SHELLFISH AQUACULTURE LEASE PROGRAM IN PECONIC BAY AND GARDINERS BAY SUFFOLK COUNTY, NY

Steve Levy, County Executive

DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT

Date Accepted: 03/19/08
Date of Public Hearing: 04/17/08
Date Written Comments Due: 05/01/08

Prepared for:
Suffolk County Department of Planning
PO Box 6100
Hauppauge, NY 11788-0099

Prepared by:
CASHIN ASSOCIATES, P.C.
1200 Veterans Memorial Highway, Hauppauge, NY 11788

March 19, 2008

SUFFOLK COUNTY DEPARTMENT OF PLANNING

DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT

for the

SHELLFISH AQUACULTURE LEASE PROGRAM IN PECONIC BAY AND GARDINERS BAY SUFFOLK COUNTY, NY

Lead Agency

County of Suffolk
H. Lee Dennison Building
100 Veterans Memorial Highway
Hauppauge, New York 11788

Prepared for:

Thomas A. Isles, A.I.C.P.
Suffolk County Department of Planning
H. Lee Dennison Building
100 Veterans Memorial Highway
P.O. Box 6100
Hauppauge, New York 11788

Contact Name:

DeWitt S. Davies, Ph.D.
Chief Environmental Analyst
Suffolk County Department of Planning
H. Lee Dennison Building
100 Veterans Memorial Highway
P.O. Box 6100
Hauppauge, New York 11788

Prepared by:

Cashin Associates, P.C.
1200 Veterans Memorial Highway
Hauppauge, New York 11788

Suffolk County Aquaculture Lease Program Advisory Committee
(*ALPAC*)

Committee Members

Thomas A. Isles, A.I.C.P., Chairman DeWitt S. Davies, Ph.D. *(Alternate)*	Suffolk County Department of Planning
Carrie Meek Gallagher Tamara S. Sadoo *(Alternate)*	Suffolk County Executive Designee Suffolk County Department of Environment and Energy
Hon. Jay H. Schneiderman	Suffolk County Legislature Environment, Planning and Agriculture Committee
Martin Trent Kimberly Paulsen *(Alternate)*	Suffolk County Department of Health Services
Gilbert Anderson, P.E. Robert H. Whelan, P.E. *(Alternate)*	Suffolk County Department of Public Works
John Aldred	Town of East Hampton
Edward Bausman	Town of Shelter Island
David O. Conover, Ph.D. William M. Wise *(Alternate)*	School of Marine and Atmospheric Sciences, Stony Brook University
Kenneth L. Koetzner Debra A. Barnes *(Alternate)*	New York State Department of Environmental Conservation, Bureau of Marine Resources
Wayne L. Grothe	The Nature Conservancy
Stuart Heath Arnold Leo *(Alternate)*	East Hampton Town Baymen's Association, Inc.
Lt. David Lessard	Town of Riverhead
James McMahon	Town of Southold
Gregg Rivara Christopher F. Smith *(Alternate)*	Cornell Cooperative Extension of Suffolk County
Karen Rivara	East End Marine Farmers Association
Cornelia G. Schlenk	New York Sea Grant Institute
Hon. Jon S. Semlear Hon. Edward J. Warner, Jr.	Town of Southampton (joint appointment)

Table of Contents

Section **Page**

Executive Summary **9**
ES-1 Description of Action 9
ES-2 Project Purpose, Need, and Benefits 10
ES-3 Impacts 10
ES-4 Mitigation 12
ES-5 Alternatives 13
ES-6 Matters to be Decided 14
Section 1 Introduction **15**
1.1 New York State 2004 Leasing Law 15
1.2 Proposed Action 16
1.3 Project Purpose, Need, and Benefits 16
1.4 Project Sponsor 17
1.5 Location 18
1.6 State Environmental Quality Review Act (SEQRA) 18
1.7 Stakeholders and Public Input 22
1.8 SEQRA Implementation Timeline 22
Section 2 Description of the Proposed Action **25**
2.1 Proposed Action 25
2.1.1 Background of Program Development 25
2.1.2 Types of Shellfish Aquaculture Under the Proposed Action 28
2.2 Location 32
2.3 Background History 34
2.4 Prior Studies 38
2.4.1 Peconic Estuary Program 38
2.4.2 Peconic Bays Aquaculture Advisory Committee (PBAAC) Final Report 40
2.4.3 Suffolk County Planning Department 41
2.5 Existing Plans and Area Designations 45
2.6 Components of Proposed Lease Program 48
2.7 Project Review and Approvals 56
2.7.1 Federal Requirements 56
2.7.2 New York State Requirements 63
2.7.3 Local Laws and Codes Relating to Shellfish Aquaculture Activities 83
2.7.4 Permits and Notification Requirements for Shellfish Aquaculture 88
2.8 Types of Aquaculture Activities 88
2.8.1 Nurseries 89
2.8.1.1 Land-based Nurseries 89
2.8.1.2 Field-Based Nurseries 90
2.8.2 Grow-outs 90
2.8.2.1 In/On-Bottom 91
2.8.2.2 Off-Bottom 91
2.8.2.2.1 Typical off-bottom systems 92
2.9 Current Shellfish Aquaculture Activities in Peconic and Gardiners Bays 93
2.9.1 Species Cultivated 93

2.9.2 Harvest Methods 94
Section 3 Underwater and Surface Water Uses 96
3.1 Legal Jurisdictions 96
3.1.1 Federal Jurisdiction 96
3.1.2 New York State's Jurisdictional Authority over Navigable Waters and Submerged Lands 100
3.1.3 Towns and Local Governments in Suffolk County 103
3.2 Ownership of underwater lands 107
3.2.1 Oyster Grants 107
3.3 Other Shellfish Aquaculture Programs 116
3.3.1 State Relay Programs 116
3.3.2 East-End Town Aquaculture Programs 117
3.3.3 Private Organization Programs 122
3.4 Institutional Programs 125
Section 4 Environmental Setting, Impacts and Mitigation 127
4.1 Natural Resources 127
4.1.1 Existing conditions/setting 127
4.1.1.1 Circulation, Currents and Wave Action 127
4.1.1.2. Water Quality 129
4.1.1.3. Finfish 156
4.1.1.4. Benthic Zone 158
4.1.1.5. Submerged Aquatic Vegetation (current and historic) 166
4.1.1.6. Shellfish Pathogens/Disease/Exotic Species 172
4.1.1.7. Critical Natural Resource Areas 176
4.1.1.8. Rare (R), Threatened (T) and Endangered (E) Species 187
4.1.1.9. Migratory Waterfowl and Other Bird Populations 189
4.1.2 Impacts 197
4.1.2.1. Amplification of Native and Exotic Shellfish Diseases 197
4.1.2.2. Harvest of Shellfish 198
4.1.2.3. Placement of On-bottom Structures on Sediment Characteristics, Benthic Fauna 204
4.1.2.4. Sedimentation and Scouring 205
4.1.2.5. Changes in the Phytoplankton Composition and Nutrient Cycling 205
4.1.2.6. Displacement and Attraction of Species 206
4.1.2.7. Suspended Sediment/Turbidity 207
4.1.2.8. Carrying Capacity/Phytoplankton Depletion/Nutrients 212
4.1.2.9. Physical Carrying Capacity 214
4.1.2.10. Production Carrying Capacity 214
4.1.2.11. Ecological Carrying Capacity 214
4.1.2.12. Enhanced Recruitment 221
4.1.2.13. Site Impacts, Down-drift Impacts 222
4.1.2.14. Accidental Release of Shellfish 227
4.1.2.15. Genetic Changes 227
4.1.2.16. Impacts to Protected and Important Species 227
4.1.3 Mitigation 228
4.1.3.1 Limit Lease Number 229

4.1.3.2. Limit Lease Size 229
4.1.3.3. Type of Lease 230
4.1.3.4. Ongoing Municipal Input 231
4.1.3.5. Limit Biomass of Shellfish 231
4.1.3.6. Restrict Harvest Methods 232
4.1.3.7. Establish Buffers Around Leases and Environmental Resources 232
4.1.3.8 Require Environmental Monitoring Plans 234
4.1.3.9. Require Disease Testing of Shellfish 234
4.1.3.10. Transient Gear Aquaculture System 235
4.1.3.11. Plot Rotation 236
4.1.3.12. Use of Local Seed Stock 236
4.1.3.13. Phasing of Program 236
4.1.3.14. Monitoring Environmental Conditions 237
4.2 Socio-economic and Cultural Impacts 240
4.2.1 Existing Conditions/Setting 240
4.2.1.1. Commercial Fishing 240
4.2.1.1.1. Types of Activities 241
4.2.1.1.2. Landings and Values 253
4.2.1.1.3. Characteristics of Commercial Fishermen 258
4.2.1.2. Oyster Grants and Temporary Marine Area Use Assignments 264
4.2.1.3. Shellfish Aquaculture in Other States 266
4.2.1.4. Recreational Finfishing 270
4.2.1.5. Commercial and Recreational Boating 275
4.2.1.6. Other Maritime Uses 277
4.2.1.7. Parks and Heritage Areas 278
4.2.1.8. Aesthetic Values 280
4.2.2 Impacts 280
4.2.2.1. Loss of Harvest Area 280
4.2.2.2. Maritime Traditions 281
4.2.2.3. Changes in Employment Opportunities/Incomes 283
4.2.2.4. Value of Fishery Resources 284
4.2.2.5. Potential Supplemental Income for Baymen 284
4.2.2.6. Shoreline Facilities 284
4.2.2.7. Conflicts Over Lease Boundaries 285
4.2.3 Mitigation 285
4.2.3.1 Performance Standards 285
4.2.3.2. Limit Acreage/Area 285
4.2.3.3. Limit Lease Size 286
4.2.3.4. Mark Lease Areas 287
4.2.3.5. Cooperation Among User Groups 287
4.2.3.6 Phased Expansion of Leases on Formerly Issued Grants 287
4.3 Transportation 288
4.3.1 Existing Conditions/Setting 288
4.3.1.1. Boating Activities 288
4.3.1.2. Navigation 288
4.3.2 Impacts 288

4.3.2.1. Hazards to Navigation 288
4.3.2.2. Restrictions on Use 289
4.3.3 Mitigation 289
4.3.3.1. Standards for Marking 289
4.3.3.2. Notification 289
4.3.3.3. Limit Placement of Structures 290
4.3.3.4. Require Buffers 290
4.4 Visual Setting 291
4.4.1 Existing Conditions/Setting 291
4.4.1.1. Buoys and Structures on Surface 291
4.4.2 Impacts 292
4.4.2.1. Loss of Aesthetic Values/Qualities 292
4.4.3 Mitigation 293
4.4.3.1. Visual Buffers and Setbacks from Critical Viewsheds 293
4.5 Use and Conservation of Energy 293
4.6 Solid Waste Management 293
4.7 Acquisition of Land 294
4.8 Groundwater Resources 294
4.9 Air Quality 294
4.10 Summary of Potential Impacts and Mitigations 294
Section 5 Alternatives 299
5.1 Overview of Alternatives Analysis 299
5.2 Alternative 1A – Minimum Lease 300
5.3 Alternative 1B – Minimum Lease with Moderate Growth 301
5.4 Alternative 2 – No Action 302
5.5 Alternative 3 – Elimination of Existing Aquaculture Activities in the Peconics and Gardiners Bays 303
5.6 Alternative 4 – Unlimited Lease Growth 303
5.7 Summary of Impact Analysis of Alternatives 305
Section 6.Cumulative and Growth Inducing Impacts 307
6.1 Existing Aquaculture, Fishing/Shellfishing 307
6.2 Shore-side Requirements 308
Section 7 Unavoidable Adverse Impacts 310
Section 8 Irreversible and Irretrievable Commitment of Resources 315
Section 9 References 317

List of Figures

Figure		Page
Figure 1	Site Location	21
Figure 2	Environmentally and Socio-economically Sensitive Areas	29
Figure 3	Shellfish Aquaculture Lease Program Cultivation Zone	30
Figure 4	Existing Private Oyster Grants and Temporary Marine Area Use Assignments	115
Figure 5	NYSDEC Water Quality Classifications for the Peconic Estuary	131
Figure 6	Peconic Estuary Program Mainstem, Peconic River and West Neck Bay Stations	141
Figure 7	Spatial Distribution of Nitrogen	142
Figure 8	Total Nitrogen Trends	143
Figure 9	Annual Mean Total Chlorophyll-*a* Levels in the Peconic Estuary	145
Figure 10	Flanders Bay Surface Water Temperatures, 1986-2004	150
Figure 11	Average Summer and Winter Surface Water Temperatures in Flanders Bay, 1986-2004	151
Figure 12	Standardized Seasonal Mean NAO Index, 1950-2007	152
Figure 13	Annual Variation of Dissolved Oxygen and Temperature in the Near-bottom Waters of Meetinghouse Creek	155
Figure 14	Critical Natural Resource Areas	177
Figure 15	Essential Fish Habitats within the Shellfish Cultivation Zone	180
Figure 16	Conceptual Diagram of Bivalve Aquaculture Interactions in Coastal Ecosystems	218
Figure 17	Conceptual Scheme of Various Components of the FARM Model	221
Figure 18	Sea WiFS Observations for Suffolk County Station 130 in Peconic Bay	240
Figure 19	New York State Shellfish Harvest Areas in the Peconic Estuary	245
Figure 20	Bay Scallop Landings in New York State, 1950-2006	246
Figure 21	Horseshoe Crab Harvest by Area, 2004	249
Figure 22	NY Resident Commercial Lobster Landings, 1981-2004	251
Figure 23	NYS Lobster Landings 1950-2006	251
Figure 24	Blue Crab Harvest in NYS 1950-2006 and Peconic Bay 2003-2006	253
Figure 25	Commercial Fisheries Landing in NYS, 1950-2006	254
Figure 26	NYS Landings and Dollar Values of Selected Species 1981-2006	255

