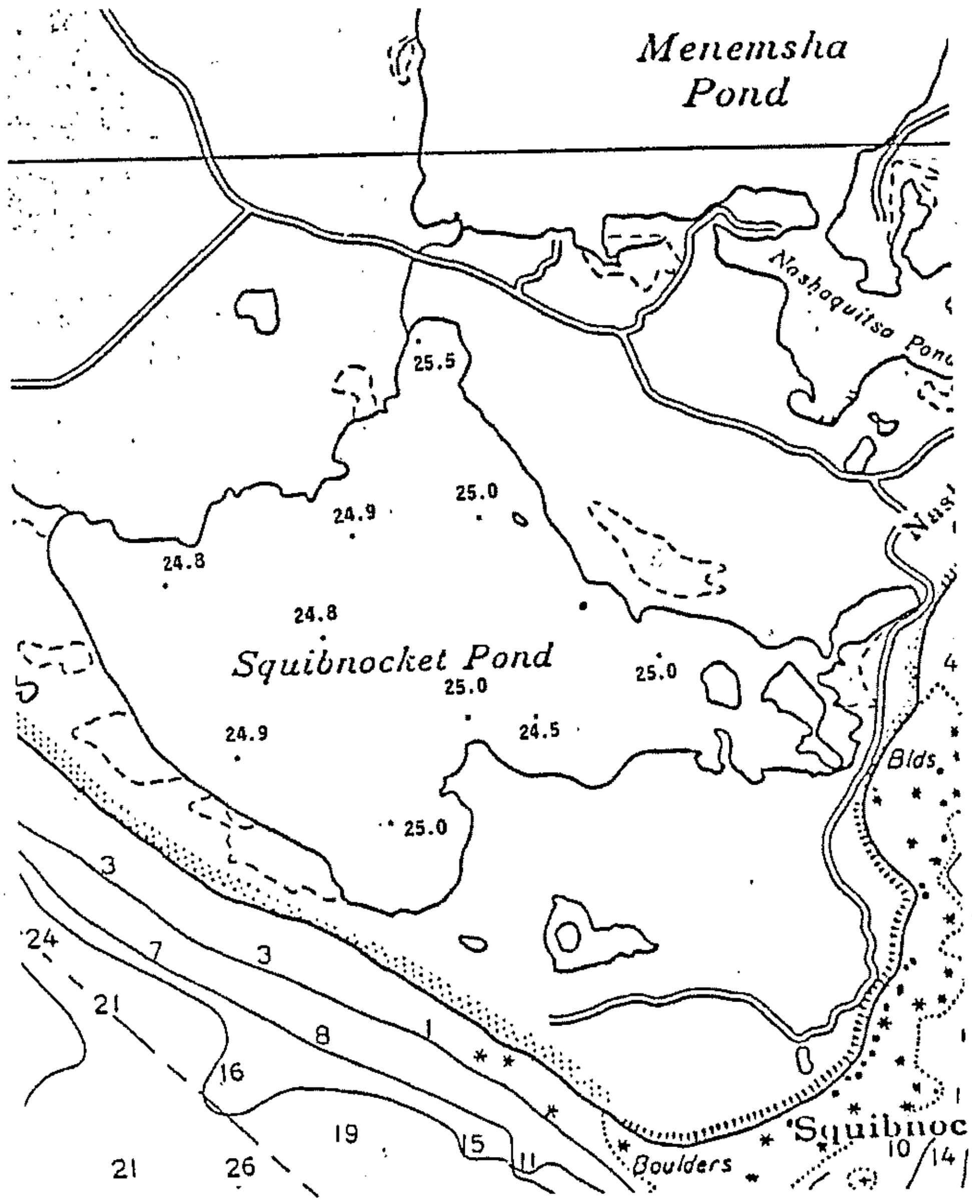

Figure 11. Surface temperatures (C) for Squibnocket Pond, July 30, 1989.

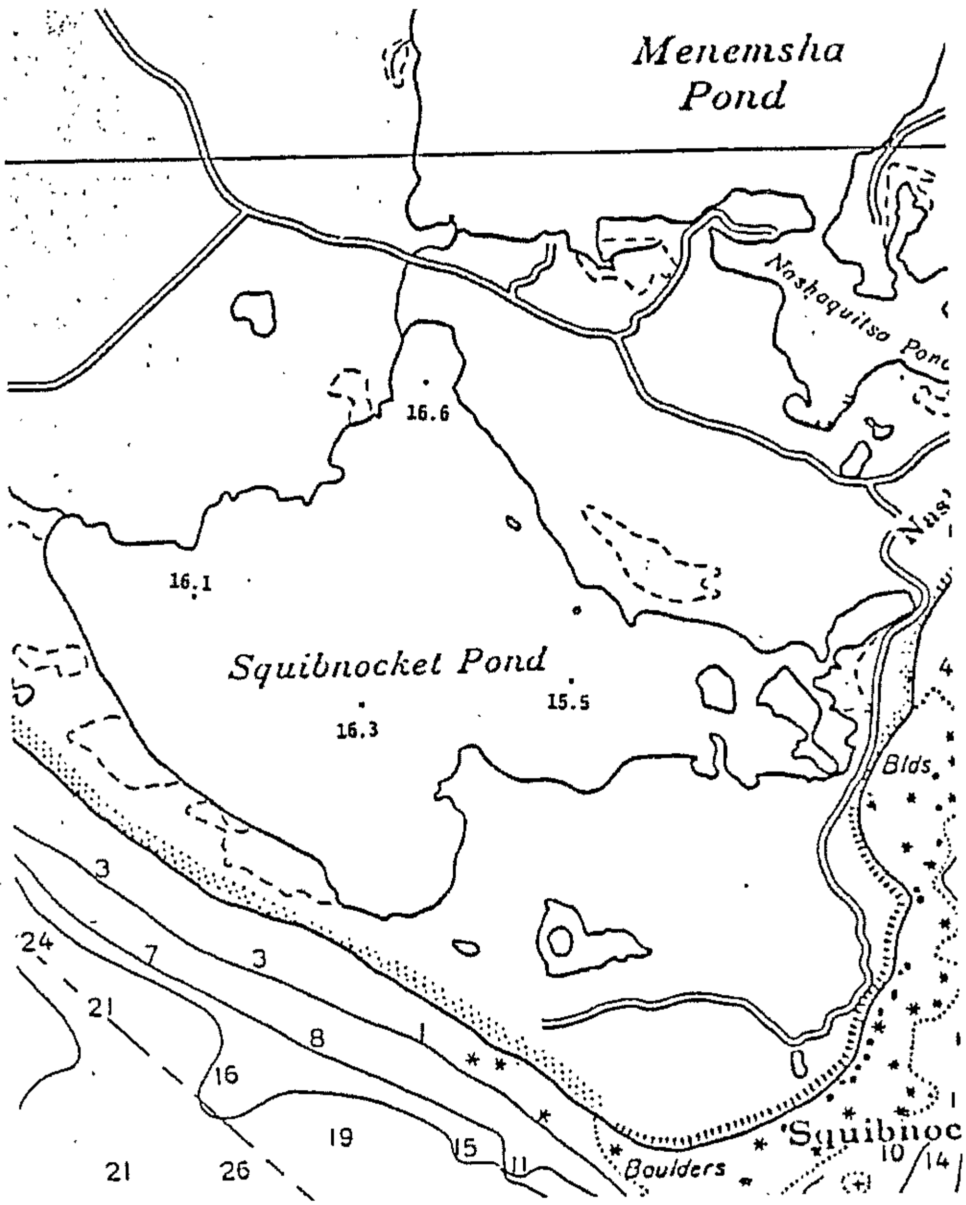

Figure 12. Surface temperatures (C) for Squibnocket Pond, September 28, 1989.

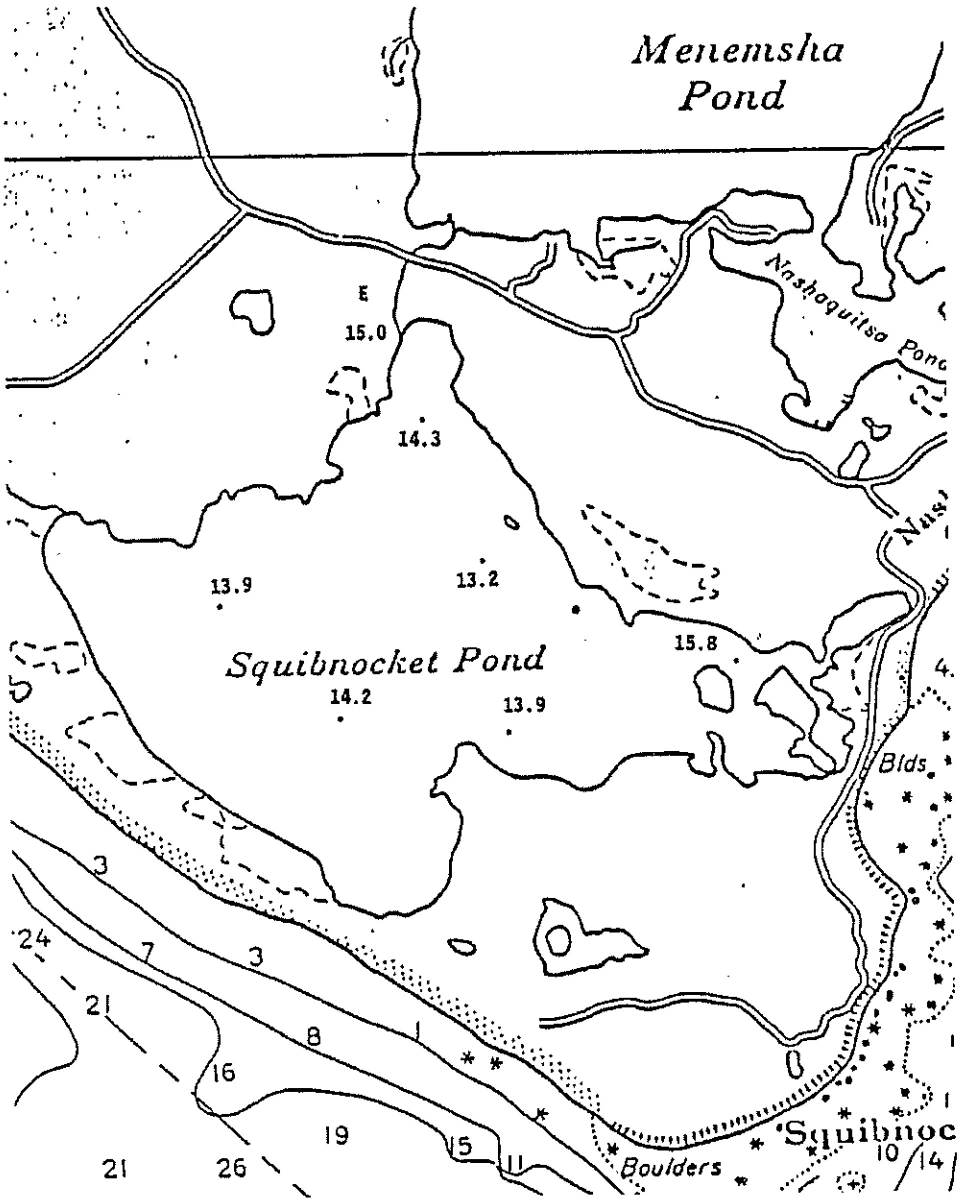

Figure 13. Surface temperatures (C) for Squibnocket Pond, October 31, 1989.

summer months, and in Nashaquitsa Cove it was very difficult to move a boat through them. At the far eastern terminus of this Cove, dystrophic conditions occurred during the late summer, with dead and deteriorating masses of these plants. To a much lesser extent, certain of the green algae occurred, such as Enteromorpha.

On September 2, we counted 81 swans in the Pond. During the summer months even greater numbers of cormorants were common, generally concentrating on the boulder clusters. More complete and authoritative records of bird occurrence are available, such as through the Massachusetts Audubon Society.