Figure 27 NYS Hard Clam Landings and Dollar Values, 1950-2006 257
Figure 28 Landings per Gear Type for Select Finfish Species Caught in NYS, 1950-2006 261
Figure 29 Total Value of the Rhode Island Shellfish Industry and Acres Leased 269
Figure 30 Commercial and Recreational Harvest of Select Finfish Species 1981-2006 271
Figure 31 Recreational Finfish Harvest in NYS "Inland" Waters 1981-2006 273

List of Tables

Table		Page
Table 1	Permit/Notification Requirements for Shellfish Aquaculture Under the Proposed Lease Program	88
Table 2	Existing Privately-owned Tax Map Parcels in the Peconic Estuary and Number of Oyster Grants on Each Parcel	108
Table 3	Current NYSDEC Temporary Marine Area Use Assignments in the Peconic and Gardiners Bays	113
Table 4	Acreage of Shellfish Closures within the Peconic Estuary	135
Table 5	Baseline Annual Total Nitrogen Load System-Wide	137
Table 6	Baseline Nitrogen Load Summary	139
Table 7	Nutrient Statistics at Tributaries Presently or Previously associated with Duck Farms	144
Table 8	Salinity in the Peconic River and Mainstem Stations, 1986-2005	146
Table 9	Mean Surface and Bottom Salinity, Temperature and Dissolved Oxygen at Mainstem Stations, 1986-2005	148
Table 10	Finfish Observed During NYSDEC Survey	157
Table 11	Shellfish Species of PEP Shellfish Survey	165
Table 12	Submerged Aquatic Vegetation Identified in the Peconic Estuary	168
Table 13	Marine Species Identified in the EFH in Western Portion of PE	182
Table 14	Marine Species Identified in the EFH in Lower Mid Portion of PE	183
Table 15	Marine Species Identified in the EFH in Upper Mid Portion of PE	184
Table 16	Marine Species Identified in the EFH in East of Shelter Island and West of Gardiners Island	185
Table 17	Marine Species Identified in the EFH Surrounding Gardiners Island	186
Table 18	Species of Special Concern that Occur or May Occur within the Shellfish Cultivation Zone	187
Table 19	Bird Species Identified during 2006-2007 Christmas Bird Count within the Shellfish Cultivation Zone and/or the Immediate Surrounding Area	190
Table 20	Waterfowl Species Recorded on LI during NYSOA Waterfowl Count	194
Table 21	Waterfowl Species that Breed within the Peconic Estuary	196
Table 22	Four Types of Carrying Capacity that May be Applied to Aquaculture	213
Table 23	Postulated and Documented Local-Scale Effects Associated with Shellfish Aquaculture	225

Table 24	Postulated and Documented Down-Drift Effects Associated with Shellfish Aquaculture	226
Table 25	Candidate Characteristics by which Deviations from the Pelagic-phase Ecological Carrying Capacity can be Assessed	238
Table 26	Recommended Indicators of Bivalve Habitat Effects with the Spatial Scale of Impact that Each Can Address	239
Table 27	Shellfish Harvest for Peconic Estuary, 2003-2006	244
Table 28	NYSDEC Whelk Landings in Peconic and Gardiners Bays	248
Table 29	1999 US Exports of Whelk	248
Table 30	Horseshoe Crab Harvest by Area, 2004-2007	250
Table 31	NYSDEC Commercial Fishing Licenses Issued in 2006, Region 1	259
Table 32	NYSDEC Shellfish Digger Permits Issued in 2006	260
Table 33	NYSDEC Seasonally-Regulated Commercial Marine Species	262
Table 34	Restrictions on Commercial Shellfish Catch Limits in NYS	263
Table 35	NYSDEC Seasonally–Regulated Recreation Marine Species	272
Table 36	Recreational and Commercial Vessels Occupying the Peconic Estuary	276
Table 37	NYSDEC 2007-2008 Waterfowl Hunting Seasons	277
Table 38	State and County Owned Parks abutting the Tidal Waters of the Peconic Estuary	278
Table 39	Potential Significant Adverse Impacts of the Proposed Lease Program	295
Table 40	Potential Beneficial Impacts of the Proposed Lease Program	297
Table 41	Total Conceivable Acreage and Potential Impact Outcomes for Each Alternative	306
Table 42	Unavoidable Impacts and Mitigation Measures	313

Executive Summary

This Draft Generic Environmental Impact Statement (DGEIS) has been prepared in accordance with the requirements of 6NYCRR Part 617, State Environmental Quality Review Act (SEQRA). This Executive Summary provides a brief overview of the essential components, issues, and facts contained in the body of this DGEIS, including:

- A description of the proposed action, discussion of its purpose, need and benefits;
- Identification of potential impacts;
- Listing of mitigation measures;
- Description of the alternative(s) considered; and
- Elaboration of the matters to be decided, including any permits, approvals, or funding associated with the action.

ES-1 Description of Action

Pursuant to New York's 2004 Leasing Law, the State of New York ceded to Suffolk County underwater lands in Peconic Bay and Gardiners Bay seaward of 1,000 feet from the high water mark for the purposes of shellfish cultivation. The Peconic Estuary has approximately 158,000 acres of surface water area. The project study area consists of approximately two thirds of the open water in the estuary, approximately 110,000 acres, which is naturally divided by peninsulas (necks) and islands into a series of interconnected embayments. The 2004 Leasing Law also requires that the County adopt regulations governing: applications for leases; notices to be given; the form and term of leases; standards for the approval or denial of leases; administration of leases; the transfer or renewal of leases; marking grounds and testing; fees; recording of leases; and other matters as are appropriate to the lease program. If no leases for shellfish aquaculture are executed by December 31, 2010, the authority of Suffolk County to issue such leases shall terminate and the County will forfeit any of its title to the underwater lands.

As described in greater detail in Section 2.5 *Components of Lease Program*, the County is proposing an action to institute a shellfish aquaculture lease program in Peconic Bay and Gardiners Bay that will support existing aquaculture activities as well as promote a

moderate growth of the industry. The program components have been designed to insure that any negative impacts on the environmental, socio-economic or historic resources have been identified and either eliminated or mitigated.

ES-2 Project Purpose, Need, and Benefits

The establishment of a County aquaculture lease program will provide people with the opportunity to obtain access to underwater lands of Peconic Bay and Gardiners Bay for culturing shellfish. Such a program will help encourage private investment in aquaculture and supporting businesses. At the same time, the establishment of a program must assure that the other bay user groups are considered and appropriately protected, and that environmental protection of the coastal waters and their natural resources is maintained to the fullest extent possible.

The proposed shellfish aquaculture Lease Program presented in this document will support current shellfish aquaculture businesses operating in the Peconic Estuary as well as allow the opportunity for new growth of the industry. Currently, approximately 6,000 acres of underwater land are available for aquaculture activities (comprised of private underwater land grants and NYSDEC Temporary Marine Area Use Assignments). In addition to these underwater lands, the Lease Program will allow for a small growth of approximately six hundred acres, or about 10%, over the next 10 years. The program will be reviewed every five years, and modifications to the program may be made after 10 years based on environmental and/or socio-economic conditions.

ES-3 Impacts

The potential for impacts of the proposed Lease Program was evaluated with respect to natural resources, as well as socio-economic and cultural concerns. Adoption of this Lease Program of itself does not impact the program area, but commits the County to an action that will permit activities likely to have an impact on Peconic Bay and Gardiners Bay. It is the intent of this DGEIS to identify potential impacts, and if any significant negative impacts are identified, suggest possible mitigation measures to eliminate or reduce the impact.

This DGEIS considers potential impacts to the geology; benthic ecology; water column (including water quality); submerged aquatic vegetation; sediment transport; critical natural resource areas; rare, threatened and endangered species; existing/historic user activities and maritime traditions. Input obtained from many knowledgable individuals, and a review of the peer reviewed and gray literature, suggest that the program, as currently envisioned, will not result in the development of significant adverse environmental impacts Potential impacts, including those listed below, along with mitigation methods where desirable, are addressed in Section 4 of this document.

- Introduction of shellfish pathogens;
- Introduction of exotic/invasive species
- Harvest method impacts;
- Impacts on sediment characteristics and benthos;
- Changes to phytoplankton composition and nutrient cycling;
- Restricted access to public underwater lands;
- Changes in maritime traditions;
- Changes in employment opportunities/incomes;
- Impact on wild fishery;
- Navigation hazards; and
- Impact on aesthetic values.

Overall, the program is expected to be environmentally and socio-economically beneficial, resulting in;

- Increased economic benefits from expansion of shellfish aquaculture;
- Increased employment opportunities for baymen;
- Restoration of maritime tradition;
- Beneficial ecological impacts associated with increased shellfish stocks, including increased water column filtering, spawning stock and habitat for other marine species;
- Potential contribution to wild shellfish stock

- Secondary impacts to support sectors including shellfish buyers/shoppers, marinas, and seed hatcheries; and
- Increased seafood production to compensate for declines in products of wild stocks.

ES-4 Mitigation

It is suggested that implementation of the proposed program will not entail any significant adverse environmental impacts, and to the contrary, may be beneficial to water quality and essential fish habitat. The potential impacts mentioned above in Section ES-3 may be mitigated by implementing the following:

- All participants in the Lease Program will be required to comply with all regulatory components of the NYSDEC's Part 48: Marine Hatcheries, On-Bottom and Off-Bottom Culture of Marine Plants and Animal Life, including the policy being adopted on Acceptable Origin of Shell and Shellstock for Introduction in New York.
- NYSDEC regulations place limits on the types of shellfish allowed to be cultured, biomass, and harvest methods to reduce impacts on the sediment, benthos, plankton, and overall carrying capacity of the bay.
- Limits will be placed on the number, size and location of leases to allow for a moderate growth rate while limiting impacts on environmental and socio-economic resources of the bays, navigation, and aesthetic values.
- The Lease Program may afford baymen an opportunity to continue with their maritime traditions by providing additional means to achieve a sustainable lifestyle from the local marine resources.
- Commercial value of the local shellfish industry is generally governed by activities from other states and not local actions. Therefore, it is suspected that the moderate growth being proposed by this program will have little or no effect on the wild fishery industry.

ES-5 Alternatives

In addition to the Proposed Components Alternative recommended in Section 2.5 of this DGEIS and the SEQRA requisite for a "no-action" alternative, a "minimum lease" alternative, an "elimination of existing aquaculture" alternative and an "unlimited growth" alternative were evaluated as part of this DGEIS. The no-action alternative as described by NYS Law § 617.9(b)(5)(iii)(v), "Preparation and Content of Environmental Impact Statements," as an alternative that "evaluate(s) the adverse or beneficial site changes that are likely to occur in the reasonably foreseeable future, in the absence of the proposed action." The no-action alternative is the primary frame of reference for evaluation whether the proposed components of this lease program conform to the requirements of SEQR. This no-action alternative suggests that the County would not institute a shellfish lease program and all underwater lands ceded to Suffolk County would revert back to the State after the "no-lease" expiration date of December 31, 2010.

The minimum lease alternative described in this DGEIS will allow for all existing aquaculture activities currently operating in the Peconic and Gardiners Bays that comply with the requirements set forth in the NYS 2004 Lease Law to become part of the County's Lease Program. All of the private land grants will be eligible, as well as the NYSDEC Temporary Marine Area Use Assignments located within the proposed cultivation zone for support under the lease program. There would be no provision for additional leases on underwater lands not previously used for shellfish aquaculture.

The elimination of existing aquaculture alternative suggests that the County will no longer support any shellfish aquaculture activities and will allow the underwater land ceded to the County to revert back to the State after the "no-lease" expiration date of December 31, 2010. This alternative suggests an action that will intentionally create a negative impact to certain environmental and socio-economic resources and, although addressed as an alternative in this DGEIS, would not be practicable (or meet the intent of the Lease Law).

Similar to the elimination of existing aquaculture alternative, the unlimited growth of private aquaculture practices in the bays would create an intentional impact to certain environmental and socio-economic resources, and although evaluated as part of this DGEIS, would not be a practicable alternative.

ES-6 Matters to be Decided

As part of the SEQRA process, this DGEIS addresses the impacts associated with proposed action, and helps to provide a pathway for the implementation of an aquaculture lease program for the Peconic and Gardiners Bays. The County, as the Lead Agency, is responsible for completing the SEQRA process for the proposed action, and adopting findings in accordance with the State law, including determining that:

- The requirements of 6NYCRR Part 617 have been met; and
- Consistent with social, economic and other essential considerations from among the reasonable alternatives available, the action is the one that avoids or minimizes adverse environmental impacts to the maximum extent practical by incorporation, as conditions to the decision, mitigative measures and safeguards identified as practicable.
- Evaluate the impact associated with the implementation of the proposed action as to whether a significant commitment of County resources and new staff for administration, implementation, oversight and enforcement which may affect several county agencies is required.

Section 1
Introduction

1.1 New York State 2004 Leasing Law

Pursuant to New York Environmental Conservation Law 13-0302 and as authorized under Laws of New York 2004, Chapter 425 the State of New York ceded to Suffolk County underwater lands in Peconic and Gardiners Bay seaward of the 1,000 feet from the high water mark for the purposes of shellfish cultivation provided the various conditions and requirements as set forth in this law are met. Pursuant to this law, the following areas cannot be leased:

- "underwater lands where bay scallops are produced regularly and harvested on a commercial basis"
- "underwater lands where there is an indicated presence of shellfish in sufficient quantity and quality and so located as to support significant hand raking and/or tonging harvesting"
- "underwater lands where the leasing will result in a significant reduction of established commercial finfish or crustacean fisheries"

The 2004 Leasing Law also requires that the County adopt regulations governing: applications for leases; notices to be given; the form and term of leases; standards for the approval or denial of leases; administration of leases; the transfer or renewal of leases; marking grounds and testing; fees; recording of leases; bond; and other matters as are appropriate to the lease program.

If no leases for shellfish aquaculture are executed by December 31, 2010, the authority of Suffolk County to issue such leases shall terminate and the County will forfeit any of its title to approximately 110,000 acres of the underwater lands in Peconic Bay and Gardiners Bay.

1.2 Proposed Action

Suffolk County prepared this Generic Environmental Impact Statement for the *Shellfish Aquaculture Lease Program in Peconic and Gardiners Bays* to:

- Fulfill the requirements of the 2004 Leasing Law
- Establish a framework for the leasing of underwater lands for shellfish aquaculture that minimizes environmental impacts and user conflicts while supporting the growth of shellfish aquaculture and the environmental, economic and natural resource benefits it provides; and,
- Develop the local laws, regulations and administrative procedures necessary to implement a shellfish aquaculture lease program.

1.3 Project Purpose, Need, and Benefits

This report will provide the framework and information needed for the Suffolk County Legislature and the Suffolk County Executive to enact the local law and regulations for the *Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay* and will enable Suffolk County to issue shellfish aquaculture leases.

The implementation of the *Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay* is expected to yield the following benefits:

- Provide people with the opportunity to obtain access to underwater lands for raising shellfish.
- Encourage private investment in aquaculture businesses and the establishment of shellfish farms at secure locations that do not pose conflicts with commercial fishermen and other bay users.
- Expand the marine-based economy and create related job opportunities.
- Augment the spawning potential of native shellfish populations and exert positive influence on water quality by helping to control nutrient cycling and to prevent noxious plankton blooms as a result of the increase in the number of shellfish.
- Provide other potential positive impacts related to the establishment of aquaculture leases such as: increase of suitable substrate for both flora and

fauna on bottom structures; commensal relationships between commercial fishing activities and culture activities; and additional opportunity for commercial fisherman to maintain their economic viability.

- Help to re-establish and strengthen traditional shellfish farming activities which have experienced decline since the early 1900's.

According to the report *Interim Final 10-Year Plan for the NOAA Aquaculture Program* (November 2006) from the NOAA Aquaculture Program Office, "a compelling case can be made for developing the domestic marine aquaculture industry in the United States to meet the growing demands for seafood." The report stated that:

- Consumption of seafood in the United States was 16.6 pounds per person in 2005, up from 16.3 pounds per person in 2004.
- Nutritionists are encouraging increased consumption of seafood.
- Of the 16 million metric tons of seafood consumed each year in the US, 1.5 million is provided by domestic commercial fisheries and 0.5 million is by domestic aquaculture.
- Aquaculture operations in the US currently produce about 500,000 metric tons of seafood per year, valued at $1 billion.
- Currently, to meet US demands, almost 70 percent of the seafood (11.2 million metric tons) is imported. Of these 11.2 million metric tons, half is produced through aquaculture.
- The US currently has a seafood balance of trade deficit of almost $8 billion.

1.4 Project Sponsor

In accordance with the State Environmental Quality Review Act (SEQRA) and its implementing regulations (6NYCRR Part 617), Suffolk County, as the Lead Agency, is preparing this Draft Generic Environmental Impact Statement (DGEIS) to evaluate the potential impacts of establishing a *Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay.*

1.5 Location

The proposed Shellfish Aquaculture Lease Program study area is located in the Peconic Estuary system which comprises the coastal waters between the north and south forks of eastern Long Island, Suffolk County, New York (Figure 1). These coastal waters are in the jurisdiction of Suffolk County's five eastern townships: Riverhead and Southold on the north fork; Southampton and East Hampton on the south fork; and Shelter Island between the forks.

1.6 State Environmental Quality Review Act (SEQRA)

This DGEIS has been prepared in compliance with Section 8-0109 of the New York State Environmental Conservation Law and State Environmental Quality Review Act (SEQRA), the implementing regulations of SEQRA at 6 NYCRR Part 617, and other applicable guidelines. The purpose of this DGEIS is to identify the potentially significant adverse environmental impacts that could result from the adoption and implementation of the proposed Shellfish Aquaculture Lease Program. If any such impacts are identified this DGEIS will investigate possible measures that could be used as mitigation. This information will facilitate the decision by Suffolk County as to whether the proposed action (as currently proposed or with amendments) should be approved. In addition, positive impacts associated with this program will also be evaluated.

The County's adoption of the proposed program, of itself, will not entail any environmental impacts, positive or negative. However, this program commits the County to a certain course of action that could impact existing environmental conditions, affect options for future surface water uses, and induce certain benefits or adverse effects. These impacts are the main focus of the environmental impact analysis presented in this DGEIS. The EIS process was utilized to develop a program that minimized potential adverse impacts and conflicts with other user groups.

As part of the final decision under SEQRA, which is known as the "Findings Statement," the County will be required to "certify that consistent with social, economic and other essential considerations from among the reasonable alternatives available, the action is

one that avoids or minimizes adverse environmental impacts to the maximum extent practicable, and that adverse environmental impacts will be avoided or minimized to the maximum extent practicable by incorporating as conditions to the decision those mitigative measures that were identified as practicable [6 NYCRR §617.11(e)]." This language clearly expresses that the implementation of SEQRA is intended to recognize environmental protection as one consideration in the decision-making process, and that a balanced approach is needed in order to give appropriate weight to all "essential considerations."

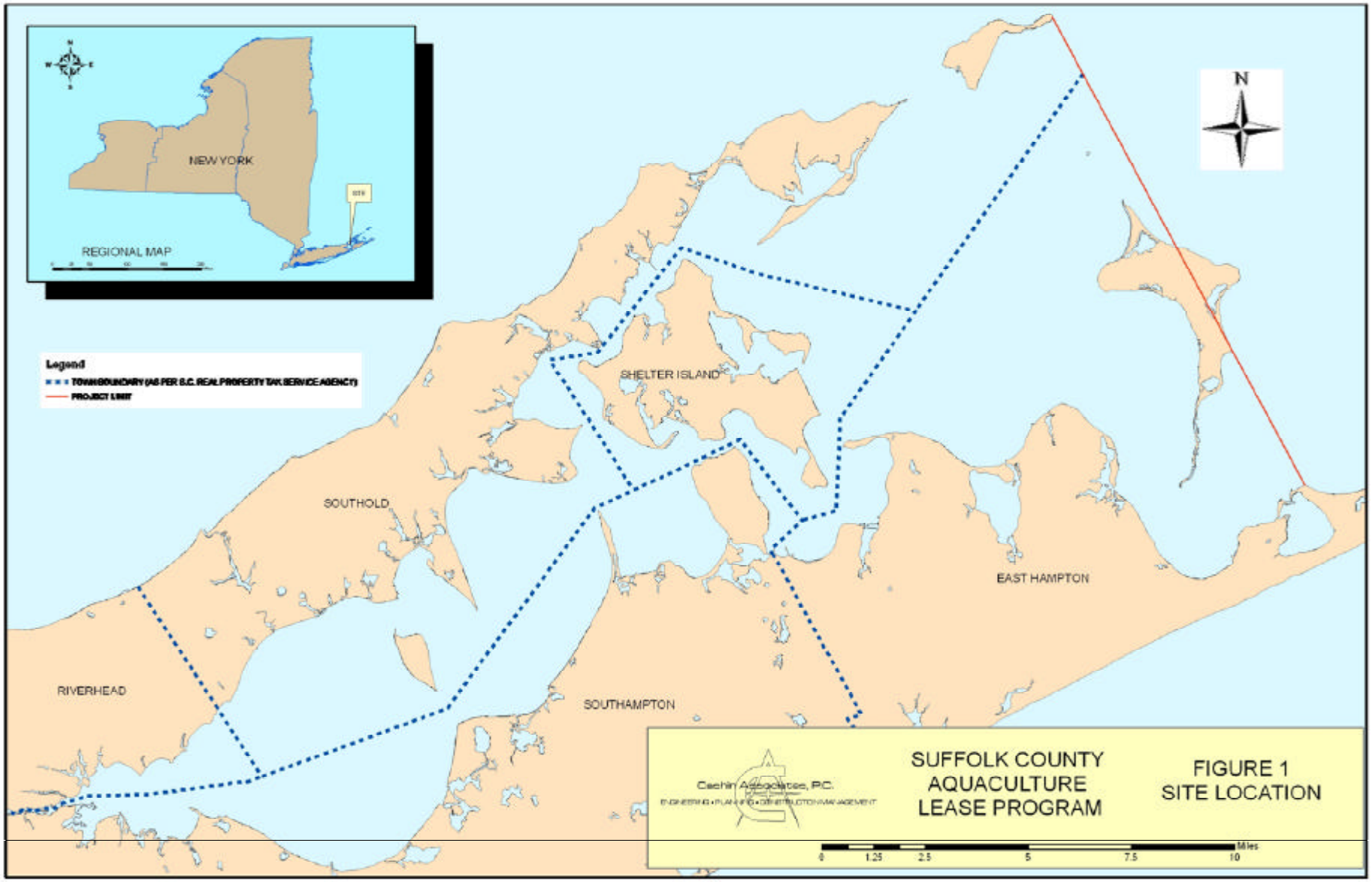
It is also important to recognize that the no-action alternative is the primary frame of reference for evaluating whether a proposed action conforms to the requirements of SEQRA. An aquaculture lease program will entail at least some adverse impacts to the environment, in comparison to conditions if the program did not occur. When such impacts are determined to be "significant," suitable mitigation is required in order to satisfy SEQRA regulations. On the other hand, any action that by its nature reduces the potential for adverse environmental impacts as compared to circumstance that would occur in the absence of said act, by definition, is consistent with the intent of SEQRA. This aquaculture lease program proposed by the County fits into the latter category. In this case the SEQRA process, including public and stakeholder input, was utilized to define an aquaculture program as a proposed alternative that minimized potential adverse impacts and conflicts with other user groups.

This DGEIS is not intended to provide a detailed analysis of the individual leases that may be undertaken by the Lease Program, but rather the purpose of this document is to perform a "generic" assessment of potential impacts of implementing the program. In accordance with 6 NYCRR §617.10(a), this DGEIS is "broader and more general than a lease area specific Environmental Impact Statement." This DGEIS will analyze existing data, conceptual information and hypothetical scenarios to reduce any potential adverse environmental impacts, to the maximum extent practicable, which could be associated with this project.

Any lease options proposed by this program will be fully governed by the requirements of SEQRA with respect to further environmental review, if necessary. However, it is the intent of this DGEIS to suggest measures to mitigate any potential adverse environmental impacts associated with the overall project in order to eliminate any "significant" environmental impacts that could occur within individual lease areas.

The remaining steps of the process for the proposed action, including completion of SEQRA review and subsequent actions of the proposed project, are as follows:

- The County will conduct a public review with respect to this DGEIS and the proposed project, including a public hearing.
- A Final GEIS (FGEIS) will be prepared to address all substantive issues that may be raised during the public review of the DGEIS.
- Based on the information and analysis contained in the DGEIS and FGEIS, the County will adopt a Statement of Environmental Findings, which is the final environmental basis for the County decision, and: (a) will establish if the proposed action avoids or mitigates significant adverse environmental impacts to the maximum extent practicable, consistent with social, economic and other essential considerations from among the reasonable alternatives available (Positive Findings); or (b) will establish that the proposed action does not satisfy this prerequisite for approval (Negative Findings).
- Using Positive Findings, the County can proceed with the official adoption of the Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay and associated management techniques, which comprise the proposed action.