Table 2 lists the marine invertebrates encountered during fieldwork. As indicated, all of these species are near their lower salinity tolerance in Squibnocket Pond. According to Murphy (personal communication) the blue crab also can be found in Squibnocket Pond.

Water Transparency

Secchi disc readings were taken on four occasions to characterize water quality in qualitative terms (Figs. 14 to 17). The data suggest that Squibnocket Pond is comparable to the most turbid coastal waters we have examined (Table 3), with values of 1.8-2.3 m (5.9-7.6 feet) between July 30 and October 31, 1989.

Transparency of natural waters is influenced by coloration and by turbidity. Streams entering the Pond are known to be highly discolored with a reddish substance, probably organic material from the wetlands (well water sampled from the watershed was not discolored in this way). Water samples from the mouth of Black Creek collected on October 9, 1989 contained 1.72 ppm of iron, and 62.4 ppm of total carbon. The carbon value is extremely high and supports the contention that the discoloration is organic. The iron content is not unusually high for natural waters (although it is high for drinking water) and is probably not responsible for discoloring the sample. Two area that seemed especially discolored were the Black Creek Cove and Nashaquitsa Cove.

Given that there are no sources of fine inorganic sediments entering the Pond, high turbidity would suggest a high standing crop of plankton in the water. We were not able to pursue this aspect of research but would like to do so in the future.

Table 2. Common marine and estuarine "intertidal" organisms in Squibnocket Pond.

Organism		Lower Salinity Tolerance (o/oo)
American oyster	*Crassostrea virginica*	5[a/]
Softshell clam	*Mya arenaria*	4 (2.5)[b/]
Blue mussel	*Mytilus edulis*	5[c/]
Green crab	*Carcinus maenus*	-

sources:
a/ Abbe, 1982 in Stanley and Sellers, 1986.
b/ Perkins, 1974 in Abraham and Dillon, 1986.
c/ Bayne, 1976a in Newell, 1989.

Table 3. Secchi depths (m) for coastal ponds on Martha's Vineyard, July 30 - October 31, 1989.

	SQB	OH	CP	KB	EGP
July 30 - Aug 3	2.1	>4.4	3.0	2.1	2.3
Aug 21	2.1	-	-	-	-
Sept. 25-28	2.3	4.3	4.0	>3.0	2.6
Oct 27- 31	1.8	>4.5	>4.5	(3.6)	(2.7)

Numbers in () indicate disk was visible on the bottom. Arithmetic averages. SQB= Squibnocket Pond; OH= Edgartown Outer Harbor; CP= Cape Poge Bay; KB= Katama Bay; EGP= Edgartown Great Pond.

Nutrients and Dissolved Oxygen

Samples collected from a profile of Squibnocket Pond were analyzed for five nutrients and for oxygen. The results (Table 4) indicate nitrogen-containing nutrients (nitrate, nitrite and ammonia) were very low, and possibly limiting to algal growth at that time. Phosphorus was abundant although not beyond the expected range of natural waters in this area. Silica was very high for brackish water. Nutrient data for Squibnocket Pond are compared with other water bodies in Table 5.

Walsh et al. (1979) gives nutrient data for samples from Vineyard Sound, Menemsha Pond and Squibnocket Pond taken in 1977 (Table 6). These data are generally consistent with our other data, except they suggest generally higher levels of nitrogen for Squibnocket Pond and adjacent waters.

Dissolved oxygen was abundant throughout the water column. Spatial measurements made at mid-day on August 21, 1989 at 2 m depth (6.6 feet) using an oxygen electrode, showed high values, the highest of which occurred in the eastern coves where submerged aquatic vegetation abounds (Fig. 18). These measurements support the idea that the Pond is highly productive. The high chlorophyll a concentrations reported by Walsh et al. (1979), averaging 1.25 ug/l, suggest a high standing crop of photosynthetic plankton, which is another indicator of eutrophication. Productivity of Squibnocket Pond is an area that deserves additional attention in the future.

Tides and Flushing

Water level, salinity, temperature and current time series were taken at the Squibnocket Pond end of Herring Creek during two week-long intervals in the autumn of 1989. These measurements were made electronically (ENDECO/YSI 1152 compensated water level recorder; ENDECO/YSI 174 SSM current meter) in the well defined channel where water enters and leaves the Pond. These data can be used to estimate exchange and materials mass balance between Squibnocket and Menemsha Ponds.

The results of the measurements (Fig. 19) indicate the restricted connection between the ponds dampens out the tide with regard to changes in surface elevation of the Pond. The spring tide range in Vineyard Sound near the mouth of Menemsha Pond is about 1.5 m (4.9 feet) and is reduced by about one half inside Menemsha Pond (Moody, 1988). During the interval of our Squibnocket observations the ocean tide (as represented by records from the Edgartown station) showed the typical semi-diurnal

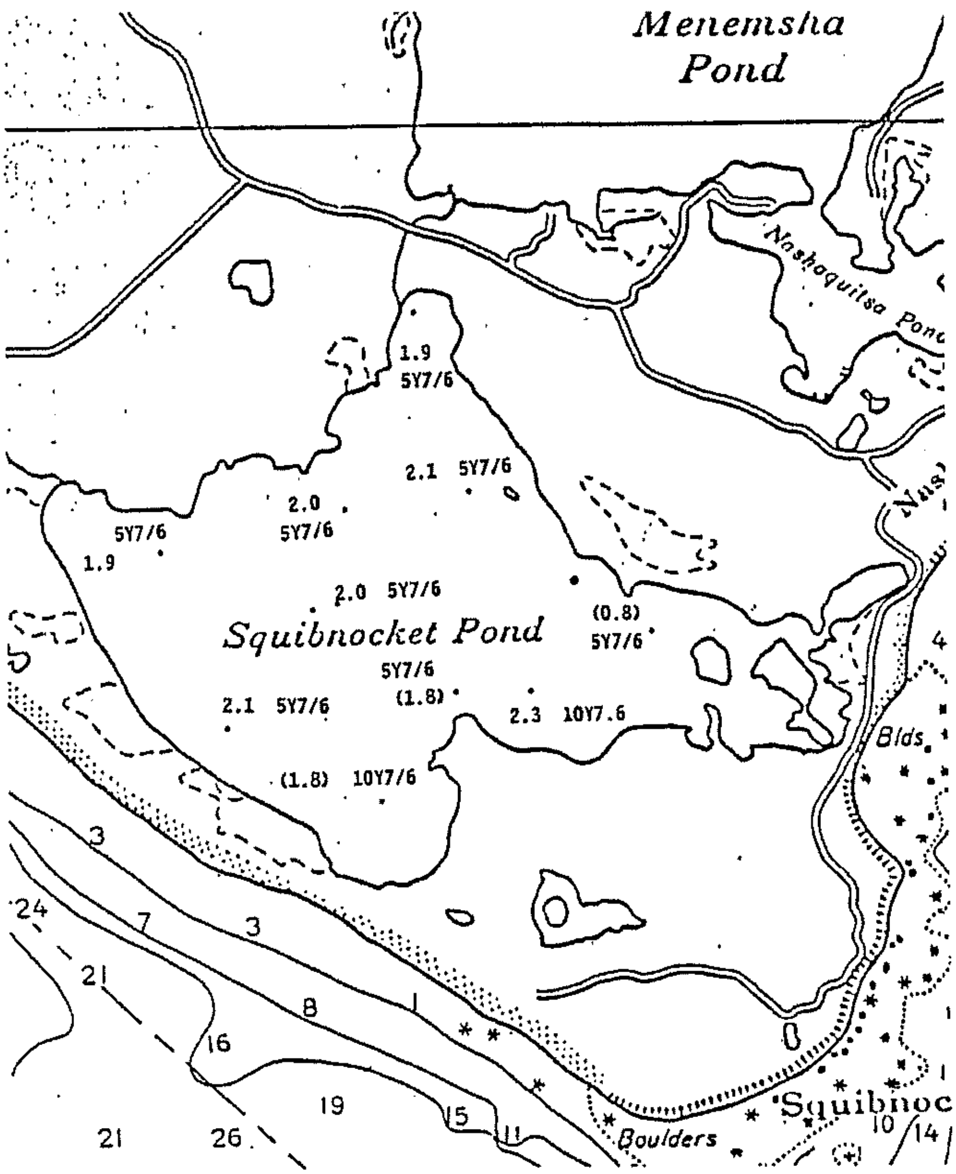

Figure 14. Transparency measurements (Secchi disk [m]) for Squibnocket Pond, July 30, 1989. Color indices refer to a standard scale. Numbers in () indicate the disk was visible on the bottom.

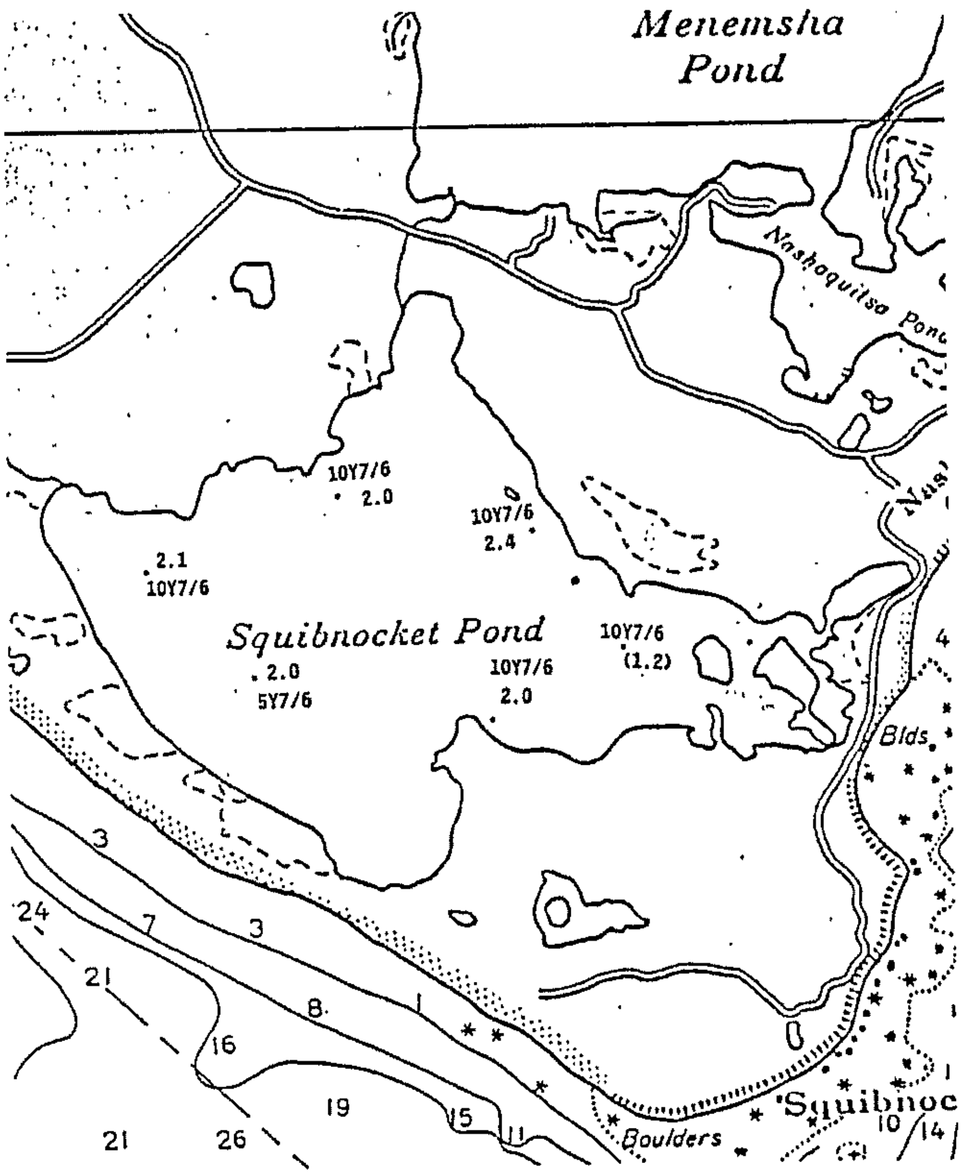

Figure 15. Transparency measurements (Secchi disk [m]) for Squibnocket Pond, August 21, 1989. Color indices refer to a standard scale. Numbers in () indicate the disk was visible on the bottom.

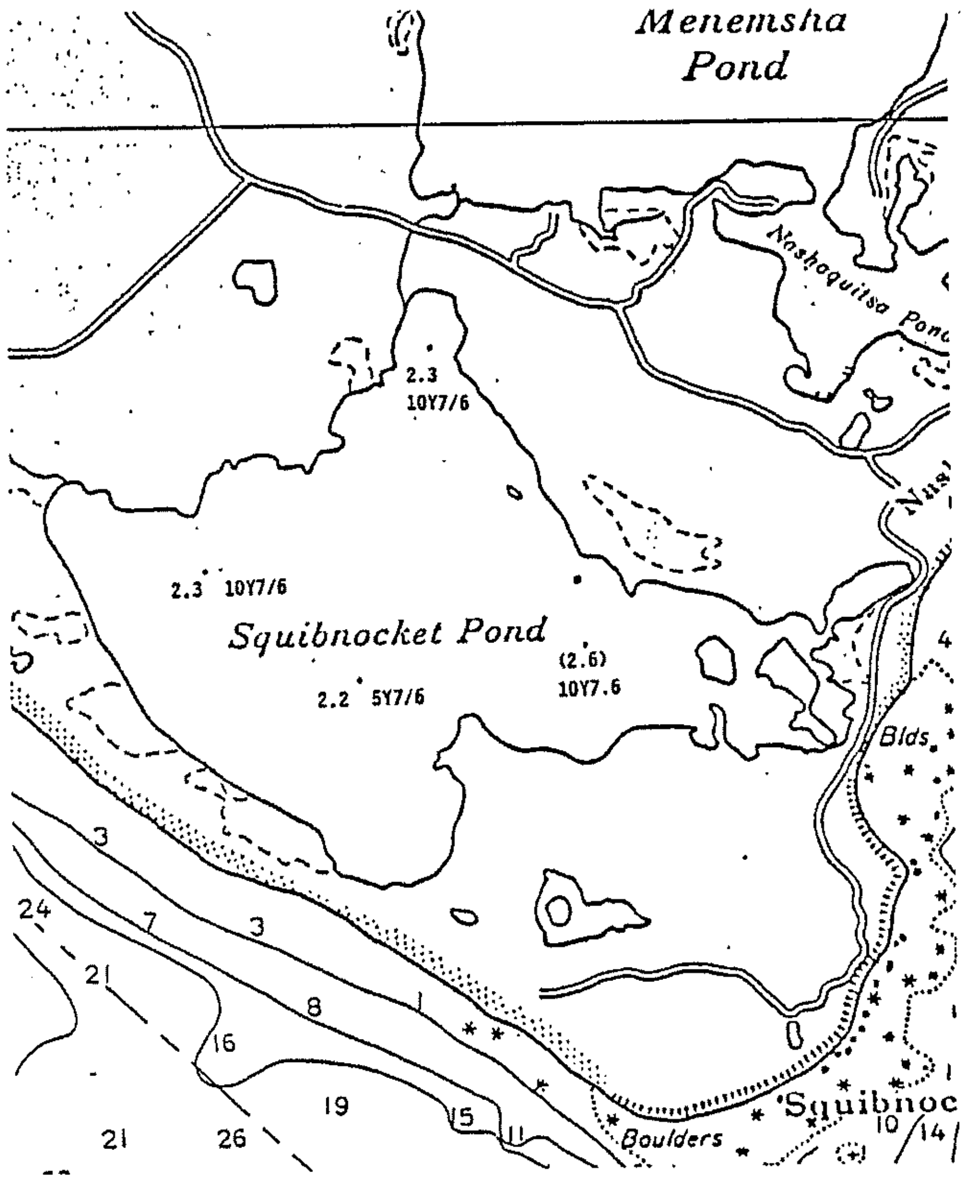

Figure 16. Transparency measurements (Secchi disk [m]) for Squibnocket Pond, September 28, 1989. Color indices refer to a standard scale. Numbers in () indicate the disk was visible on the bottom.

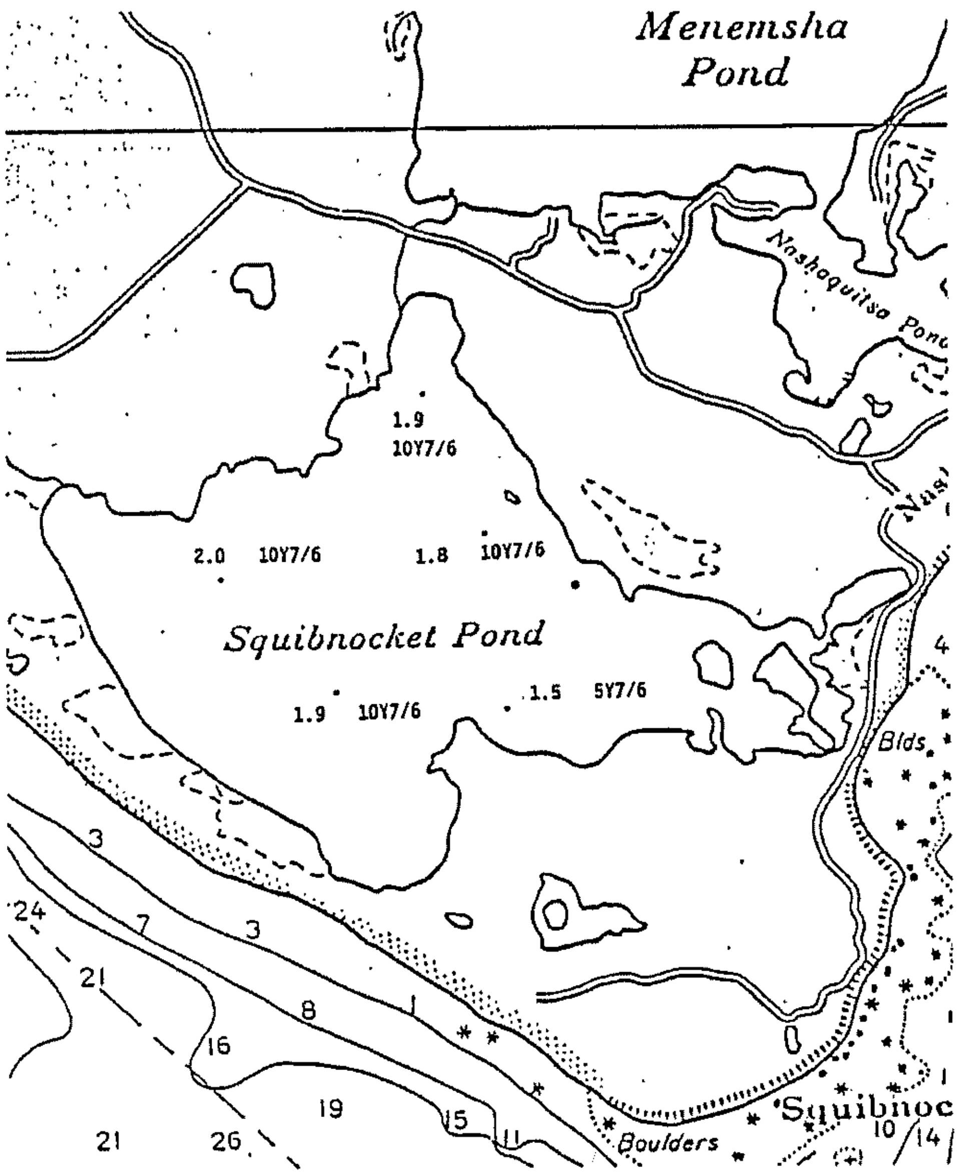

Figure 17. Transparency measurements (Secchi disk [m]) for Squibnocket Pond, October 31, 1989. Color indices refer to a standard scale. Numbers in () indicate the disk was visible on the bottom.

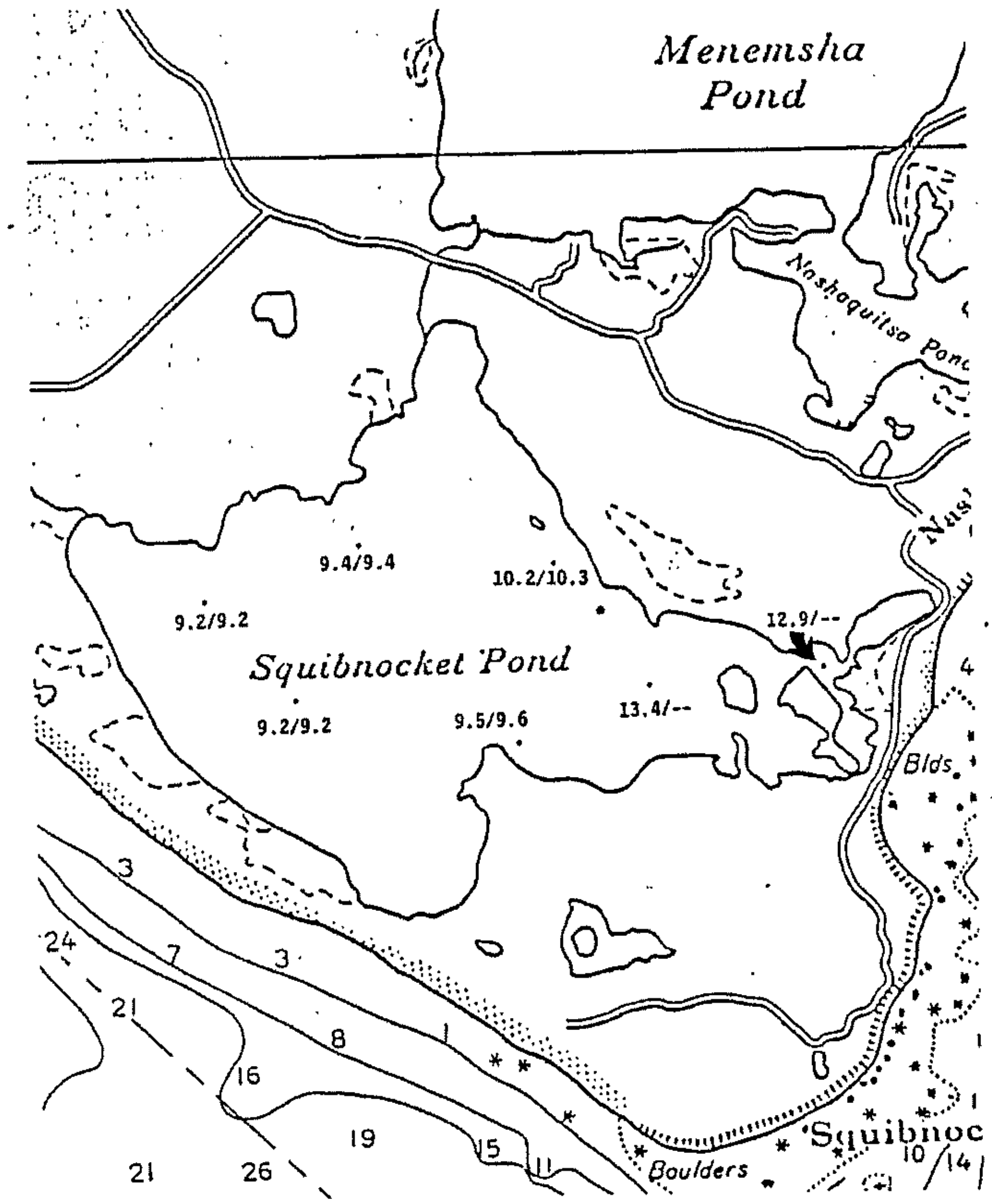

Figure 18. Dissolved oxygen (mg/l) at 0 and 2 m depth in Squibnocket Pond, August 21, 1989.

Table 4. Nutrient and hydrographic data for Squibnocket Pond, primary monitoring station (central basin). September 2, 1989.