NEW YORK
REGIONAL MAP
Legend
TOWN BOUNDARY (AS PER S.C. REAL PROPERTY TAX SERVICE AGENCY)
PROJECT LIMIT
N
SHELTER ISLAND
SOUTHOLD
EAST HAMPTON
RIVERHEAD
SOUTHAMPTON
Cashin Associates, P.C.
SUFFOLK COUNTY
AQUACULTURE
LEASE PROGRAM
FIGURE 1
SITE LOCATION
0
1.25
2.5
5
7.5
10
Miles

1.7 Stakeholders and Public Input

As part of the development of this plan, the County Executive established an Aquaculture Lease Program Advisory Committee (ALPAC) to obtain input regarding aquaculture and other users of the estuary. The ALPAC meetings were held approximately monthly and included a public session in which public comments were accepted. The ALPAC consisted of members representing government agencies, private aquaculture interests, commercial fishermen, regulatory agencies and other individuals associated with the Peconic Estuary. The stakeholder and public comments were in addition to the public review required under SEQRA, and provided valuable input into the development of the proposed alternative.

1.8 SEQRA Implementation Timeline

The implementation timeline for the SEQRA process for implementation of the Suffolk County Shellfish Aquaculture Lease Program for Peconic Bay and Gardiners Bay is given below.

Task	**Date of Completion**
EAF prepared	February 2, 2007
Coordinated Review Letter	February 5, 2007
CEQ Pos Dec Request Letter + EAF + DRAFT Determination of Significance	February 7, 2007
CEQ Meeting: Recommend Pos Dec w/ public scoping	February 21, 2007
EPA Meeting: Approved CEQ recommendation and forwarded to full Legislature	February 26, 2007
Legislature: Considered EPA recommendation, approved, Legislature drafts Pos Dec, IR	March 6, 2007
30 day coordinated review ends – Suffolk County assumes lead agency status	March 8, 2007
EPA Meeting: Considered Legislature's IR for Pos Dec – Forward to full Leg	March 12, 2007
Preliminary Draft Scoping Document submitted to Suffolk County Planning for review	March 12, 2007
Legislature: Issued Pos Dec Planning as initiating unit, authorized to proceed with public scoping and DGEIS preparation	March 20, 2007
CEQ Meeting: Established role CEQ will play in public scoping process.	March 21, 2007
ALPAC Meeting: Review of preliminary draft scoping document	March 22, 2007
Distribute draft scoping document	April 11, 2007
Public scoping hearing	May 3, 2007

Task (cont)	**Date of Completion (cont)**
End of written comment period on Scoping Document	May 17, 2007
Final Scope completed by Suffolk County Planning Department	May 31, 2007
Final Scoping Document submitted to CEQ	June 6, 2007
CEQ Meeting: Review of Final Scoping Document	June 20, 2007
EPA Meeting: Considers CEQ recommendation on Final Scoping Document	June 30, 2007
Legislature: Considers EPA recommendation, if approved, Leg drafts IR	August 7, 2007
EPA Meeting: Considers Legislature's IR adopting Final Scoping Document	August 13, 2007
Legislature: Adopted Final Scoping Document	August 21, 2007
SC Planning Department completes DGEIS	TBA
DGEIS submitted to CEQ	TBA
CEQ Meeting: Considers DGEIS. If accepted, prepares & forwards notice of completion/public hearing to EPA – 30 Day public comment period begins.	TBA
Optional public hearing	=15 and <60 days after filing of notice of completion
30 day public comment period ends	TBA
SC Planning Department submits DGEIS, comments & hearing record to CEQ	TBA
CEQ Meeting: Determines if comments are substantive. If so recommends FGEIS.	TBA
EPA Meeting: Considers CEQ recommendation to proceed with FGEIS	TBA
Legislature: Considers CEQ's recommendation to proceed with FGEIS.	TBA
EPA Meeting: Lays lead agency IR on table recommending to proceed with FGEIS	TBA
Legislature: Considers lead agency resolution recommending proceeding with FGEIS.	TBA
Cashin submits FGEIS & draft findings to Suffolk County Planning Department	TBA
Suffolk County Planning Department submits FGEIS and draft findings statement to CEQ.	TBA
CEQ Meeting: Reviews FGEIS along with draft findings statement and makes recommendation to County Executive & Legislature	TBA
EPA Meeting: Reviews CEQ's recommendation to adopt FGEIS and issues findings statement.	TBA
Legislature: Reviews CEQ's recommendation to adopt FGEIS and findings statement.	TBA
EPA Meeting: Lays lead agency IR on table adopting FGEIS and findings statement	TBA
Legislature: Reviews lead agency resolution adopting FGEIS and findings statement.	TBA

Note: EAF-Environmental Assessment Form; CEQ-Council for Environmental Quality; EPA-Environment, Planning and Agriculture Committee; IR-Introductory Resolution; DGEIS-Draft Generic Environmental Statement; FGEIS-Final Generic Environmental Statement.

THIS PAGE INTENTIONALLY LEFT BLANK

Section 2
Description of the Proposed Action

2.1 Proposed Action

As briefly discussed in the preceding Section 1.2 of this document, the proposed action involves Suffolk County's development of a Shellfish Aquaculture Lease Program for Peconic Bay and Gardiners Bay. This program is designed to fulfill the requirements set forth in the NYS 2004 Leasing Law by establishing a framework for the leasing of underwater lands for the propose of shellfish aquaculture that will minimize environmental impacts and user conflicts while supporting the growth of the shellfish aquaculture industry. The Lease Program will also develop laws, regulations and administrative procedures necessary for implementation.

2.1.1 Background of Program Development

The development of this program was a formidable undertaking that required the collective knowledge and input from numerous individuals, agencies, organizations, businesses and other interested parties. Obtaining this knowledge was facilitated by the participation of the Aquaculture Lease Program Advisory Committee (ALPAC), which was established by County Executive Orders, and by conducting information gathering meetings including public input sessions. In addition to the ALPAC meetings, individual and group meetings were held that involved site visits to aquaculture operations and interviews with over 70 individuals, including local government representatives, shellfish growers, baymen, fishermen, environmental organizations, professional/trade groups, recreational boaters, and academic institutes.

Also as part of the program's development, significant data on the environmental characteristics and features of Peconic Bay and Gardiners Bay including wetlands, submerged aquatic vegetation, water quality, natural resources, and sediments were collected. In addition to the environmental information required for inclusion in the DGEIS, data on socio-economic and maritime traditions were also collected and analyzed to assess any impacts to those resources that may occur through implementation of a lease program.

As a result of the meetings, interviews and data analysis, various environmental resource conditions were delineated and an Environmentally and Socio-Economically Sensitive Area was created (Figure 2). Some of the conditions delineated on this figure were: the 1,000 foot high water buffer zone; town boundary lines, NYS Significant Coastal Fish and Wildlife Habitats; NYSDEC Shellfish Closure Areas; NYSDEC Temporary Marine Area Use Assignments; areas that support multiple commercial fisheries; private oyster grant parcels; NYSDEC regulated fish trap locations; current commercial hard clam harvest areas; current and historic eelgrass bed locations; navigation channels; and current and historic scallop areas, as identified below.

- 1,000 foot high water buffer zone – The apparent high water mark was delineated by tracing the water line depicted on the New York State Clearinghouse 2004 aerial photographs and then establishing the 1,000 foot buffer boundary by measuring off that apparent water line. This method was used because no matter what phase the tidal cycle was in when the photos were taken, measuring off that line would always represent either a line equal to or greater that 1,000 feet off the apparent high tide mark of Peconic Bay and Gardiners Bay.
- Town boundary lines – The Suffolk County Real Property Tax Maps were used to delineate these lines.
- NYS Significant Coastal Fish and Wildlife Habitats – These areas were delineated using data from the New York State Department of State.
- NYS Shellfish Closure Areas – These areas were delineated using data from the NYS Department of Environmental Conservation on current shellfish closure areas within Peconic Bay and Gardiners Bay.
- NYSDEC Temporary Marine Area Use Assignments – These areas were delineated using data provided by NYSDEC Bureau of Marine Resources.
- Areas that support multiple commercial fisheries – Data compiled from ALPAC meetings, interviews with local commercial fisherman, existing documentation research and the NYSDEC were used to delineate these areas.

- Areas of existing and historic shellfish aquaculture activities – The oyster grants were identified based on Suffolk County Tax Map data and title search results and NYSDEC aquaculture permit records (Suffolk County Department of Planning, 2008).
- USACOE fish trap locations – These areas were delineated using data supplied by the USACOE, New York District and local fishermen.
- Current commercial hard clam harvest areas - Data compiled from ALPAC meetings, interviews with local commercial fisherman, existing documentation and the NYSDEC were used to locate these areas.
- Current and historic eelgrass bed locations – These areas were delineated using existing documentation, meetings with individuals conducting research on Submerged Aquatic Vegetation in Peconic Bay and Gardiners Bay, as well as meetings with various user groups.
- Current and historic bay scallop areas - Data compiled from ALPAC meetings, meetings with local commercial fisherman, existing documentation research and the NYSDEC were used to locate these areas.
- Navigation Channels – Nautical charts used as the base figure for the environmentally and socio-economically sensitive areas depicts navigational channels. Information on the navigational channels was also received during the numerous information gathering meetings with various stakeholders.

The mapped environmental and socio-economic sensitive areas were coupled with the research data and information collected from the meetings and interviews to create a Shellfish Cultivation Zone (Figure 3) where leases would be applicable. The Shellfish Cultivation Zone defines the areas suitable for the potential placement of leases that would have a minimal impact on existing resources, as defined below:

- Underwater lands where bay scallops are produced regularly and harvested on a commercial basis.
- Underwater lands where there is an indicated presence of shellfish in sufficient quantity and quality and so located as to support significant hand raking and /or tonging harvesting.

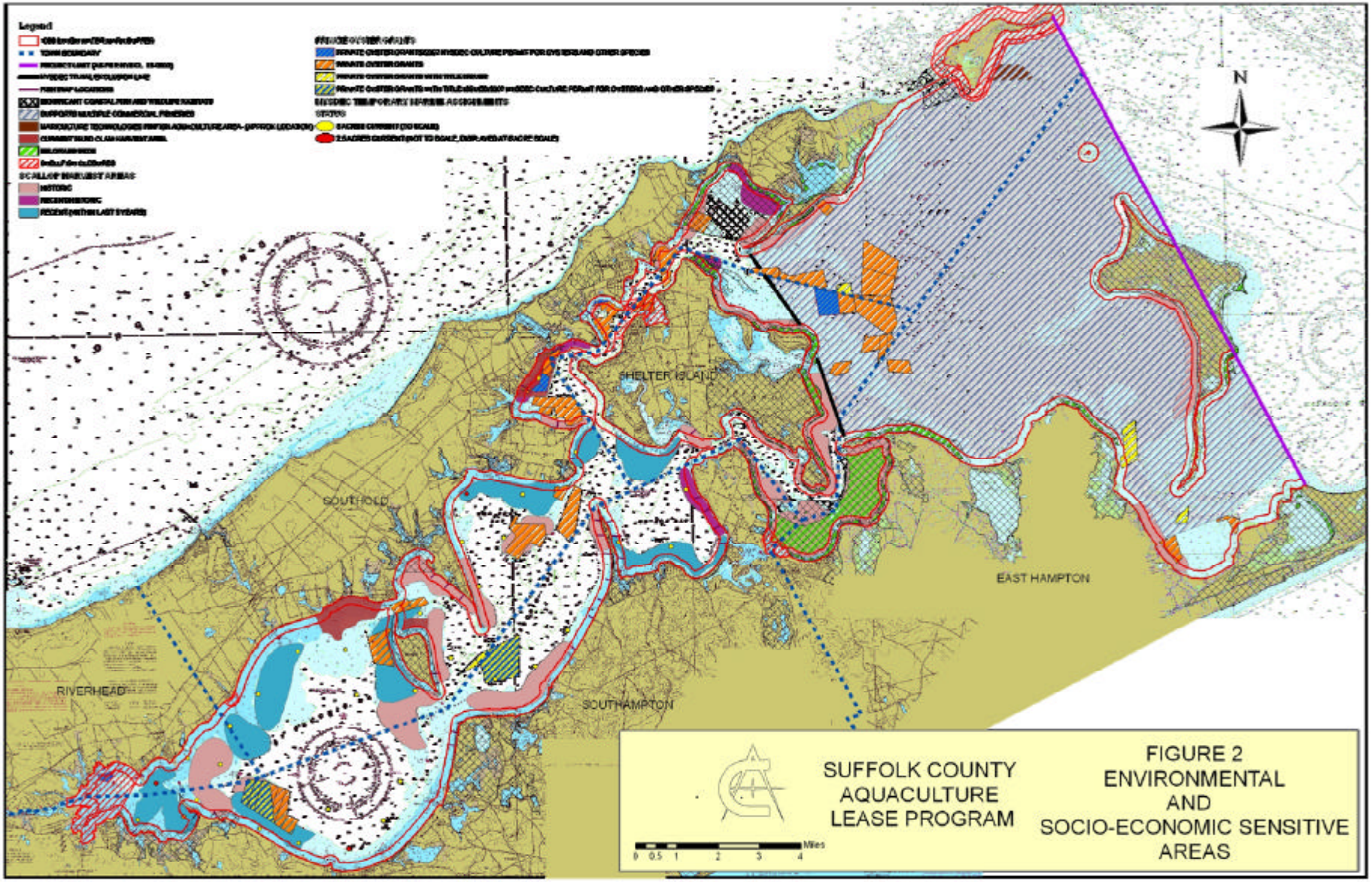
- Underwater lands where the leasing will result in a significant reduction of established commercial finfish or shellfish (crustacean and gastropods) fisheries.
- Underwater lands where the placement of buoys and submerged aquaculture structures would impede on boat traffic in navigational channels.

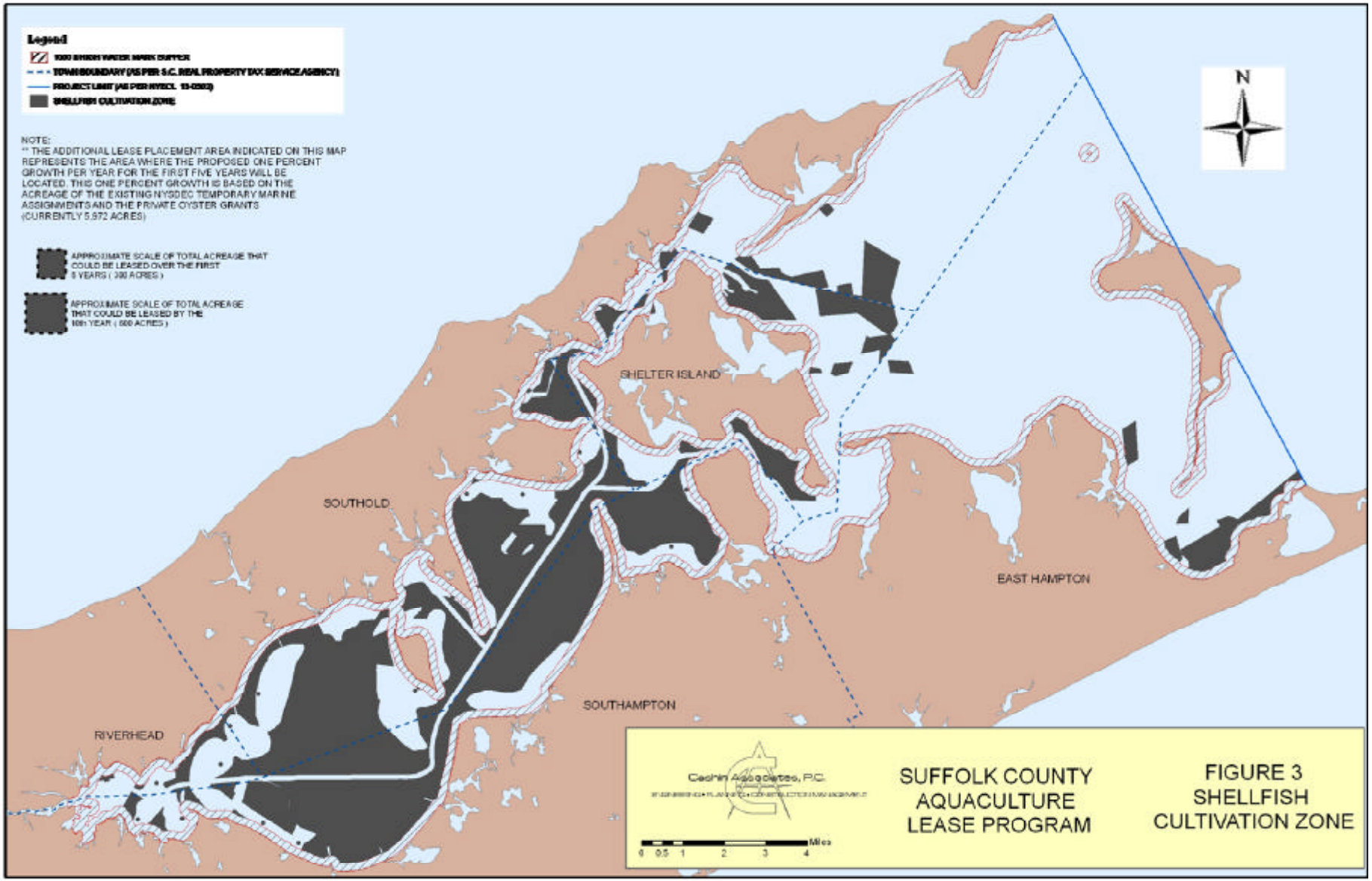
The Shellfish Cultivation Zone includes areas outside the 1,000 foot high water delineation mark and consists of the existing private oyster grants, active NYSDEC Temporary Marine Area Use Assignments, and areas that have not been identified as being environmentally or socio-economically sensitive. The Shellfish Cultivation Zone was used to help define the Proposed Action, which is discussed in greater detail in Section 2.6 of this document.

2.1.2 Types of Shellfish Aquaculture Under the Proposed Action

The implementation of the Lease Program will provide a mechanism for shellfish aquaculturists to continue to cultivate shellfish species that historically and currently play an important role in the maritime tradition in Peconic Bay and Gardiners Bay. It will also allow the opportunity for expansion into the cultivation of other shellfish species. As with past and current shellfish aquaculture practices, all aquaculture operations associated with the proposed Lease Program will require approval through the NYSDEC permitting process.

Although the proposed action that is the subject of this DGEIS is the implementation of a County lease program that will provide access to underwater lands for shellfish aquaculture, the proposed action will allow for the continuation and expansion of shellfish aquaculture in the subject bays, as is the goal of the program. As a generic EIS, it is not the purpose of this document to assess site-specific impacts of all possible shellfish leasing activities. Nevertheless, the DGEIS does identify the specific types of shellfish aquaculture expected to be continued and expanded under the program, as discussed below and in other sections of this document.


Legend
N
SHELTER ISLAND
SOUTHOLD
EAST HAMPTON
RIVERHEAD
SOUTHAMPTON
Miles
0 0.5 1 2 3 4
SUFFOLK COUNTY
AQUACULTURE
LEASE PROGRAM
FIGURE 2
ENVIRONMENTAL
AND
SOCIO-ECONOMIC SENSITIVE
AREAS


Legend
NOTE:
** THE ADDITIONAL LEASE PLACEMENT AREA INDICATED ON THIS MAP REPRESENTS THE AREA WHERE THE PROPOSED ONE PERCENT GROWTH PER YEAR FOR THE FIRST FIVE YEARS WILL BE LOCATED. THIS ONE PERCENT GROWTH IS BASED ON THE ACREAGE OF THE EXISTING NYSDEC TEMPORARY MARINE ASSIGNMENTS AND THE PRIVATE OYSTER GRANTS (CURRENTLY 5,972 ACRES)
N
SHELTER ISLAND
SOUTHOLD
EAST HAMPTON
SOUTHAMPTON
RIVERHEAD
SUFFOLK COUNTY AQUACULTURE LEASE PROGRAM
FIGURE 3 SHELLFISH CULTIVATION ZONE

The implementation of a lease program will allow for the coninuation and expansion of the cultivation of the most common species currently being cultivated in Peconic Bay and Gardiners Bay; the common oyster (*Crassostrea virginica*) and the hard clam (*Mercenaria mercenaria*). There is also potential for the continuation and expansion of aquaculture as it relates to other species such as bay scallops (*Aequipecten irradians*), deep-sea scallops (*Placopecten magellanicus*), blue mussels (*Mytilus edulis*), soft-shelled clams (*Mya arenaria*) and razor clams (*Ensis directus*). It is expected that these are the types of activities that will continue and in some cases be expanded under the proposed Lease Program.

There are two types of shellfish aquaculture activities being considered for the Lease Program: in-bottom and off-bottom culture. In-bottom culture activities consist of cultivated species being placed directly on or in the bottom sediment where they remain until it is time for harvesting. Off-bottom culture involves the grow out of species within some sort of containment structure, either placed on the bay bottom or suspended beneath the water surface. Off-bottom culture usually requires maintenance of the structure, and is more labor intensive than in-bottom culture. The type of culture activity chosen is dependent on the species selected for culture. For example, hard clams cultured in-bottom are more commercially valuable then those grown off-bottom because the development of the shell of the in-bottom culture is more visually pleasing to the consumer. On the other hand, most oyster culture in the estuary is performed through the use of containment structures. Protection from predators is also an important consideration in evaluating the use of off-bottom culture and containers for grow-out of the stock. These activities are discussed in much more detail in Sections 2.8 and 2.9 of this document.

Overall, the adoption of the proposed Lease Program will provide for the continuation and expansion of the shellfish aquaculture operations presently occurring in the study area, and may provide for development of new activities and new technologies as the industry grows.

2.2 Location

The Suffolk County Shellfish Aquaculture Lease Program study area is located in the Peconic Estuary, which comprises the coastal waters between the north and south forks of eastern Long Island, Suffolk County, New York. These coastal waters are within the jurisdiction of Suffolk County's five eastern townships: Riverhead and Southold on the north fork; Southampton and East Hampton on the south fork; and Shelter Island between the forks (as depicted on Figure 1).

As described by Suffolk County Department of Health Services (SCDHS) in their document *Brown Tide Comprehensive Assessment and Management Program Summary* (SCDHS, 1992), the Peconic Estuary comprises a total of approximately 158,000 acres of surface water area (Peconic Estuary Program, accessed from www.peconicestuary.org/AboutPEP.html on February 26, 2008). The project area consists of approximately two thirds of the open water in the estuary, approximately 110,000 acres, which is naturally divided by peninsulas (necks) and islands into a series of interconnected embayments. These include:

- The inner estuary (west of Robins Island) – Flanders Bay (including Reeves Bay) and Great Peconic Bay.
- The middle estuary – Little Peconic Bay (including Cutchogue Harbor and Hog Neck Bay), West Neck Harbor, Noyack Bay, Sag Harbor Bay, Sag Harbor Cove, Northwest Harbor, Southold Bay, Shelter Island Sound, and Orient Harbor (including Long Beach Bay and Hallock Bay); and
- The outer estuary (east of Shelter Island) – Gardiners Bay (including Coecles Inlet and Three Mile Harbor), Napeague Bay (including Accabonac Harbor and Napeague Harbor), and western Block Island Sound (including Lake Montauk).

Numerous additional small bays, harbors, inlets, and creeks extend from the major embayments listed above.

Non-point discharges from groundwater seepage and surface runoff constitute the greatest source of freshwater received by the estuary. The Peconic River is the primary

point source of fresh surface water input to the estuary, discharging into Flanders Bay at the western end of the system. The headwaters of the Peconic River are located in the Town of Brookhaven, near the intersection of William Floyd Parkway (Suffolk County Road 46) and Middle Country Road (State Route 25). The river and its tributary streams are about 15 miles in total length.

More than 60 freshwater creeks flow into the estuary at various points along the shoreline of both the north and south forks and Shelter Island (SCDHS, 1992). These creeks are generally short in length, and have a discharge derived primarily from groundwater underflow.

The Peconic Estuary is characterized as a shallow, vertically well-mixed estuary which has little or no seasonal stratification. Circulation is horizontal and is governed almost entirely by tidal flow, which greatly exceeds freshwater input (SCDHS, 1992). Salinity generally increases from west to east.

Water depths in the Peconic Estuary vary greatly among the major embayments, as described below (Hardy, 1976).

- Flanders Bay – the shallowest major bay, with an average depth of five feet (1.5 meter), and a 15 foot (4.6 meter) maximum depth.
- Great Peconic Bay – average depth of 15 feet (4.6 meters); deepest point at 34 feet (10.4 meters), within the South Race off Robins Island.
- Little Peconic Bay – average depth of 21 feet (6.4 meters); deepest point at 68 feet (21 meters) in the channel between Hog Neck and Jessups Neck, and 61 feet (19 meters) just east of the southerly tip of Little Hog Neck.
- Waters around Shelter Island – average depth of 16 feet (4.9 meters); deepest points at 95 feet (29 meters) in the channel south of Greenport and 78 feet (24 meters) in Shelter Island Sound, west of Great Hog Neck.
- Gardiners Bay and Block Island Sound – depths generally range from 25 feet (8 meters) to 40 feet (12 meters) to the east of Gardiners Island, with a maximum of

190 feet (58 meters) in Plum Gut (between Orient Point and Plum Island); depths to the east of Gardiners Island are highly variable, ranging from shoal areas near the shore to almost 300 feet (90 meters) in The Race (to the west of Fishers Island).

The mean tidal range in the Peconic Estuary generally decreases slightly from west to east, as follows: 2.7 feet in Flanders Bay, 2.5 feet in Great Peconic Bay, 2.4 feet in Little Peconic Bay and around Shelter Island, 2.5 feet in Gardiners Bay, 2.2 feet at Little Gull Island (east of Plum Island), and 2.0 feet at Montauk Point. It takes approximately three hours for the tidal wave to travel from Orient Point to Riverhead (Hardy, 1976).

2.3 Background History

Since the arrival of the earliest settlers to the coastal areas of the United States, shellfish gathering has been a method of providing food to the shoreline inhabitants. As the demand for shellfish grew, many shoreline inhabitants began to gather shellfish commercially and some coastal areas supported a very lucrative shellfish industry. However, over-fishing, loss of habitat and degrading water quality resulted in many of these natural shellfish areas becoming depleted. Some shellfishermen realizing that the wild stock was being depleted began to use shellfish aquaculture as a method of maintaining a sustainable fishery. Today many coastal communities along the eastern, western and gulf coasts of the United States support sustainable aquaculture businesses.