Depth (m)	Salinity (o/oo)	silicate (uM/l)	nitrate (uM/l)	nitrite (uM/l)	ammonia (uM/l)	phosphate (uM/l)	oxygen (ml/l)
0	10.03	113.22	0.01	0.00	0.08	0.92	5.40
		113.22	0.01	0.01	0.08	0.92	6.06
1	10.07	113.22	0.01	0.01	0.56	1.39	5.54
		113.22	0.02	0.00	0.06	0.93	5.99
2	10.03	114.69	0.02	0.00	0.06	0.92	----
		114,69	0.02	0.00	0.06	0.92	5.74
3	10.04	115.67	0.01	0.00	0.08	0.93	5.83
		115.67	0.01	0.00	0.08	0.93	5.71
4	10.08	114.69	0.01	0.00	0.06	0.92	5.72
		114.69	0.01	0.00	0.06	0.92	5.63

Table 5. Summarized nutrient (uM/l) and hydrographic data for coastal ponds in southern Massachusetts taken during summer and autumn months.

			Edgartown Harbor					
	SQB	EGP	CP	KB	OH	LP	GP	TC
Salinity (o/oo)	10	20	32.2	31.2	32.4	29.7	30.2	30.7
Silica	114	8.8	2.6	10.3	2.0	---	---	---
Nitrate	0.01	0.01	0.06	0.05	0.06	0.06	0.50	0.17
Nitrite	0.00	0.01	0.00	0.01	0.00	0.02	0.01	0.04
Ammonia	0.07	0.05	0.01	0.26	0.01	0.55	0.62	0.72
Total N	---	---	---	---	---	22.2	23.0	20.9
Phosphate	0.93	0.12	0.55	0.88	0.56	0.47	0.51	0.86

SQB= Squibnocket Pond; EGP= Edgartown Great Pond; CP= Cape Poge Bay; KB= Katama Bay; OH= Edgartown Outer Harbor; LP= Lagoon Pond; GP= Green Pond (Falmouth); TC= Town Cove, Orleans

Table 6. Nutrient and hydrographic data for Vineyard Sound, Menemsha Pond and Squibnocket Pond (April-December 1977). Averages from data of Walsh et al. (1979). Numbers in () indicate sigma

	Vineyard Sound		Menemsha Pond		Squibnocket Pond	
Temperature (C)	17.0	(4.40)	17.6	(4.6)	20.0	(5.8)
Salinity (o/oo)	30.7	(0.96)	30.7	(0.8)	9.9	(2.5)
PO_4 (uM/l)	0.77	(0.58)	0.73	(0.40)	0.67	(0.42)
NO_3+NO_2 (uM/l)	0.61	(0.45)	0.56	(0.26)	0.73	(0.41)
NH_4 (uM/l)	0.45	(0.49)	0.54	(0.39)	0.27	(0.20)
O_2 (ppm)	8.6	(0.6)	8.5	(0.84)	-	-
Chlorophyll a (ug/l)	0.68	(0.43)	0.80	(0.51)	1.25	(0.47)
Transparency (m) (Secchi Depth)	4.8	(0.3)	4.6	(0.4)	0.6	(0.2)

pattern for this area, superimposed on a longer term (declining) trend, possibly representing the fortnightly tide (Fig. 19, top panel). Although one might expect some expression of long period constituents of the astronomical and meteorological tides, this was not observed in terms of surface elevation changes during our period of measurements. No elevation changes could be related to wind. Nevertheless, the range in surface elevation at Squibnocket Pond during our observations was about 0.8 feet (0.24 m). This variation appears to be related to precipitation events, as indicated by the abrupt changes in elevation around the time rainfall was recorded at the Cape Poge weather station.

In terms of both water velocity and salinity, however, the semi-diurnal tide is strongly expressed at the mouth of Herring Creek in Squibnocket Pond. As shown in Fig. 19, there is an asymmetrical flood/ebb pattern, characterized by short duration flood tide currents (averaging 15-51 cm/sec over a tidal cycle) conveying water of about 30 o/oo into Squibnocket, and longer ebb flow (averaging 11-29 cm/sec) conveying water of about 10 o/oo out of the Pond.

The pattern of current and salinity is variable with time. On November 13-14, when the diurnal inequality in the ocean tide was great and the long period tide near a low, the flood signal in both current and salinity is missing. The next day the flood current returned but flow was inadequate to bring high salinity water into the Pond. The shape of the salinity time series indicates that ebb and flood waters are rapidly removed from the proximity of the Creek mouth. Because incoming seawater has a higher density (higher salinity) than Pond water, incoming water and its dissolved and suspended contents sink to the bottom of the Pond. This circulation pattern has been observed for similar coastal ponds (see Aubrey, 1983; Gaines, 1975).

As a result, Squibnocket Pond serves as a trap for incoming materials, which are mixed into the water column over a long period where they are subject to biological and chemical transformations and, for particulate material, to sedimentation. This is a very different situation from open estuaries, such as Edgartown Harbor, where tidal flushing and mixing can effectively remove materials brought in on a previous tide.

These data were used to characterize exchange of water between the ponds (Table 7). Based on the mean flux of individual tidal events, the mean volume of sea water entering the Pond was 11,600 m^3/day; and the mean volume leaving with ebb tide was 26,600 m^3/day. Based on the accumulated excess of discharge over influx, the estimated freshwater discharge into Squibnocket Pond was 13,900 cubic meters/day, over this period of measurement. For theoretical reasons we believe this represents a minimum discharge rate.

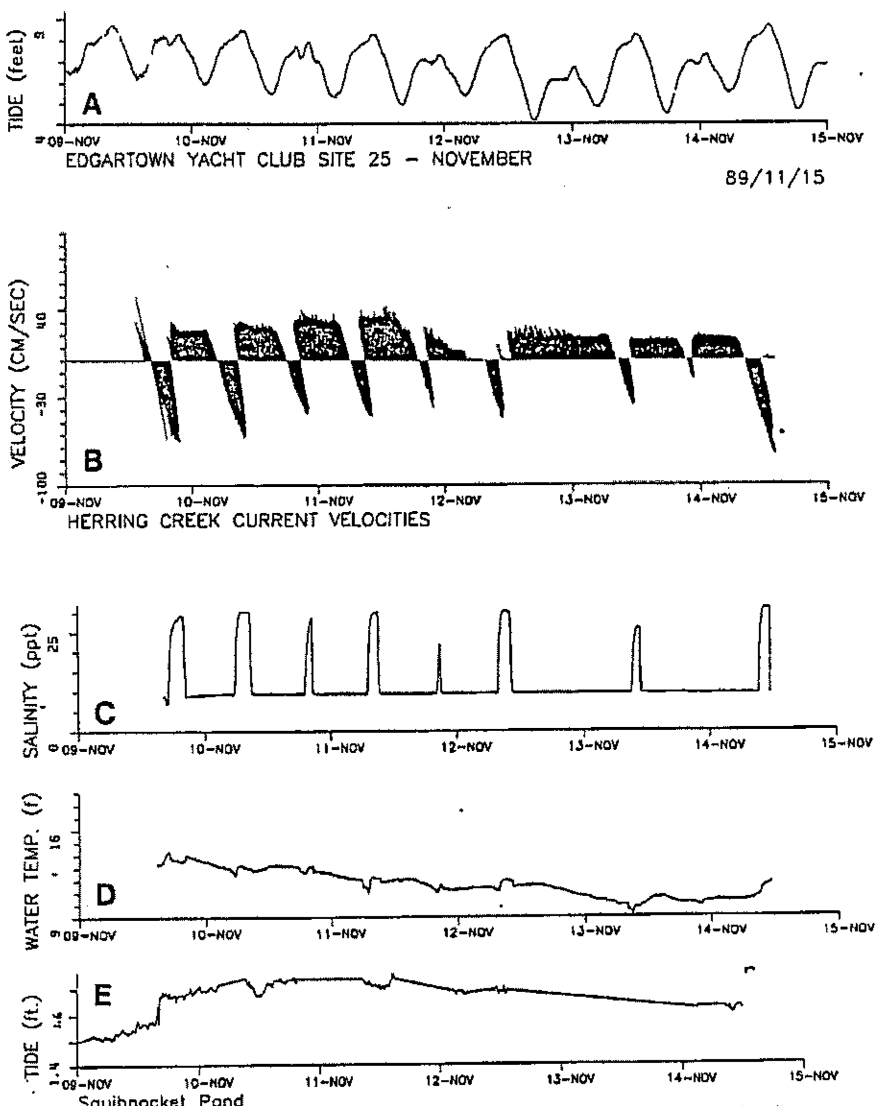

Figure 19. Hydrographic and tidal data for the Squibnocket mouth of Herring Creek (Gay Head), November 9-15, 1989. A) reference tide measured at Edgartown Harbor; B) current velocity (cm/sec)[up is ebb, down is flood]; C) salinity (o/oo); D) water temperature [F]; E) Pond surface elevation (feet; arbitrary datum).

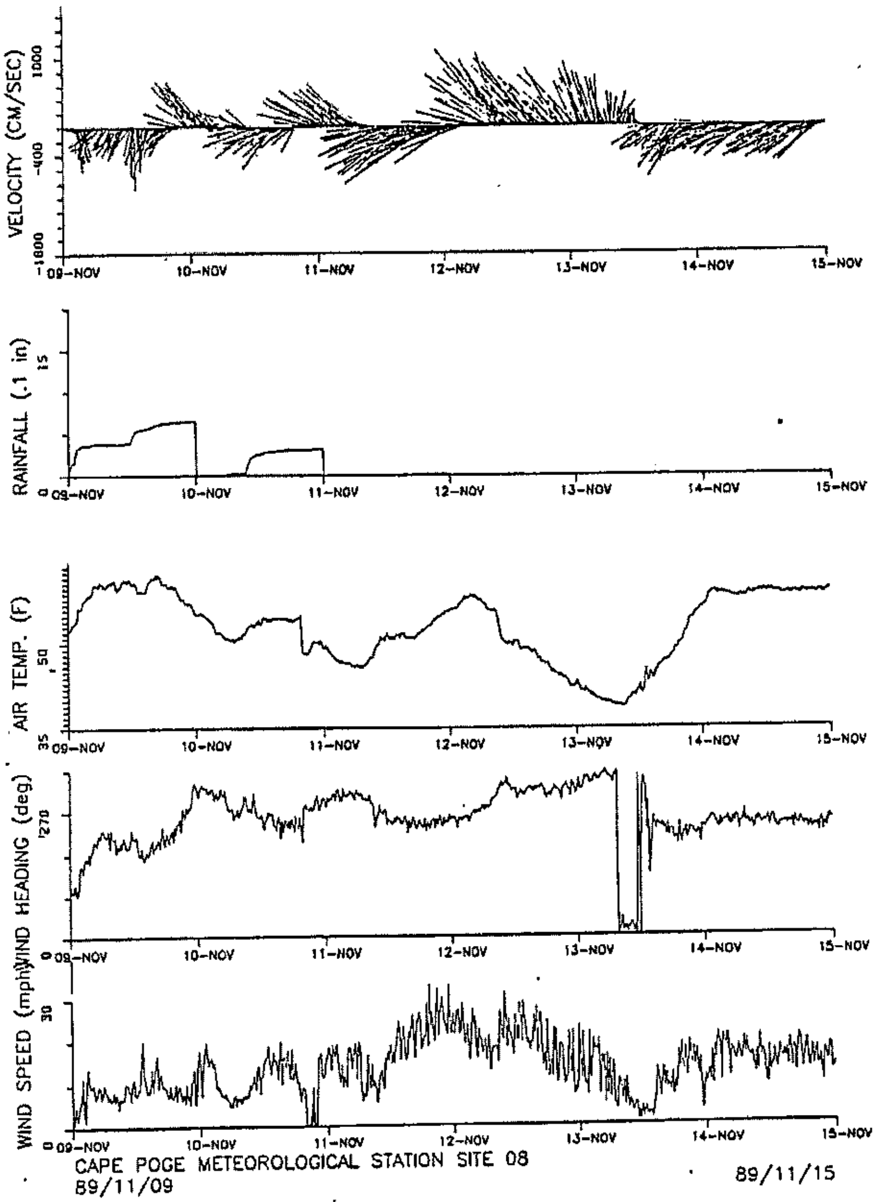

Figure 19a. Weather data for November 9-15, 1989 taken at Cape Poge Lighthouse.