Maritime Tradition of Shellfish Aquaculture on Long Island

There are two shellfish species that have played an important role in the maritime tradition of aquaculture on Long Island: the common oyster (*Crassostrea virginica*) and the hard clam (*Mercenaria mercenaria*). Although both of these species are native to Long Island waters, aquaculture activities involving the oyster and hard clam have been a major contributor to the commercial value of both fisheries.

According to the Long Island Planning Board's document *Assessment of Existing Mariculture Activities in the Long Island Coastal Zone and Potential for Future Growth*

(1979), commercial shellfishing on Long Island began in the 1600s when oysters were harvested primarily for local consumption. The seemingly limitless bounty of oysters in Long Island bays encouraged inhabitants of shorefront communities to specialize in oyster gathering.

Although shellfish gathering and fishing were always a subsistence pursuit for the first settlers of the region, in the early 1800s it developed into a major commercial activity and by the 1880s, Great South Bay was referred to as "the most populous oyster-grounds north of the Chesapeake Bay" and the "Blue Point" oyster gained international fame (Davies, 1980). However, over-harvesting, degrading water quality and loss of habitat resulted in the depletion of many of these naturally occurring oyster beds.

As a result of declining natural stock, and in an attempt to revive the industry, oystermen began experimenting with planting oysters in the Great South Bay as early as the 1840s (Lang, undated). By the late 19th century, much of the Great South Bay bottom was sectioned into parcels and leased to private oyster growers (Economic Analysis, Inc., 1999). Currently, most of the oyster industry's commercial yield in New York is a result of aquaculture activities on Long Island.

As oyster production declined between 1900 and the early 1950s, activities on Long Island shifted to the harvesting of the hard clam (*Mercenaria mercenaria*). This fishery was of national importance as evidenced by Nassau-Suffolk's harvest of hard clams in 1977 which accounted for 55 percent of the total U.S. production of this species (Long Island Regional Planning Board, 1979). Similar to the oyster, the natural stock of hard clams began to decline, and aquaculture activities helped to support this thriving industry.

In the late 1900s aquaculture activities involving hard clams became more prevalent with a technique called "shellfish relaying" (moving shellfish from one area to another) and by 1994 about one-third of New York's hard clam production was from relaying (Barnes, 1991).

Maritime Tradition of Oyster Aquaculture in Peconic Bay and Gardiners Bay

Shellfish aquaculture in the Peconic and Gardiners Bay system dates back to 1884 when the State passed legislation (known as Chapter 385) ceding underwater lands of Gardiners and Peconic Bays to Suffolk County for the cultivation of shellfish. This legislation permitted Suffolk County to issue grants of underwater land for the purpose of oyster culture. The County appointed three Commissioners of Shell Fisheries to oversee the grant program and they were authorized to sell and convey, by warranty deed, four acre parcels of underwater lands to persons who would agree to plant specified quantities of oysters within one year.

Although originally conceived in 1884 and in reaction to the growing demands and issues of the oyster industry, significant amendments (1896, 1906 and 1923) were made to this legislation. The amendments included: increasing the acreage from four to 25 acres (1896), specifying ten bushels of oysters per acre as a minimum to be planted by each grantee within one year (1896); and extending the one year cultivation stipulation to three years (1906). Also, in lieu of automatic reversion, the amendment of 1906, required an order of the Supreme Court, based on a finding of bad faith on the part of the grantee, to effect the reversion. The 1923 amendment altered the description of the land ceded to the County to include "lands underwater of Gardiner's Bay and the Peconic Bays and the tributaries there of" (L1923, ch 191). Grants of land in such tributaries made prior to the date of the act were confirmed (Suffolk County Department of Planning, 2002).

From the latter part of the 1800s though the early 1900s, the oyster industry flourished in Peconic Bay and Gardiners Bay and during the peak years between 1948 and 1955 annual harvests were recorded to be over 100,000 bushels (Kassner, 1995). In reaction to this flourishing industry, between 1885 and 1914 approximately 40 percent (45,081 acres) of the Peconic Bay and Gardiners Bay were granted to private entities (Suffolk County Department of Planning, 2002). However, as oyster production decreased in the mid 1900s many of the grants were abandoned and the majority of those lands have since reverted to the State. Presently, only 5,822.08 acres of underwater lands are controlled

by private interests including 1,165.5 acres that still have title issues (Suffolk County Department of Planning, 2008).

Although oysters could be found in the wild in the Peconic Bay and Gardiners Bay, they did not support a sustainable commercial fishery. The robust oyster industry that once existed in the bays was the result of aquaculture activities on underwater land grants. The majority of these aquaculture activities in the bays involved the transplanting and bedding of oysters from other areas (such as Connecticut and Great South Bay). From as early as 1890, seed oysters from Connecticut were planted in Gardiners and Peconic Bays (Anderson and Spatz, 1997).

Currently, the majority of the oysters being harvested from the Peconic Bay and Gardiners Bay are from aquaculture activities. These aquaculture activities are being conducted on private underwater land grants and on Temporary Marine Area Use Assignments for off-bottom shellfish culture issued by the New York State Department of Environmental Conservation.

Maritime Tradition of Hard Clam Aquaculture in Peconic Bay and Gardiners Bay

Similar to oysters, the robust hard clam fishery in the Peconic Bay and Gardiners Bay has been significantly influenced by aquaculture. By the late 1980s, because of the dramatic decline in wild hard clam stocks in certified waters throughout New York State, there was increased participation in the Peconic Bay and Gardiners Bay shellfish transplant program (Timmons et al., 2004). The shellfish transplant program entails an aquaculture activity known as relaying, which is the transplanting of shellfish from uncertified waters into clean waters for depuration. After a standardized time period the shellfish are harvested and sold. In 1989, initial wholesale value of hard clams in New York State was estimated to be $10-$16 million (Barnes et al., 1991) and in 2001 the shellfish transplant program accounted for approximately 45 percent of the annual hard clam production in New York State, which was valued at almost $6 million (Timmons et al., 2004). In 2003, the NYSDEC cancelled the program due to a discovery of the hard clam parasitic disease QPX (Quahog Parasite Unknown) in the harvest area of Raritan Bay (Timmons et al.,

2004). The program was reinitiated in 2005 when about 25% of the Raritan Bay harvest area was reopened (Debra Barnes, NYSDEC Bureau of Marine Fisheries, personal communication, November 2007).

Status and Trends of Shellfish Cultivation

According to the Suffolk County Department of Planning's document *Policy Guidance for Suffolk County on Shellfish Cultivation in the Peconic and Gardiners Bays* (2002), there are probably 200 to 300 individuals who directly derive an income from aquaculture products grown in the Peconic Bay and Gardiners Bay.

- Nearly 90% of the annual hard clam production and over 90% of the oyster production in the Peconics come from aquaculture activities
- Each year in 1999 and 2000, about half a million oysters were grown to market size and about 70,000 bushels of hard clams were relayed to the Peconics. The 70,000 bushels of hard clams represents about 80% of the hard clams relayed within the State, and about 37% of the statewide hard clam landings.
- The transplanting of hard clams into Gardiners and Peconic Bays accounted for more that 95% of the total hard clam production in this area.

2.4 Prior Studies

2.4.1 Peconic Estuary Program

In September 1992, the Peconic Estuary was accepted into the National Estuary Program (NEP) and in 1993, the Peconic Estuary Program (PEP) officially commenced with a kick-off conference. One of the tasks set forth by the program was to develop a Comprehensive Conservation and Management Plan (CCMP). The CCMP required a tremendous amount of research and effort by resource agency staff and local citizens serving on the various task force committees known collectively as the PEP Management Conference. The following is a list of the main objectives of the CCMP:

- To protect and improve the Peconic Estuary system's water quality to ensure a healthy and diverse marine community;
- To preserve and enhance the integrity of the ecosystems and natural resources present in the study area so that:

  - Optimal fish and wildlife habitat and diversity of species can be ensured; and
  - Conservation and wise management of consumable, renewable resources of the estuary are promoted and enhanced;
- To optimize opportunities for water dependent recreation;
- To promote to the maximum practicable extent, the social and economic benefits that have been associated with Peconic Estuary system;
- To minimize health risks from human consumption of shellfish and finfish; and
- To promote, to the maximum extent possible, public awareness and involvement in estuarine management issues.

The PEP developed several recommendations to achieve the objectives set forth in the CCMP, including Recommended Action Plan HLR 10 which discusses the development of an aquaculture plan for the Peconic Estuary. This action calls for the development and implementation of an estuary-wide aquaculture plan. According to the CCMP, the plan should include criteria regarding scale, location, assessment, monitoring, and methodologies of shellfish and finfish aquaculture which would be ecologically beneficial and would help sustain aquaculture as a beneficial estuarine use when performed in a manner that is sensitive to the natural conditions, productivity and ecology of the Peconic Estuary (PEP, 2001).

The PEP identified several priority management topics including such concerns as brown tide, nutrients, habitats and living resources, pathogens, toxics, critical lands issues, public education and outreach, financing, and overall implementation. As a result of these concerns the program has conducted numerous studies to evaluate their impacts on the estuary. Several of these studies were reviewed in the preparation of this DGEIS to evaluate the impacts associated with the development of the Suffolk County Shellfish Aquaculture Lease Program. Pertinent findings have been incorporated into the appropriate sections of this DGEIS.

2.4.2 Peconic Bays Aquaculture Advisory Committee (PBAAC) Final Report

In July of 2001, The Nature Conservancy of Long Island formed The Peconic Bays Aquaculture Advisory Committee (PBAAC) to examine the extent to which the waters and underwater lands of the Peconic and Gardiners Bays can and should be made available for private, commercial shellfish culture.

The committee identified a number of issues that are critical to determining whether and to what extent commercial aquaculture should be undertaken in the Peconic Estuary. Most of the issues identified by the committee are similar to the issues being addressed in this DGEIS and are as follows:

- Species of animals and genotypes
- Methods of cultivation
- Scale of operations
- Locations for aquaculture
- Amount/type of artificial structures allowed
- Monitoring/enforcement/compliance requirements
- Baseline mapping
- Management mechanisms best suited to controlling leases

The committee developed an *Aquaculture Management System* that they believe offers a structured approach to directing the future of commercial aquaculture in the Peconic and Gardiners Bays. Their approach responds to the potential of aquaculture to contribute to the economic and social well-being of East End residents and communities, as well as to impose minimal impact on other users of the bays. The following are the PBAAC's recommendations taken from the *Final Report of the Peconic Bays Aquaculture Advisory Committee* (2002), which at that time, were evaluated in relation to the Laws of New York 1969, Chapter 990. (It should be noted that this law was repealed by Laws of New York 2004, Chapter 425.)

Not Recommended for Leasing	Consider for Leasing
-Oyster grant lands that have been ratified and confirmed, subject to payment of taxes to Suffolk County	-"Decommissioned" oyster grant lands
-Areas documented to be naturally productive of shellfish	-Unused, nearshore areas (limited "off-bottom" culture, only)
-Areas containing submerged, rooted aquatic vegetation	-Areas not demonstrating natural shellfish productivity in past ten years
-Areas occupied and permitted by the NYSDEC and/or Army Corps of Engineers for pound and trap nets	-Areas of light to moderate recreational fishing activity or compatible commercial fishing activity
-Officially designated navigation channels	-Natural resource management areas/critical environmental areas
-Areas where bay scallops are now harvested commercially or have been harvested commercially sometime in the past twenty years, including Northwest Harbor and Orient Harbor	
-Areas of active commercial or heavy recreational fishing activity that are not compatible with shellfish aquaculture operations	
-Endangered species/marine mammal habitats	
-Underwater cable and/or utility easements	

Note: This information is taken from Table 1 in the Final Report of the Peconic Bays Aquaculture Advisory Committee (2002).

This DGEIS examined each of the issues and recommendations brought forth in the committee's final report relative to how they will relate to the County's Lease Program. When applicable under the requirements set forth in the 2004 Leasing Law, the recommendations by the PBAAC were considered for incorporation into the Lease Program.

2.4.3 Suffolk County Planning Department

Policy Guidance for Suffolk County on Shellfish Cultivation in Peconic and Gardiners Bays (2002)

On June 12, 2001, the Suffolk County Executive signed into the law Resolution No. 487-2001, which called for the creation of the Suffolk County Aquaculture

Committee. The focus of the Committee was on the potential role that Suffolk County could play in managing future shellfish cultivation activities in Peconic and Gardiners Bays under Laws of New York 1969, Chapter 990.

During the period from August 10, 2001 to May 23, 2002, the committee held nine meetings and hosted two public hearings. As a result of these meetings and hearings the committee formulated the following determinations pertaining to private shellfish culture in Peconic and Gardiners Bays (Suffolk County Department of Planning, 2002):

- "Private shellfish aquaculture in Peconic and Gardiners Bays offers advantages to the people and economy of the County, if conducted in a manner and scale that does not cause undue conflict with other users of marine resources and space, or harm to the marine environment";
- "Private shellfish aquaculture is a legitimate water-dependent activity that requires the provision of secure and equitable access to publicly owned marine space for private use"; and
- "Equitable access for the prospective aquaculturist is achievable through a program that is buttressed by judicious site selection; that allows culture activity to be conducted at appropriate scale; that regulates the use of technology so as to protect marine resources and the environment; and that is rigorously monitored and enforced."

Before the County could lease or use the underwater lands ceded to it by the State, certain requirements needed to be met. This policy guidance document stated that one of these requirements is the County must accurately survey the land and prepare maps for the survey, which is discussed in more detail in the *Survey Plan for Shellfish Cultivation Leasing in Peconic and Gardiners Bays* (Suffolk County Department of Planning, 2003) section below. In addition, local laws must then be enacted, which contain regulations governing the lease program to include:

- Lease application, required notices, and fees for filling application, map and documents;

- the form, terms, transfer & renewal of leases;
- re-survey, and mapping where significant changes in the location of the shoreline occur, or where there are changes in range markers of navigation aids;
- the placing and maintenance of marker buoys; and
- the use of lands not leased.

The guidance document states that once the County has completed the surveys and adopted the regulations, underwater lands may then be leased for the purpose of shellfish cultivation only to Suffolk residents (one year residency required) in plots containing 50 acres or more for a term of 10 years. In addition, seventy-five percent of the lease fees received by the County must be returned to the Towns of Riverhead, Southold, Shelter Island, Southampton and East Hampton in an amount proportional to the leased acreage located within each town.

The guidance document also assessed the tax status of the underwater lands and the Suffolk County Department of Planning Division of Real Estate prepared a tax search on all underwater land parcels in the bays for the 2000/2001 tax year. The search revealed that approximately 8,953 acres of underwater lands were held by private interests, many of which were defaulted of taxes. On April 10, 2002, Suffolk County took ownership of 61 parcels totaling about 5,190 acres for non-payment of taxes, reducing private current ownership by 58 percent (3,763 acres).

According to the committee's findings the majority of the hard clam and oyster production in the Peconic and Gardiners Bays came from approximately 2,900 acres on which aquaculture activities are conducted. This represents only 2.4 percent of the underwater land in the bays. Those aquaculture activities are compatible with the traditions of the East End, allowing for cultivation of a renewable resource, and providing baymen with opportunities for sustainable incomes as the harvests of wild shellfish decline.

The findings of the committee indicate that not only is shellfish aquaculture currently established in the bays, but that it is also compatible with other users of these public underwater lands. The County's Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay and this DGEIS refer to this document for guidance on how the Lease Program should be executed.

Survey Plan for Shellfish Cultivation Leasing in Peconic and Gardiners Bays (2003)

On December 20, 2002, the County Executive signed Resolution No. 1229-2002 directing the County to prepare a plan to conduct the survey specified in Laws of New York 1969, Chapter 990. Elements of the survey plan included feasibility; methodology; projected survey costs; and potential sources of funding (Suffolk County Department of Planning, 2003).

The plan evaluated several survey components and came up with recommendations as to how each component should be addressed. The plan also expressed the need to portray all the different components (spatial/survey) on a Geographic Information System (GIS) base map. Below is a summary of the survey components and the plan's recommendations:

- Town Boundary Lines – Use town boundary descriptions from the Suffolk County Real Property Tax Service Agency.
- Ordinary High Water Mark and Boundary Line 1,000 feet Seaward of Same – The plan recommended that the National Ocean Survey (NOS) Nautical Charts 12358 (Edition 19, printed September 2002) and 13209 (Edition 23, printed October 1999) be used for this required item.
- Location of Existing Grants, Easements, Franchises and Cable Lines – The plan recommends contacting all entities needed to ascertain the locations of land grants, cable lines and established navigation channels and ferry routes.
- Federally-designated Fish Trap Areas – These areas should be ascertained by contacting the NYSDEC, United States Coast Guard and United States Army Corps of Engineers for the location/boundary of designated fish trap areas.

- Private Oyster Cultivation Grants – This survey component should be limited to cover only those oyster grant parcels that are privately owned.
- Areas Where Bay Scallops are Produced Regularly and Harvested on a Commercial Basis – These areas should be determined by using the report – *An Inventory of Submerged Aquatic Vegetation and Hardened Shorelines of the Peconic Estuary, New York* (Tiner et al. 2003) and input from commercial scallop fisherman.
- Structures on the Land and Federal Aids to Navigation which are Useful for Taking Ranges and Determining Location on Bay Surface Waters – When Global Positioning Systems (GPS) are used, land reference points and navigational buoys are not necessary; therefore, this requirement is no longer valid.
- Proposed Plots for Leasing and Points for the Location Buoys from which the Boundaries of said Plots can be Readily Determined – The survey suggests that a lease program should issue two types of leases. Off-bottom culture leases should not exceed 10 acres, and on-bottom culture leases should not exceed 50 acres in size. GPS coordinates for each of the corners of a square-shaped lease would suffice for location of lease plots.

When applicable, the recommendations set forth in this document were reviewed and where applicable incorporated into the Shellfish Cultivation Zone Map to assess proposed shellfish aquaculture lease sites.

2.5 Existing Plans and Area Designations

- Significant Coastal Fish and Wildlife Habitats (SCFWH)

  According to the NYSDOS Division of Coastal Resources website (accessed from http://nyswaterfronts.com/consistency_habitats.asp) the New York State Department of Environmental Conservation (NYSDEC) evaluates the significance of coastal fish and wildlife habitat areas, and following a recommendation from the NYSDEC, the Department of State designates and maps specific areas. Projects located in these designated areas must be evaluated

for impacts to the SCFWH. If a determination is made that a proposed action is subject to a consistency review, an applicant may be required to address the impacts on the habitats.

There are thirty-seven SCFWHs located in the Peconic and Gardiners Bay system; however, only a small portion of those are found within the Shellfish Cultivation Zone. The existing privately owned underwater land grants that are located in any SCFWH will not be excluded from the Lease Program. Currently, there are approximately 500 acres of privately owned underwater land grants located in SCFWHs, which represents less that 0.46 percent of underwater land of the Peconics and Gardiners Bays. Therefore, any aquaculture leases that will be issued on grants located in any designated significant habitats will most likely have little or no adverse effect on the existing SCFWHs.

- Essential Fish Habitats

  In 1996, the Magnuson-Stevens Fishery Conservation and Management Act was amended, strengthening the ability of National Marine Fisheries Service (NMFS) and their appointed Councils to protect and conserve the habitat of marine, estuarine, and andromous finfish, mollusks, and crustaceans. This habitat known as "essential fish habitat (EFH)" is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Act requires NMFS and their Councils to: describe and identify the essential habitat for the managed species; minimize to the extent practicable adverse effects on EFH caused by fishing; and identify other actions to encourage the conservation and enhancement of EFH.

  The measures to protect the EFH established by the Act require NMFS and its Councils to coordinate with other federal and state agencies; and also require those agencies to consult with NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect the EFH. In addition, NMFS must provide recommendations to federal and state

agencies which may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH resulting from actions or proposed actions authorized, funded, or undertaken by an agency.

New York State is part of the NMFS's Mid-Atlantic region. Under the auspices of NMFS and the Mid-Atlantic Fishery Management Council, essential fish habitats have been identified for a total of 59 species covered by 14 fishery management plans (FMPs). Many of these species are found within the Shellfish Cultivation Zone and Section 4.1 of this DGEIS will evaluate the impacts of this program on these species.

- Peconic Estuary Program Comprehensive Conservation and Management Plan

  According to the Peconic Estuary Program website, in 1993, the Peconic Estuary became the 20th estuary in the nation to receive the designation as an "Estuary of National Significance" by the U.S. Environmental Protection Agency (EPA). After acceptance into the National Estuary Program (NEP), the Peconic Estuary Program (PEP) was formed by partnering local, state, and federal governments; citizen and environmental groups; businesses and industries; and academic institutions and charged with developing and implementing a watershed-based comprehensive management plan. As a result of this partnership, the PEP Comprehensive Conservation and Management Plan (CCMP) was formally approved on November 15, 2001 by EPA with the concurrence of New York State. There are 340 management tasks included in the CCMP; priority topics include Brown Tide, nutrients, habitat and living resources, pathogens, toxic pollutants, and critical lands protection. Section 4 of this DGEIS discusses environmental settings, impacts and mitigations associated with the Lease Program including several of the priority topics set forth in the PEP's management tasks.

  One of the goals set forth in the CCMP is to ensure that the existing and future aquaculture (shellfish and finfish) and transplanting activities are situated in

ecologically low-productive areas of the estuary and that they are mutually beneficial to the aquaculture industry, natural resources, and water quality. According to PEP, these goals can be measured by the extent and location of aquaculture/transplant facilities, water quality measures and natural resource data, and are explained in more detail in the CCMP's Actions HLR-1, 3, 4, 6, 10, 15 and 17.

- Local Waterfront Revitalization Plans (LWRP)

  In 1981, the New York State Legislature enacted the Waterfront Revitalization and Coastal Resources Act (Article 42 of the Executive Law) to implement the State Coastal Management Program (CMP). The CMP and Article 42 establishes a balanced approach for managing development and providing for the protection of resources within the State's designated coastal area by encouraging local municipalities to prepare Local Waterfront Revitalization Programs. Local municipalities with State approved LWRPs have certain authorities 1500 feet seaward of their landward boundaries. Section 3.1.3 in this DGEIS discusses these authorities as they relate to the shellfish aquaculture lease program.

2.6 Components of Proposed Lease Program

The proposed Lease Program involves the conversion of NYSDEC Temporary Marine Assignments to leases, allows private oyster grant holders to participate in the Lease Program, and also provides for future growth of the industry by permitting additional use of underwater lands for shellfish aquaculture within defined limits. This alternative would make available approximately an additional 300 acres of bottom land for new entities at the end of the first five year period, and another approximately 300 acres at the end of 10 years. The program components outlined below make reference to the *Suffolk County Aquaculture Lease Program Shellfish Cultivation Zone* (Figure 3). The Shellfish Cultivation Zone indicates areas suitable for lease placement based on environmental, socio-economic and historical considerations. The zone includes areas where environmental impacts and conflicts with existing users of the estuary are minimized, and areas with a prior history of aquaculture activities.

General Components

1. **Suffolk County as Program Lead Agency --**Suffolk County will be the lead agency for the Suffolk County Shellfish Aquaculture Lease Program for underwater lands ceded from New York State by the 2004 Leasing Law. Participation in the County Lease Program does not obviate the need to obtain any permits required for aquaculture activities by regulatory agencies.
2. **Ten Year Lease Terms --** The term of the initial lease will be 10 years, with 10 year renewable options.
3. **Sizes of Leases --** Leases on underwater lands not currently used for aquaculture will be 5 or 10 acres (these limits do not apply to active private oyster grants or temporary assignments).
4. **Shape of Lease Areas --** Leases on underwater lands not currently used for shellfish aquaculture will be square in shape (this criterion does not apply to active private oyster grants or assignments).
5. **Five Year Program Reviews --**The program will be subject to review during the second 5 year period after program implementation begins, to establish program components after 10 years. During the 5 year review process, the Shellfish Cultivation Zone map will be reviewed and updated as needed. The review will be based on environmental assessment, results of the program to date, need/demand for additional lease space, Town, public and industry input, and other factors. Data on environmental conditions in the bay, including that from the ongoing County water quality monitoring program, will be utilized in the assessment.
6. **Environmental Review for Significant Program Changes --** If significant changes to the program are desired after 10 years, an environmental review will be performed to assess potential impacts of the proposed changes. Significant changes would include an expansion of total lease area, number of leases, or location of leases. Any significant program changes and environmental review will comply with State Environmental Quality Review Act (SEQRA) requirements.

7. **Relocation of Leases --** In the event that the program review requires a change in the Shellfish Cultivation Zone where new leases are permissible, the lease holder may be required to relocate his lease area. The relocation would be required by the end of the lease period or within 5 years, whichever is more. The lease holder would be given the option to move to an allowable area in the Shellfish Cultivation Zone as close to the original lease location as practical. The County will establish criteria for changing the boundary of the Shellfish Cultivation Zone, and deciding whether a lease is to be relocated.
8. **Annual Reporting of Activities --** All lease holders must provide annual reports as to the type of shellfish aquaculture undertaken on the subject lease. The reports must include documentation as to the types and quantities of shellfish being cultivated and harvested on the subject lease and include the time periods of cultivation and harvesting, and other information deemed appropriate by the County.
9. **Permits from Other Regulatory Agencies --** The County Lease Program will provide access to underwater lands only. Type of cultivation in terms of species and method of harvest will not be specified under the lease, but will be subject to NYSDEC permit requirements. Lease applicants must obtain all necessary permits from NYSDEC and other regulatory agencies.
10. **Marking and Surveying of Lease --** Boundaries of all leases must be properly marked according to County specifications. Lease sites must be surveyed by a licensed land surveyor prior to execution of the lease.
11. **Annual Lease Rent --** Lease applicants must pay an annual lease rent, which will be determined by the County, based on the number of acres leased.
12. **Aquaculture Equipment Removal --** Lessees will be responsible for removal of all shellfish aquaculture equipment from the lease area, upon termination of the lease. All equipment must be labeled with grower's name and permit number.
13. **Town and Public Review of Lease Applications --** Prior to issuance of a lease, the lease application will be submitted to the Towns of Southold, Riverhead, Shelter Island, Southampton, and East Hampton, as well as the NYSDEC and incorporated villages bordering the estuary, for review. Input and comment

provided by the Towns, villages, and the NYSDEC, within a specified time period will be taken into consideration by the County during the lease application review and approval process. Public notification of lease applications will also be required.