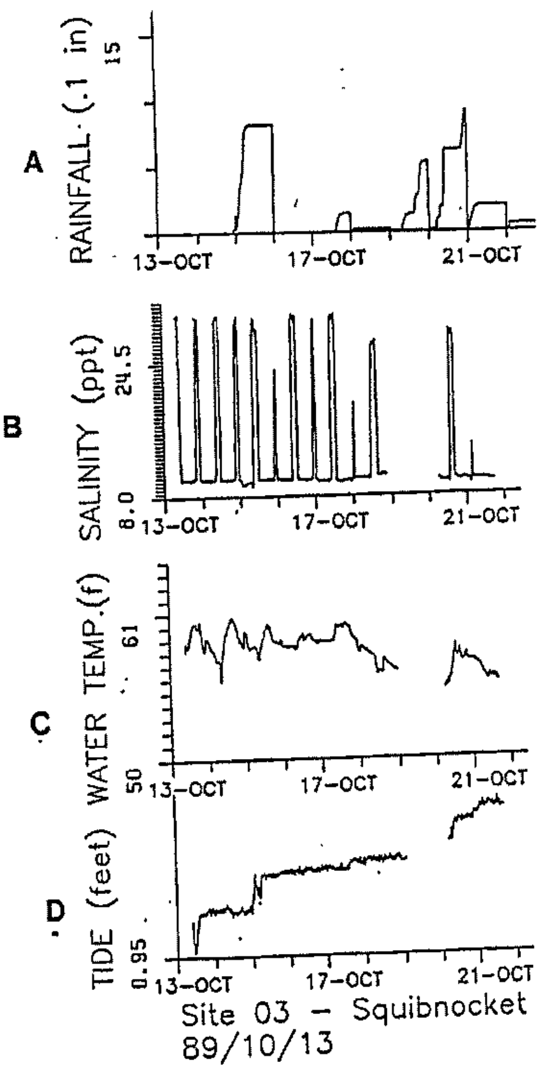

Figure 20. Hydrographic and tidal data for the Squibnocket mouth of Herring Creek (Gay Head), October 13-22, 1989 and precipitation data from Cape Poge Lighthouse. A) daily rainfall; B) salinity (o/oo) of water in Herring Creek; C) water temperature at Herring Creek (F); D) water surface elevation in Squibnocket Pond (feet; arbitrary datum).

Table 7. Tidal exchange between Squibnocket Pond and Menemsha Pond for 8 tidal cycles between November 9-14, 1989.

Duration (hrs)		Avg. Speed (cm/s) [a]		Transport (m^3/day)		
Flood	Ebb	Flood	Ebb	Flood	Ebb	
3.86		19.5		10,700		
	8.60		21.2		11,500	
4.20		37.8		10,000		
	9.10		25.0		14,400	
2.60		26.9		4,410		
	9.70		29.1		17,900	
2.96		31.2		5,830		
	9.96		29.3		18,400	
1.83		20.8		2,400		
	7.70		11.5		5,600	
	19.60		18.3		22,600	
3.00		19.4		3,700		
	9.96		14.5		9,100	
1.30		6.4		530		
	9.80		16.0		10,400	
3.16		51.6		10,300		
2.86	10.55	26.7	20.6	5,980	13,740	Avg

Freshwater Discharge = 13,900 m^3/day

a/ Current observations were two minute averages; values reported here are averages of observations over the duration of flood or ebb.

"Residence time", the volume of water in the Pond divided by the rate it is entering, is an index of how long water remains in the Pond. Using a volume for the Pond of 6.3 million cubic meters (based upon the estimated Pond area of 2.51 square km; and an assumed average depth of 2.5 m [8.2 feet] based on the bathymetry of Zapal [in Walsh et al., 1979]) the residence time of fresh water in the Pond is about 300 days (this takes into account that only 2/3 of the water in Squibnocket Pond entered as fresh water). Residence time for seawater in the Pond is about 180 days.

Fecal Coliform Bacteria

The concentration of fecal coliform bacteria is used by state agencies to classify waters with regard to water quality in the context of human use. The presumption is that this bacterial index reflects recent contamination of the water by human fecal material. A count higher than 14/100 ml suggests sufficient contamination to prohibit shellfishing. Although in many ways it is the best index available, it unfortunately does not distinguish among human contamination and that from other warm blooded animals, such as birds and small mammals.

Coliform bacteria were measured in Squibnocket more as a test of the usefulness of this index than because human fecal contamination was suspected. In Figs. 21 and 22, a value of 7-9 indicates the state standard may be exceeded and a value of 10 means it is over 90% likely that the standard is exceeded. Based on these results, the following sites were in possible exceedance of shellfish standards: Herring Creek (during ebb); Nashaquitsa Cove; the shore at Hillman's Point; and the central Squibnocket Pond.

The likelihood of human contamination in Squibnocket Pond is remote, whereas the opportunity for of bird or wild mammal contamination is clear. Regardless, the legal responsibility and power to interpret data such as these resides with the Massachusetts Division of Marine Fisheries, and town government is unable to influence their decision. This perspective must be retained in a management scheme for Squibnocket Pond, because Town or Tribal efforts to improve shellfish habitat here could be confounded by closures based upon an ambiguous public health index.

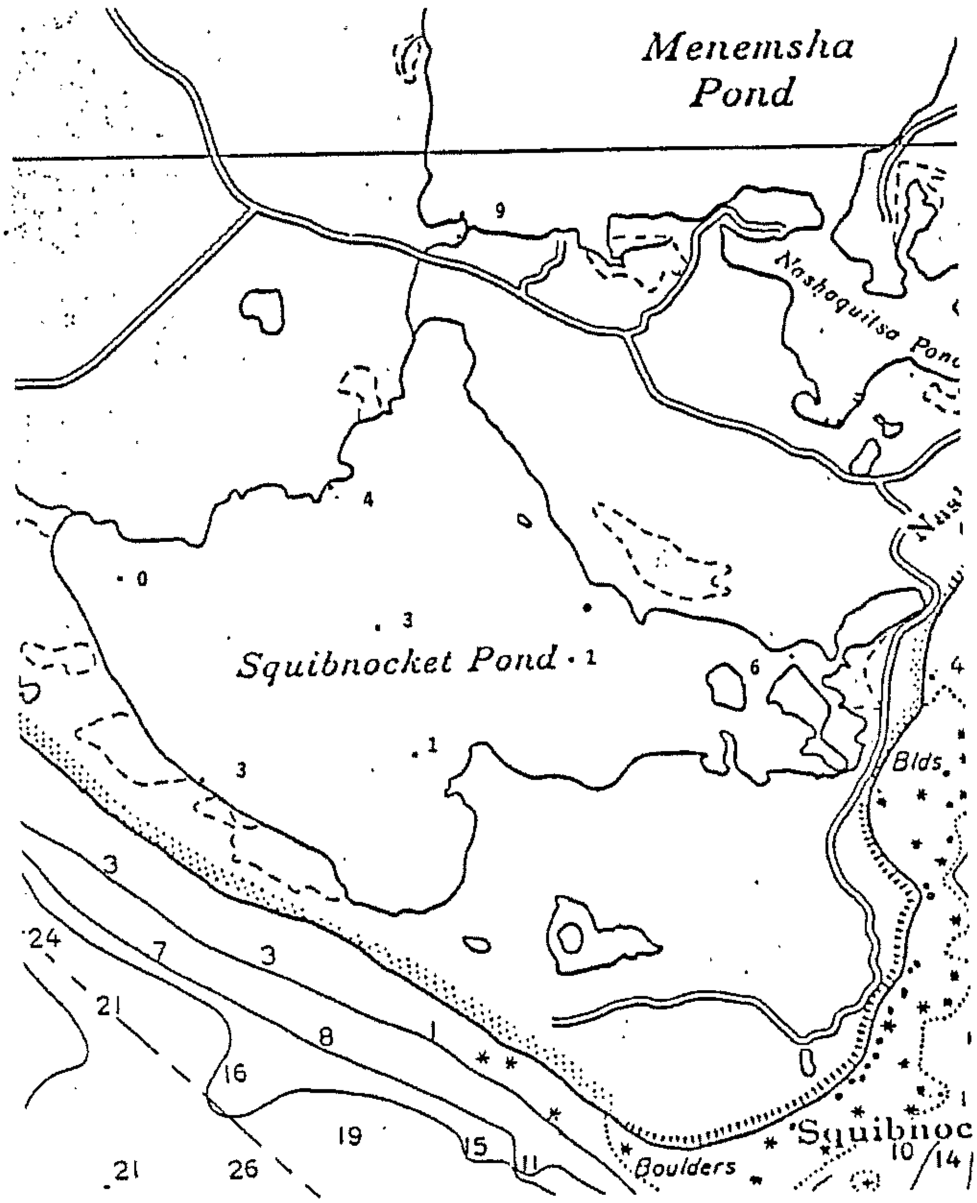

Figure 21. Fecal coliform bacteria results for Squibnocket Pond, May 29, 1989 (numbers are not bacterial counts; see text).

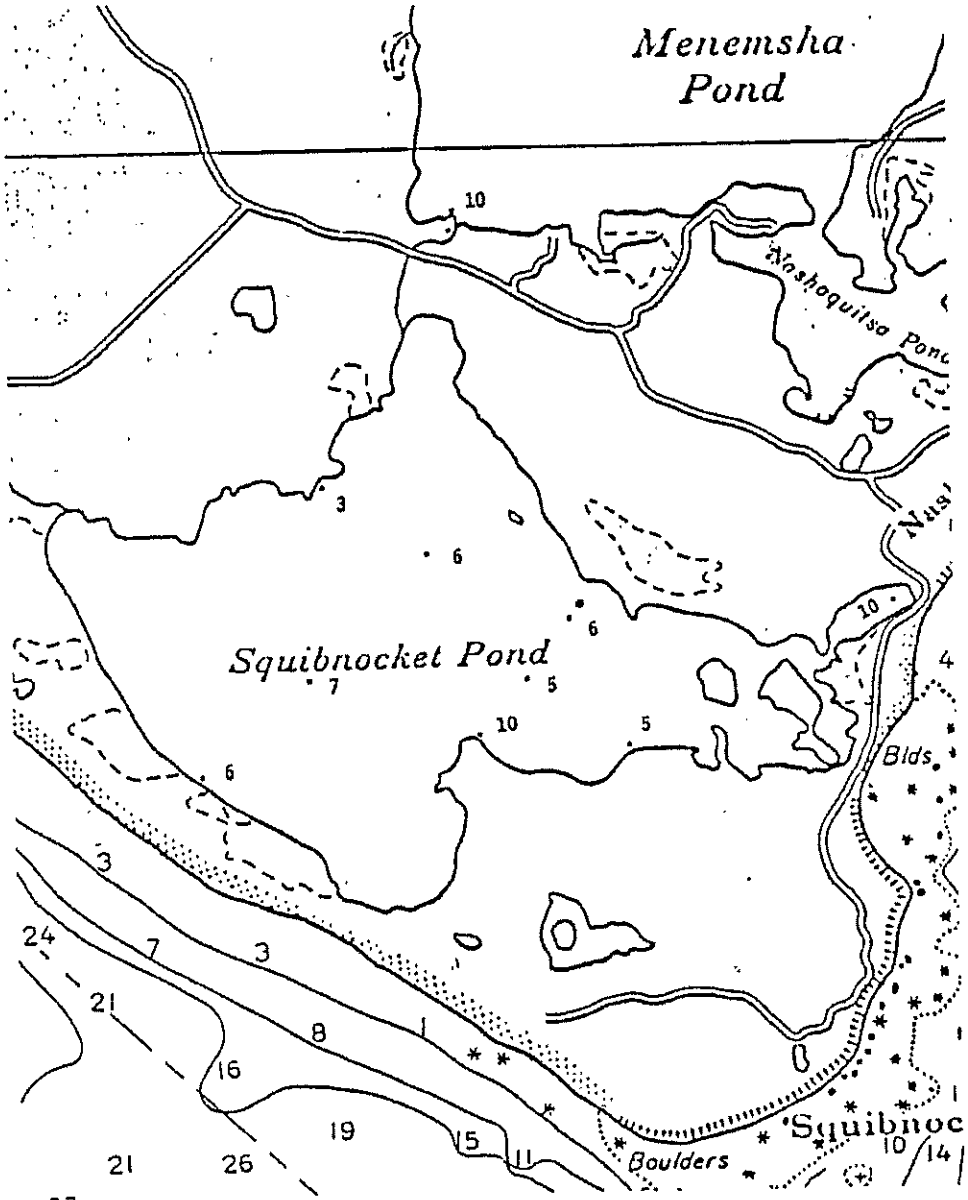

Figure 22. Fecal coliform bacteria results for Squibnocket Pond, August 12, 1989 (numbers are not bacterial counts; see text).

Squibnocket Watershed

Road Runoff

As measured on a U.S.G.S. topographic map (1972), there are about 4.38 km (2.74 miles) of paved road within the Squibnocket watershed. A rigorous assessment of the impact of runoff from this surface has not been conducted, but it would seem to be a small effect compared with that for more developed areas. For perspective, the Menemsha watershed contains about 7.60 km (4.76 miles) of paved road.

Nutrients

In order to assess sources of nutrients to Squibnocket Pond, samples from streams and seeps as well as from domestic and test wells were analyzed (Fig. 23; Table 7, 8). There is much to discuss in these data, but our principal concern here is their value in determining nitrogen loading, which is treated later.

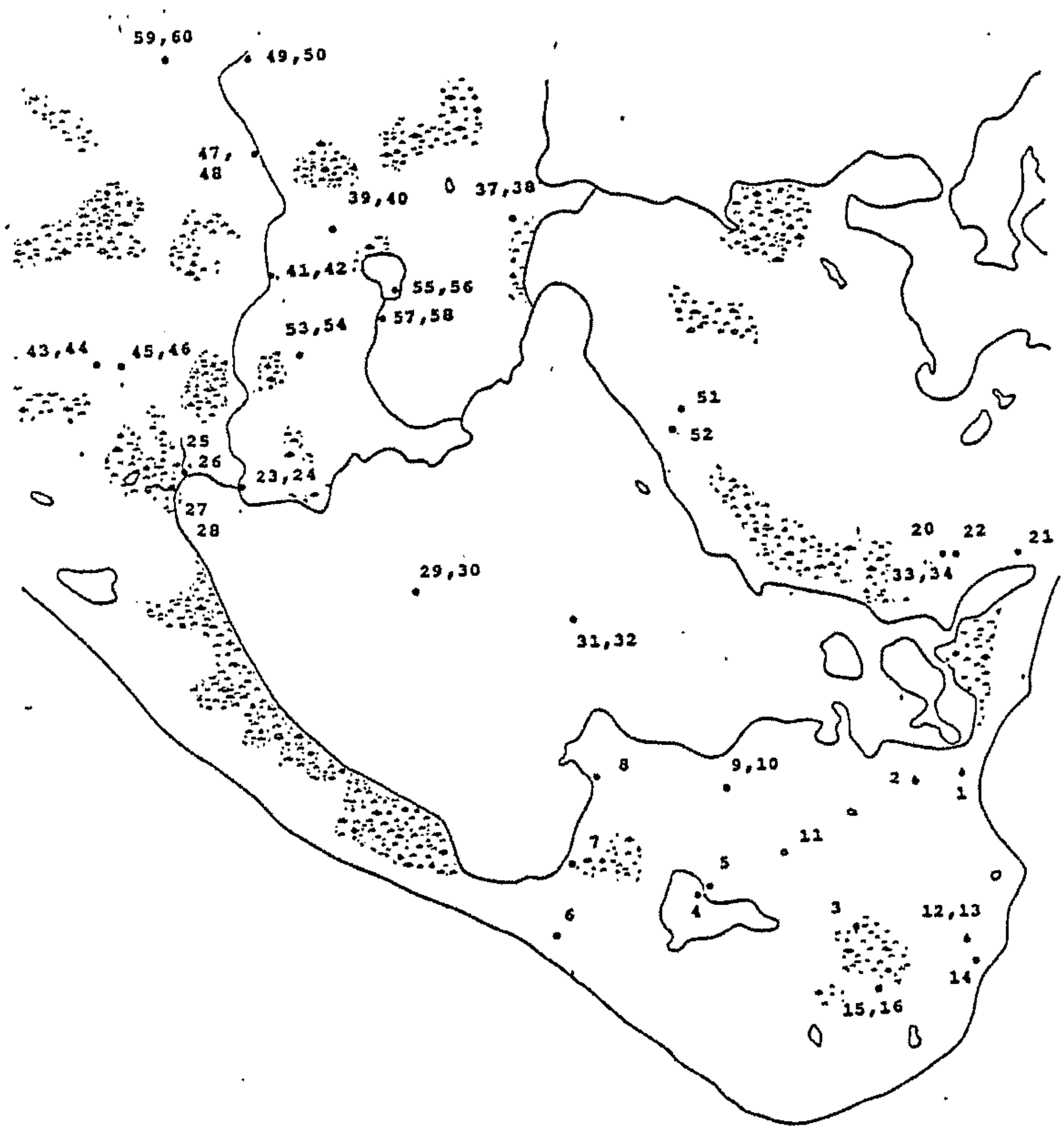

Figure 23. Distribution of sampling sites in the Squibnocket Pond area for nutrient analyses.

Table 8. Nutrient data for groundwater samples (wells, springs, cisterns) from the Squibnocket Pond area. Samples collected October 9, 1989. Concentrations in uM/l.

Squibnocket Ridge Sector

Site	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP	comments
1	384.8	0.07	0.03	1.28	0.37			W_d
2	262.0	0.00	0.03	27.82	1.02			W_d
15	29.3	11.64	0.06	0.21	0.51			W_t9, 2 hr
16	61.0	8.87	0.07	1.26	3.48			W_t9, 49 hr
12	17.7	30.64	0.05	0.03	0.42			C, wl hse
13	13.1	31.16	0.05	0.21	0.43			C, wl hse
avg	127.9	7.40	0.05	5.14	1.04			
sigma	157.2	12.48	0.02	11.13	1.22			

Nashaquitsa Sector

Site	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP	comments
20	143.7	87.54	0.08	19.74	0.25			W_d Cl/old
33	127.0	88.32	0.34	25.83	0.20	120.4	0.94	W_d Cl/old
34	127.0	90.06	0.34	25.30	0.23	120.9	0.70	W_d Cl/old
22	127.8	77.69	0.04	0.40	0.94			W_d Cl/new
21	114.2	107.74	0.02	0.07	0.96			W_d Re
51	2.0	63.50	0.14	28.24	2.81			W_d Cis St
52	5.0	0.69	0.05	2.76	0.16			W_d Bog St
avg	92.4	73.65	0.14	14.62	0.79			
sigma	61.3	34.84	0.14	12.95	0.96			

Black Brook Sector

Site	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP	comments
37	115.5	13.32	0.00	0.12	1.31	14.2	1.40	Cook's Sp.
38	141.0	13.48	0.03	0.80	1.53	14.8	1.60	Cook's Sp.
39	10.3	3.28	0.02	0.46	0.10	3.8	0.10	W_d Pr
40	13.1	3.09	0.00	0.10	0.10	3.7	0.09	W_d Pr
43	149.0	38.48	0.03	0.49	0.56	39.5	0.94	W_d Sm
44	157.8	38.84	0.01	0.20	0.30	39.6	0.45	W_d Sm
53	97.5	2.66	0.04	1.64	0.80			W_d Fi
54	108.5	2.37	0.03	0.14	0.78			W_d Fi
avg	99.1	14.19	0.02	0.49	0.69	19.3	0.76	
sigma	57.7	15.88	0.02	0.52	0.53	16.4	0.65	
Gr Avg	105.1	34.0	0.07	6.53	0.82			
sigma	93.3	36.4	0.09	10.90	0.87			

Table 9. Nutrient data for surface water samples (streams, ponds, wetlands) from the Squibnocket Pond area. Samples collected October 9, 1989. Concentrations in uM/l.

Black Brook Series

Site	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP	Comments
49	6.89	0.01	0.63	3.09	0.90	45.34	0.94	Hwy
50	5.85	0.02	0.64	2.94	0.83	52.45	0.94	Hwy
47	5.15	0.02	0.31	1.46	0.57	41.30	0.70	Drt Rd
48	4.55	0.03	0.31	1.38	0.53	39.01	0.70	Drt Rd
41	4.27	0.02	0.24	1.51	0.21	31.50	0.70	M. Tr.
42	9.58	0.00	0.26	1.71	0.62	31.11	0.70	M. Tr.
23	12.56	0.01	0.23	1.66	0.58	32.10	0.94	@ SQB P.
24	5.82	0.00	0.27	2.06	0.59	38.06	0.94	@ SQB P.
avg	**6.83**	**0.01**	**0.36**	**1.98**	**0.60**	**38.85**	**0.82**	
sigma	2.85	0.01	0.17	0.67	0.21	7.49	0.12	

Flowing Steams (entering Black Brook Cove)

Site	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP	Comments
27	46.44	0.01	0.16	4.48	0.59	17.51	2.52	C.Cr.s
28	49.08	0.01	0.14	4.27	0.40	26.60	2.52	C.Cr.s.
25	14.32	0.02	0.11	2.00	0.56	23.68	1.30	C.Cr.n
26	13.54	0.00	0.11	1.72	0.45	21.86	1.30	C.Cr.n
23	12.56	0.01	0.23	1.66	0.58	32.10	0.94	Bl. Cr.
24	5.82	0.00	0.27	2.06	0.59	38.06	0.94	Bl. Cr.
avg	**23.62**	**0.01**	**0.17**	**2.70**	**0.53**	**26.64**	**1.42**	
sig	18.95	0.01	0.07	1.31	0.08	7.42	0.91	

Table 9 (cont). Nutrient data for surface water samples (streams, ponds, wetlands) from the Squibnocket Pond area. Samples collected October 9, 1989. Concentrations in uM/l.

Fresh Ponds and Wetlands

Site	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP	Comments
3	6.57	0.01	0.23	7.98	0.47			Lt. 7 P.
5	1.33	0.01	0.19	1.12	0.10			Rnd P. Cr.
4	6.21	0.03	0.10	1.14	0.92			Rnd P.
6	11.93	0.01	0.08	1.24	0.12			F.Toad P.
55	8.78	0.95	0.31	2.67	1.53			Witch P.
56	9.68	0.83	0.32	2.44	1.58			Witch P.
57	9.77	0.18	0.33	1.95	1.80			Witch Cr.
58	8.79	0.11	0.34	2.13	1.69			Witch Cr.
45	8.93	0.01	0.28	2.60	0.49	42.65	0.82	Mo.Cr.
46	8.34	0.02	0.31	2.24	0.44	42.49	0.82	Mo.Cr.
7	3.79	1.05	0.89	2.97	0.40			sw Mrsh
8	17.70	0.98	0.41	2.19	0.00			nw Mrsh
9	4.72	1.15	0.09	1.66	1.29			w St. n
10	6.82	0.01	0.08	1.47	0.19			w St. n
11	10.53	0.02	0.55	2.48	1.44			Hl Tp Mrsh
14	29.28	11.64	0.06	0.21	0.51			Wl Hs St.
59	4.42	3.88	0.19	2.28	0.32			GH dump
60	4.67	0.04	0.20	2.19	0.32			GH dump
avg	**9.01**	**1.16**	**0.28**	**2.28**	**0.76**			
sigma	6.24	2.78	0.20	1.58	0.62			

Brackish Ponds

Site	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP	Comments
29	99.24	1.04	0.21	1.23	1.00	38.46	1.18	SQB P. w
30	98.36	1.14	0.11	1.79	0.93	36.64	0.94	SQB P. w
31	94.40	1.01	0.12	1.59	1.08	33.40	1.24	SQB P. e
32	94.84	1.53	0.09	0.57*	1.08	34.11	1.24	SQB P. e
avg	**96.71**	**1.18**	**0.13**	**1.53**	**1.02**	**35.65**	**1.15**	
sigma	2.45	0.24	0.05	0.28	0.07	2.33	0.14	
35	8.95	0.36	0.08	1.19	0.87	10.16	1.02	Kat. Bay
36	8.54	0.36	0.08	1.05	0.83	10.47	1.06	Kat. Bay
avg	**8.75**	**0.36**	**0.08**	**1.12**	**0.85**	**10.32**	**1.04**	

* Data point not used in averaging

Table 10. Summary of nutrient data (uM/l) for the Squibnocket Pond watershed for samples collected October 9, 1989.

	$Si(OH)_4$	NO_3	NO_2	NH_4	PO_4	TN	TP
Groundwater							
Squib. R. Sec.	127.9	7.40	0.05	5.14	1.04		
Nashaquitsa Sec.	92.4	73.65	0.14	14.62	0.79		
Black Brook Sec.	99.1	14.19	0.02	0.49	0.69	19.3	0.76
Grand Avg	105.1	34.0	0.07	6.53	0.82		
Flowing Steams	23.62	0.01	0.17	2.70	0.53	26.6	1.42
Ponds/Wetlands	9.01	1.16	0.28	2.28	0.76		
Brackish Ponds							
Squib. Pond	96.71	1.18	0.13	1.53	1.02	35.7	1.15
Katama Bay	8.75	0.36	0.08	1.12	0.85	10.3	1.04

MANAGEMENT CONSIDERATIONS

Because of the complexity of natural systems, management decisions surrounding coastal resources generally need to be based upon incomplete information--hopefully the best information available. Since more than one political entity has jurisdiction over parts of Squibnocket Pond, unilateral management measures may be subject to challenge by other interested parties. As is normally the case in management of limited resources the questions of allocation and distribution of benefits need to be addressed.

Exchange with the Sea

For several years it has been proposed to construct an opening between Squibnocket Pond and the sea. Our review of historical information indicates that the Pond formerly had a natural breachway on the spit near Squibnocket Beach, and two small artificial connections to the sea of which one, Herring Creek, is still open. Because of the importance of salinity and flushing in terms of habitat, the extent of exchange with the sea is of primary importance to living coastal resources of the Pond and the larger sphere of biota and human activities that depend on them. As indicated earlier, the conspicuous marine invertebrates in the Pond are at or near their lower salinity tolerance limit; and the abundant submerged aquatic vegetation present is of a freshwater variety, presumably near its upper limit of salinity.

A question that must inevitably be addressed is what would be the biological response to increased exchange? This question is vastly more difficult to answer than may seem to be the case. One is inclined to assume organisms favoring higher salinities would be enhanced or introduced, while those favoring lower salinities or fresh water would decline. This is an oversimplification, however, because, for example, the introduction of predators, competitors, nuisance species or diseases can have an over-riding affect. In the case of Squibnocket Pond, management options regarding exchange with the sea would probably be reversible and any one would not preclude future adoption of alternatives.

Decreased exchange with the sea

As one management option the present connection to the sea could be modified to prevent the incursion of seawater, so that over a few years Squibnocket Pond would become a fresh pond. It would become the largest freshwater pond on Martha's Vineyard and could provide the Island with increased habitat diversity for wildlife, as well as recreational and artisanal commercial potential. The Pond in this condition may be a better alewife spawning area than at present, if one or more fish ladders were provided to insure access by the adults.

As a fresh pond, Squibnocket Pond may have high dissolved organic carbon content, given that its principal streams drain wetlands and are stained brown with "tannins". The Pond may also be subject to catastrophic inundation by the sea during storms, with habitat instability associated with abrupt changes in salinity. If the Pond level were allowed to rise significantly, it could increase the potential for natural breaching of the barrier. An estimated 3 to 6 years would be required to flush out existing seawater and several additional years for expression of the direct biological response to the change.

Free exchange with the sea

An unstructured natural inlet to the sea, occurring naturally or induced through human activities, would cause a major alteration in the salinity and flushing of Squibnocket Pond. The resulting pond may well resemble Menemsha Pond in terms of living coastal resources and habitat. Data of Walsh et al. (1979) indicate the salinity of Menemsha Pond departs very little from Vineyard Sound (see Table 6), despite known sources of fresh water entering the Pond.

From the general relationship between the volume of tidal exchange and the cross sectional area of natural inlets, it is possible to estimate the size of an unstructured inlet for Squibnocket Pond for different tidal range scenarios (Table 11). For perspective, the present inlet to Menemsha Pond has a cross sectional area of about 38 m^2 (410 ft^2) according to Moody (1988). This is about 30% of the predicted equilibrium cross sectional area for an unstructured inlet at Menemsha Pond. The very long inlet channel at Menemsha would have the effect of reducing the natural cross sectional area.

An inlet that resulted in tidal fluctuations matching scenario C (Table 11) would result in a major increase of flushing in Squibnocket Pond. In principle it could reduce residence time of seawater in the Pond from about half a year to about a week. Tidal flushing similar to that of Menemsha Pond would result in a residence time of less than four days. In this hypothetical example the salinity of the Pond would be about 0.1 o/oo lower than undiluted seawater of 31 o/oo.

The site of an artificial inlet would have a major effect on its stability, and hence on the maintenance needed to keep it open. An unstructured inlet at the site of the historical inlet at Squibnocket Beach would most probably be unstable and require repeated opening, like other artificial inlets to coastal ponds on the south shore of Martha's Vineyard. An unstructured inlet in the barrier spit could also be subject to horizontal migration, a process that would destroy the dunes presently located there. An inlet located near Nashaquitsa Cove at the east end of the Pond would probably be partially cut in glacial deposits and may be more resistent to migration. It would be exposed to storm waves of infinite fetch, however, and shoaling would most likely occur near the mouth.

An alternative site for an artificial inlet would be at Herring Creek, presently connecting Squibnocket Pond to Menemsha Pond through a restricted channel. At this site glacial and wetland deposits would be encountered, and the state highway would need to be crossed. However, inlet migration and sediment transport would probably pose little problem in the sheltered waters of the Ponds. An inlet at this site would affect and be affected by the fact that Menemsha Pond itself has an inlet. The need for increased flow at this inlet may necessitate modifications to the artificial structures that currently stabilize it. Increased flow could also affect sediment transport at Menemsha inlet.

The effect of an inlet of natural dimensions on salinity of the Pond would be expressed rapidly--perhaps a matter of several days. The response of organisms to the change would begin within a period of days and major changes directly associated with the opening would probably be complete in a few years. For example, the effect on alewives may not be evident in less than 3 to 6 years.

Controlled exchange with the sea at intermediate levels

It may be desirable to have the capability of managing exchange with the sea at intermediate levels. For example, in the event of an oil spill it would be useful to be able to close the Pond entirely for several days. If it is considered desirable to increase the salinity of the Pond to the range where commercial shellfish (except scallops) might grow, this may be possible with only minor modification to the existing Herring Creek. For example, if the amount of seawater entering the Pond could be doubled, from about 11,500 m^3/day to 23,000 m^3/day, the salinity of the Pond would rise from 10 o/oo to approximately 20 o/oo, which is well within the range for oysters and clams. The required 23,000 m^3/day is less than currently leaves the Pond on average with ebb tide, and it is less than 1% of the likely exchange through a natural inlet.

The present cross sectional area of Herring Creek where it enters Squibnocket Pond is about 1.7 m^2 (18 ft^2). The culvert that conducts Herring Creek under the state highway, and associated concrete structure, is only one of the sites that may provide an opportunity to regulate flow.

Salinity changes in the Pond accompanying doubled flood tide input of seawater would occur most rapidly over the first several months; in about six months, one half of the total expected salinity change would likely occur. Half of the remaining expected change would occur over the next six months. Little cumulative change in salinity would be expected after three years. The direct biological response could be in a state of flux for several years beyond that.

Management of Nutrients

The growth and abundance of plants depends upon numerous conditions, of which one set involves the availability of adequate nutrients. In many naturally occurring situations a limited supply of certain nutrients is responsible, in turn, for limiting the abundance and/or productivity of plants. Under these circumstances plant growth may be artificially stimulated by adding the nutrient(s) responsible for limiting growth, often nitrogen or phosphorus. Growth may be stimulated intentionally through fertilization (as any gardener or aquaculturist knows) or inadvertently through unintended enrichment associated with various human activities. In either case, it is in principle possible to manage plant growth through management of limiting nutrients. For water bodies that have high or excessive plant productivity ("eutrophic" water bodies), reduction or removal of a limiting nutrient can reduce undesired features of high productivity.

Before attempting to manage nutrients in a water body, it is necessary to have some idea of the existing status of plant growth as well as the natural and human sources of nutrients. It is also prudent to decide what uses are intended for the water body or what condition is regarded as desirable. The very low nitrogen concentration in samples collected in the Pond on September 2 suggests that plant growth can at some times be limited by nitrogen (phosphorus was high in all our samples). Under these conditions it would generally be assumed, therefore, that restricting additions of nitrogen-containing nutrients would prevent further plant growth. It should be noted that seasonal data of Walsh et al (1979; Table 6), and our own data for samples collected on October 9 (Table 9), suggest the periods of nitrogen limitation in Squibnocket Pond may be brief.

This study of Squibnocket Pond produced results we find quite surprising and informative. As expected, we found nitrogen loading is much less than for developed areas of southern Massachusetts--an estimated 20-25% (Table 12). The nitrogen concentration in entering groundwater also appears to be very low compared with more developed areas--an estimated 10-50% (Table 12). However, more than one source of data suggests Squibnocket Pond is highly productive (eutrophic): the abundance of submerged aquatic vegetation in the coves; the high turbidity

Table 11. Calculated equilibrium cross-sectional areas (A_c) at MSL versus tidal prism (T_p) for a hypothetical inlet at Squibnocket Pond based on existing empirical models (modified from Kana and Mason, 1988). A_c in ft.^{2} and (m^2).

Source	Equation	Application	Predicted Ac* A	B	C
O'Brien (1969)	$A_c = 2.0 \times 10^{-5} T_p$	General	1770 (164)	1180 (110)	591 (55)
Nayak (1971)	$A_c = 1.89 \times 10^{-5} T_p$	Unjettied	1680 (156)	1120 (104)	560 (52)
Jarrett (1976)	$A_c = 7.75 \times 10^{-6} T_p^{1.05}$	Atlantic Coast	1720 (160)	1120 (107)	540 (53)
Jarrett (1976)	$Ac = 5.37 \times 10^{-6} T_p^{1.07}$	1 or no jetties	1710 (160)	1110 (107)	530 (53)

* Estimated for tidal range in Squibnocket Pond of ca.:

A - 3 feet (1 m); $T_p = 2.51 \times 10^6$ m^3;
B - 2 feet (0.66 m); $T_p = 1.67 \times 10^6$ m^3;
C - 1 foot (0.33 m); $T_p = 8.37 \times 10^5$ m^3.

of the water; high oxygen concentration during daylight hours; and high chlorophyll a concentrations (Table 6). Our suspicion is that this results from the nature of existing exchange with the sea which causes the Pond to act as a trap for incoming materials. We also suspect that eutrophication has been a natural process in Squibnocket Pond, although it is estimated that present human sources of nitrogen have doubled the natural loading rate (Table 12).

What is the likelihood, from a practical viewpoint, that future nutrient input could be effectively managed? The Squibnocket Pond watershed is not extraordinarily large (i.e., in contrast with that of Lagoon Pond; Table 12) and involves only a small portion of the two Towns involved. The Pond itself occupies a larger portion of its catchment area than the others listed in Table 12. All of these attributes are favorable to nutrient management. Furthermore, the high proportion of wetland within the watershed implies existing legal restrictions on watershed modification, and provides a potentially effective nutrient trap. Finally, large portions of the watershed are presently undeveloped, and land owners here have in the past demonstrated an uncommon sensitivity and commitment to preservation of the land and Pond. These factors also could be favorable to nutrient management.

The results of our study can be used for a first estimate on the importance of various areal sources of nutrients to Squibnocket Pond. From data in Table 10 it is concluded that groundwater discharge is probably the most important vehicle for nitrogen loading. For this assessment it is assumed that no human intervention will occur in the beach/wetland sector of the watershed, which falls under conservation use restrictions; our assessment is limited to the remaining three watershed sectors. Table 13 summarizes the calculations. Nitrogen loading was calculated from total nitrogen groundwater concentrations (Table 10) for each sector, and the groundwater discharge from that sector assuming it is directly proportional to the area of the sector and given a total discharge of 13,900 m^3/day. The results (Table 13 column A) indicate that the Nashaquitsa sector is responsible for nearly 60 % of present loading, even though it occupies only 18% of the watershed.

We then calculated hypothetical nitrogen loading for other sectors if future land use resulted in groundwater nitrogen concentrations equal to that of the present Nashaquitsa sector (Table 13 columns B and C). The results indicate the Squibnocket Ridge sector could provide an increase over present loading by about 40% [(187-27)/392 = 0.40); Black Brook sector could increase loading by 173% [(815-135)/392 = 1.73]. If both sectors delivered groundwater at the concentration presently delivered by Nashaquitsa sector, nitrogen loading would increase by a factor of over 3 (Table 13 column C; 1230/392 = 3.14).

Table 12. Data and calculations for groundwater discharge and other characteristics of coastal ponds in southern Massachusetts: Lagoon Pond (Martha's Vineyard), Green Pond (Falmouth), Town Cove (Orleans), and Squibnocket Pond (Martha's Vineyard).

	LP	GP	TC	SP
Shoreline Length (Km)	11.6	9.3	11.5	9.47
Coastal Pond Area (km^2)	2.18	0.63	1.63	2.51
Groundwater Recharge Area (km^2)	13.5[a/] 19.7	4.3 7.6	4.6	5.41
Total Catchment Area (km^2)	15.7 21.9	4.9 8.2	6.2	7.86
Recharge Area/Pond Area	6.2 9.0	6.7 12.1	2.8	2.2
Groundwater Recharge (m^3/day)				
@ 16.1 in./yr (=0.41m/yr.)	17,600 24,600	5,500 9,200	7,000	8,800
@ 22 in/yr. (=0.55m/yr)	23,700 33,000	7,400 12,400	9,300	11,800
field estimate[b/] (m^3/day)	30,000 60,000	7,900 11,600	2,000 100,000	13,900
calc (@ Q_{sqb}/A_d) rate[c/]	29,400	10,500	8,100	13,900
Estimated N-loading (M/day)				
anthropogenic	1,560	2,100	1,400	194[d/]
total	-	-	1,800	392
Est. N concentration (uM/l)	53	200	220	28

a/ Range given where two methods for estimating recharge area gave different results.

b/ Estimated from salinity time series for LP, GP and TC; estimated from velocity time series for SP.

c/ Based on measured discharge rate for Squibnocket Pond/catchment area, applied to recharge areas for other ponds.

d/ Natural loading estimated by applying average N concentration of Squibnocket Ridge and Black Brook sectors to entire watershed. Anthropogenic = Total - Natural.

Table 13. Estimated nitrogen loading (nitrate, nitrite and ammonia) to Squibnocket Pond (Martha's Vineyard) via groundwater discharge.

		$NO_3+NO_2+NH_4$ (uM/l)	Q_{gw} a/ (m^3/day)	N-Loading (M-N/day)		
				A	B b/	C c/
Groundwater Sec.						
Squibnocket R.		12.6	2,120	27 (7%)	187 (34)	187 (15)
Nashaquitsa		88.4	2,540	230 (59%)	230 (42)	230 (17)
Black Brook		14.7	9,230	135 (34%)	135 (24)	815 (66)
				392	552	1230
Flowing Steams		2.88	?			
Ponds/Wetlands		3.72	-			
Brackish Ponds						
Squib. Pond d/	out	1.00	-26,500	-26.8		
	in	1.10	11,500	12.7		
	net			-14.1 (-4%)		

a/ Assumes measured discharge for Squibnocket Pond is attributable to groundwater discharge.

b/ Calculated assuming Squibnocket Ridge sector discharged groundwater with nitrogen concentration equal to present Nashaquitsa estimated value.

c/ Calculated assuming Squibnocket Ridge and Black Brook sectors discharged groundwater with nitrogen concentration equal to present Nashaquitsa estimated value.

d/ Average nitrogen concentrations from data of Walsh et al (1979); see Table 6.

For perspective, EPA estimates indicate nitrogen loading associated with a typical U.S. household, including inputs from the septic system (1.2) and use of lawn fertilizer (0.8), is about 2 M/house/day. Thus the current loading from each sector in EPA "house-input equivalents" is about: Nashaquitsa, 100; Squibnocket Ridge, 12; and Black Brook, 60.

The flux of nitrogen resulting from tidal exchange was also estimated. This amounted to a loss of only about 4% of current loading by groundwater (Table 13 column A, bottom). Hence, unless other mechanisms for large losses can be identified, the results suggest most nitrogen entering the Pond is trapped there in the biota and sediments. Other mechanisms that should be evaluated are denitrification and movements associated with migration of animals, such as fish and birds. Under conditions of nitrogen limitation, which we believe prevail for some periods in Squibnocket Pond, it is possible nitrogen is imported by tidal exchange.

Management tools that have been used to reduce nitrogen loading are: reduced lawn fertilizer application; upgraded zoning for residential construction; and innovative denitrifying septic systems, to name a few. Further assessment should also be given removal of nitrogen after it has already entered the Pond, such as by shellfish aquaculture, and fisheries development. Greatly increased exchange with the sea could also serve to remove nitrogen. All of these mechanisms should be quantitatively assessed before they are implemented.

Management of Wildlife Habitat and Fisheries Resources

Management of the alewife resource has been assessed by Bourne (1990; Appendix 1) as part of this study. The conclusions and recommendations of that study are given in his self-standing report. As mentioned earlier, shellfish of potential commercial value are at or near their lower limit of salinity tolerance in Squibnocket Pond. Management steps to enhance the environment for shellfish may reduce its value for alewives. Attempts to manage the Pond for shellfish may also lead to conflict with its use by natural predators of shellfish, such as starfish, drills, waterfowl and aquatic mammals, or by nuisance species such as the seaweed Codium. The opportunities and tradeoffs associated with integrated management of fish and wildlife make management of these resources a challenging and worthwhile endeavour. The basic environmental information provided in this report provides a strong basis on which to begin a discussion of management.

Recreational Uses

Active and passive recreational use of the Pond has been limited by its remote location and restricted public access. This has effectively limited the use of boats and motors, and of recreational vehicles on adjacent lands. The low level of active recreational use is assumed to have a positive effect on the value of this area to wildlife, and on its wilderness ambience and value for passive recreation. The decision by private landowners to preserve the shoreline in its natural state has also served to enhance the value of the Pond for passive recreation and wildlife use.

Management of the Vista

The value and sensitivity of the natural vista at Squibnocket are subject to individual assessment and caprice. Our subjective belief (not entirely appropriate in this report) is that they are of great and unique value and of great vulnerability to human modifications. This area of management is most difficult and important, and it bears on fundamental rights of citizens under our system of government. The visual impacts associated with modification of the vista are difficult to assess quantitatively or objectively. Past management in this area has been most effectively practiced by the private land owner or conservation organization, and through public land acquisition.

Protection of Archaeological Sites

The abundant native American archaeological sites at Squibnocket are of particular interest and relevance, given that members of the Wampanoag Tribe continue to live in this area. The sites have added interest because of the undeveloped nature of lands around the Pond. Although several laws bear on preservation of these sites, ignorance of their location may be equally important for their survival. From a philosophical viewpoint, however, it would seem inappropriate to base a management plan for the sites on ignorance, given that their alleged presence is offered as justification for land preservation.

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EXHIBIT C

Arthur G. Gaines, Jr.
Reports and Publications
(November 2013)

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C

COMMONWEALTH OF MASSACHUSETTS

DUKES COUNTY, SS,

LAND COURT DEPARTMENT
CASE NO. 13 MISC 478175

CHARLES PARKER and VIRGINIA P. DAWSON, RICHARD W. REGAN, MANAGER OF THE REGEN FAMILY STORKS NEST LLC, DOUGLAS and ELIZABETH LIMAN, BARBARA GOLDMUNTZ (LIFE ESTATE), and BARBARA HUNTER FOSTER, TRUSTEE OF PACER II NOMINEE TRUST,

Plaintiffs,

vs.

CHRIS MURPHY, FRANK LORUSSO, WENDY WELDON, RUSSELL MALONEY, ALLISON BURGER, TODD CHRISTY and ALLEN HEALY, as they are members of the Town of Chilmark Zoning Board of Appeals and the TOWN OF CHILMARK, acting by and through its Board of Selectmen,

Defendants.

AFFIDAVIT OF CHARLES BENBROOK

I, Charles Benbrook, hereby depose and state as follows:

1. My name is Charles Benbrook. I am a research professor in the Center for Sustaining Agriculture and Natural Resources, Washington State University. I have a Ph.D. in Agricultural Economics from the University of Wisconsin-Madison and an undergraduate degree from Harvard University.

2. I worked in Washington, D.C. on agricultural policy, pesticide use and regulation, and risk assessment science issues from 1979 through 1997. I served for one and one-half years as the agricultural staff expert on the Council for Environmental Quality. From 1981 to 1983, I was the Executive Director of the Subcommittee on Department Operations, Research and Foreign Agriculture in the U.S. House of Representatives. From 1984 to 1990 I was the Executive Director of the Board of Agriculture of the National Academy of Sciences.

3. My specific area of research has included the study of the glyphosate herbicide, the active ingredient in the end-use product known as "Rodeo" produced by Monsanto Corporation. I am the author of numerous reports, papers, and publications dealing with the use and impact of glyphosate on weed communities and the emergence of resistant weeds, the environment and human health, and I am considered an expert in the field of weed management systems and herbicide use, and related impacts.

4. I am aware that this litigation involves the proposed use of the glyphosate (specifically "Rodeo") in and around Squibnocket Pond as a means to eradicate phragmites that are located adjacent to and in Squibnocket Pond. I am also aware that there are over five private drinking wells in the immediate vicinity of Squibnocket Pond in the Town Chilmark.

5. I have reviewed the environmental standards and regulatory requirements and precautions put forth by the manufacturer relative to the use of Rodeo, as stated on the Environmental Protection Agency (EPA) label attached to Rodeo products. I have reviewed the provisions of Section 12.6(H) of the Chilmark Zoning By-laws which prohibit the use of chemical fertilizers, herbicides, fungicides, pesticides, chemical septic system cleaners (as well as other substances which may be determined by the Chilmark Board of Health) in and around Squibnocket Pond and the land within 500 feet of the pond.

6. In my opinion, this zoning regulation is a reasonable land use regulation to protect the environmentally fragile Squibnocket Pond, and is moreover in purpose and intent, consistent with binding provisions on the Rodeo label. The use of Rodeo within such close proximity to the Pond would almost certainly have a detrimental impact on water quality, and as a result, also adversely impact populations of shellfish, finfish and other aquatic plants in and around the pond. It is also my opinion that the use of Rodeo within such close proximity to private drinking wells, not only is inconsistent with the Rodeo label precautions, but also threatens to an unknown degree the drinking water quality of these private drinking wells.

7. Numerous recent studies have supported the conclusion that the use of glyphosate to eradicate plants, such as phragmites, can have negative unintended consequences.

8. In my opinion, phragmites can be eliminated through other less intrusive methods than the use of Rodeo. I commend the Town of Chilmark for its efforts to preserve Squibnocket Pond. In my opinion, Section 12.6(H) of the Chilmark Zoning By-law is a reasonable, site specific, land use regulation carefully tailored to protect the Pond and its immediately surrounding area.

Signed under the pains and penalties of perjury this 13 day of November, 2013.

Charles Benbrook

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