14. **Documentation of Natural Non-Productivity of Proposed Lease** -- If, during the application public comment period, a comment is received and documentation can be provided as proof to the presence of significant natural shellfish productivity on the proposed lease site, the applicant will not be permitted to lease that site. The County will identify what will be considered adequate documentation of the status of natural shellfish stock; such documentation may include, but not be limited to, a field benthic survey of the underwater land.
15. **Minimum Levels of Performance for Lease Holders** -- Lease holders must meet minimum levels of performance to confirm that the lease is actually in use for aquaculture. The County will define these levels and specify what documentation will be required. The County will also establish a time period within which aquaculture activities must be initiated after execution of a lease. Failure to meet minimum performance levels and timeframe can result in termination of the lease. Provision will be made for hardship allowance, based on information to be provided to and considered by the County.
16. **Termination of a Lease –** The County may terminate a lease if certain conditions of the lease are not met. The criteria for terminating a lease will include, but is not limited to, non-payment of lease fees, violation of the NYS Environmental Conservation Law as it pertains for marine-related activities, significant adverse impacts to marine resources, or if lease performance standards are not met.
17. **Limit of Lease Ownership and Sub-Leasing** -- Ownership of leases will be limited to a maximum of two leases per individual and/or corporate entity. Sub-leasing of lease areas will be permitted. The lease holder must provide assurance that the sub-lease meets all stipulations required by the County in the primary lease. Ownership of sub-leases will also be limited to a maximum of two sub-leases per individual and/or corporate entity.

18. **Transfer of Leases --** Leases may be transferable to another individual/entity for the remainder portion of the lease term, in accordance with terms established by the County.
19. **Seed Stock Requirements –** All participants in the Lease Program will be required to comply with all components of the NYSDEC's Part 48: Marine Hatcheries, On-Bottom and Off-Bottom Culture of Marine Plant and Animal Life, including the policy being adopted by NYSDEC (anticipated to be adopted in 2008) on Acceptable Origin of Shell and Shellstock for Introduction in New York.

Specific Requirements– Existing Temporary Marine Assignments

20. **Conversion of Temporary Assignments --** Existing temporary assignments in the Shellfish Cultivation Zone must be converted into County leases once the County Lease Program is implemented, in accordance with the provisions given below. Temporary assignments that are being converted into a lease without any change in their operations or size will be retained as a circular shaped 5-acre lease. Temporary assignments that wish to expand can convert to a 10-acre square lease, as long as the expansion occurs in the Shellfish Cultivation Zone.
21. **Phasing of Converted Temporary Assignments into Lease Program --** Temporary assignments that wish to be incorporated into the County Lease Program will have up to one year to comply with the lease requirements. This phasing will allow for the time required to comply with new lease requirements (e.g. completing lease requirements if converting to a 10-acre lease).
22. **Productivity Documentation for Conversion of Existing Temporary Assignments --** The need for a benthic survey will not apply to existing temporary assignments holders who chose not to significantly change or expand their operations under the County Lease Program, but would apply to those expanding onto previously unused underwater land if there is comment indicating significant natural shellfish stocks during the public comment period (as discussed in item 14 above).

23. **Temporary Assignments within 1,000 ft of Shoreline --** Temporary assignments that are located within 1,000 feet of the shoreline will be given the opportunity to obtain a lease beyond the 1,000 foot line at a location in the Shellfish Cultivation Zone as close to their original position as practical. The lease site will be 5 or 10 acres. Temporary assignments lying within 1,000 feet of shore that do not choose to locate within the Shellfish Cultivation Zone will not be subject to the County Lease Program and may be subject to termination by NYSDEC.
24. **Temporary Assignments Partially within 1,000 ft of Shoreline --** Temporary assignments that are partially located within 1,000 feet from shore will be permitted to adjust their areas so that they lie beyond 1,000 feet.
25. **Pending Applications for Temporary Assignments --** Applicants with pending applications to obtain a temporary assignment from the NYSDEC will be given the opportunity to obtain a lease in accordance with the provisions established above. The applications must have been made by December 31, 2007.

Site Specific Requirements – Private Oyster Grants

26. **Continuation of Grant Activities --** Grant owners can cultivate oysters on their grants without a lease from the County. Grants and portions thereof that are located more than 1,000 feet from shore can be considered for inclusion in the County Lease Program (grants that are located within 1,000 feet from shore are not within the jurisdiction of the County Lease Program), should there be the desire to cultivate species other than oysters. Shellfish cultivation activities on these grants are regulated by the NYSDEC.
27. **Lease Establishment on Grants –** Grants actively cultivating shellfish must obtain a lease from the County if they wish to cultivate species other than oysters on their grant. Leases on active grants do not have specified acreage limits. Owners of grants can apply under the County Lease Program to overlay a lease on the entire grant area, or a portion thereof.

28. **Phased Expansion of Leases on Fallow Grants**

    A grant can enter the Lease Program if the owner can document a prior historical or current use of the grant for shellfish aquaculture. If a grant has not been used for shellfish aquaculture within a time frame established by the County (i.e. has been fallow for an extended time), it can enter the Lease Program in a limited phased process. Conditions pertaining to establishment of leases on underwater lands not formerly used for shellfish aquaculture, as outlined above, would apply to placement of leases on fallow grants. However, the restriction on ownership to two leases would not apply to a grant owner seeking additional leases on their grant. Each lease application on a fallow grant would need to go through a County review process that would include public notification. This will provide for a phased approach for the establishment and expansion of leases on these fallow grants. The County will establish criteria on what constitutes adequate documentation of former aquaculture use.

<u>Proposed 1% Increase</u>

29. **One-Percent per Year Increase in Acreage for Aquaculture --** The Lease Program will provide for a one percent increase in the amount of underwater land available for aquaculture each year for the first five year planning period. The one percent increase will be based on the existing total acreage of temporary assignments as of December 31, 2007, plus the total acreage of existing private oyster grants within the study area (Peconic and Gardiners Bay, extending east to the regulatory limit). The allowable one percent per year will not include leases placed on the existing oyster grants, and will not include the expansion of existing temporary assignments converted to leases as discussed herein.
30. **Carry-over of Yearly Allocation --** If the one percent increase is not used for a particular year, the unused amount will be carried over to future years within the five year period. The cap on total lease area over the five year period will not exceed 5 percent.

31. **Carry-over of 5 Year Allocation --** If the 5 percent cap is not used up during the first five year period, the remainder can be carried over to the second five year period.
32. **Cap on New Leases After 10 Years –** It is anticipated that the second five year period will have the same limitations and conditions as those set for the first five year period. The program will include a cap on new leases after 10 years at which time an additional environmental review may be required to determine impacts of increased growth beyond this time.

Non-commercial Shellfish Cultivation Leases

33. **Experimental/Educational Leases --** The program will have a provision for issuing experimental/educational leases. These leases would be limited in scope and duration, but must be located in the Shellfish Cultivation Zone, as mapped. These leases would not be subject to all of the restrictions outlined above, and would be reviewed by the County on a case-by-case basis. The acreage of these leases would not be included in the one percent increase (item 29).
34. **Leases for Shellfish Resource Restoration --** Leases can be issued for shellfish resource restoration. These leases must be located in the Shellfish Cultivation Zone, as depicted in Figue 3, and are also otherwise subject to the requirements outlined above. Sub leasing of these leases would not be permissible. The acreage of these leases would not be included in the one percent increase (Item 29).

Options for Future Consideration

35. **Potential for Issuing Leases Larger than 10 Acres –** The County Lease Program will consider issuing leases larger than 10 acres but not exceeding 50 acres, after the completion of the first five year planning period, based on review of environmental and economic conditions.

As part of the development of the Shellfish Aquaculture Lease Program, the County will prepare a Leasing Program Document that defines in detail the administrative procedures,

regulations and criteria for all aspects of the leasing process. The various critera, standards and reqirements referenced in the above Program Components (Section 2.6) will be defined in that document. Administrative needs required by the County to implement the program will also be identified. The level of detail to be included in the Lease Document will be necessary for implementation of the program, but is not necessary for the assessment prepared for this Generic EIS.

2.7 Project Review and Approvals

Aquaculture in general and shellfish aquaculture in particular, are governed by a myriad of laws and regulations administered by many agencies at the federal, state and local levels. This collection of public policy statements, administrative guidance statements, statutory requirements, and regulatory requirements may present barriers to entities wishing to engage in shellfish aquaculture. One of the goals for the Suffolk County Aquaculture Lease Program is to design its administration in a manner which will facilitate a coordinated system for notifying lease applicants of the necessary regulatory requirements which must be satisfied in order to obtain a County shellfish aquaculture lease. Another important goal is to ensure that a lease holder is operating according to the terms of the lease conditions, and the applicable regulatory requirements.

This discussion identifies the controlling programs associated with regulatory agency reviews and permitting of shellfish culturing and harvesting activities at the federal, state and local levels. Wherever necessary for this discussion, agency representatives were interviewed to better define how each regulatory entity administers its individual program.

2.7.1 Federal Requirements

- **US Army Corps of Engineers**

  Shellfish aquaculture activities affecting or obstructing navigable waters of the US, including but not necessarily limited to activities resulting in the discharging of dredge or fill materials into navigable waters, are subject to the review and

approval by the US Army Corps of Engineers (USACOE). This review and approval process is administered through a permit system. Federal regulations define the permit system requirements. The USACOE's authority for permitting is derived from the following federal acts.

- **Section 10 Rivers and Harbors Act**

  Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) requires the review and approval by the USACOE of any structure and work in or affecting navigable waters. Under its "public interest review" of requests for aquaculture facilities, the Corps considers the benefits and detrimental effects to the public interest, including aspects of navigation, the environment, economics, aesthetics, property rights, and international interests.

- **Section 404 Clean Water Act**

  Section 404 of the Clean Water Act (33 U.S.C. 1344) authorizes the USACOE to regulate and issue permits for the discharge of dredge or fill materials into US waters. Any activity requiring this permit requires a certification from the responsible state agency that the proposed activity would not result in a violation of that state's water quality standards.

- **Section 401 Clean Water Act**

  Section 401 of the CWA (33 U.S.C. § 1341) provides that all projects requiring federal permits, including USACOE permits for discharging of dredged or fill materials into the navigable waters, require a Water Quality Certification from the state. New York State's Water Quality Certification program is further discussed below.

- **Section 103 Marine Protection, Research and Sanctuaries Act of 1972**
  The Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA §103) authorizes the USACOE to regulate and issue permits for the transportation of dredge materials for the purpose of dumping into ocean waters, where the Secretary determines that the dumping activities will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecosystem, or economic resources.

- **USACOE Nationwide Permit NWP 48**

The USACOE's Nationwide Permit NWP 48, entitled: "Existing Commercial Shellfish Aquaculture Activities and General Conditions"; (Federal Register: Vol. 72, No. 47, March 12, 2007, effective March 19, 2007) authorizes existing shellfish aquaculture activities including: the installation of buoys, floats, racks, trays, nets, lines, tubes and containers, and other structures; and discharging of dredged or fill material for seeding, rearing, cultivating, transplanting, and harvesting of shellfish. The permit requires reporting of certain aquaculture conditions and activities, and under defined conditions requires preconstruction notification to the district engineer.

This permit does not authorize: new operations; expansion of the project area for an existing activity; the cultivation of new species (i.e., species not previously cultivated in the water body); features such as docks, piers, ramps, stockpiles, or staging areas; nor does it authorize deposition of shell materials back into the waters. New commercial shellfish aquaculture activities are not authorized under a nationwide permit. According to the preamble discussion in the Federal Register, the Corps determined that new commercial shellfish aquaculture activities may be authorized by regional general permits or individual permits.

According to a telephone conversation on October 9, 2007 with Ms. Stacey Jensen, USACOE Aquaculture Programs Point of Contact for the New York District, the District does not at this time have a general permit for new

commercial shellfish aquaculture activities. New commercial shellfish aquaculture lessees are required to apply for an individual permit. Applications are reviewed according to USACOE standards and according to the NYSDEC's aquaculture off-bottom culture permitting requirements. Also, it was reported that the application is reviewed by the National Marine Fisheries Service, which has requirements that must be satisfied for protecting marine wildlife, such as sea turtles, from harm due to the presence of lines and cages in the water column for shellfish aquaculture. Ms. Jensen stated that the Corps will authorize an applicant's proposed project through a Letter of Permission.

- **US Coast Guard Aids to Navigation**

  Permits issued by the USACOE will be conditioned on compliance with the Coast Guard's Aids to Navigation regulations (Code of Federal Regulations, CFR Titles 33 and 46) for the marking of structures, such as buoys and anchoring devices for cages.

- **National Marine Fisheries Service, Essential Fish Habitats**

  Under the Magnuson-Stevens Fishery Conservation and Management Act, the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service has regulatory responsibilities affecting aquaculture development in the proposed project area. The National Marine Fisheries Service, and its local council, the Mid Atlantic Fishery Management Council, are responsible for reviewing and commenting on federal and state actions and, most likely, the Suffolk County Lease Program as it relates to impacts on the EFHs located in Peconic Bay and Gardiners Bay. The Mid Atlantic Fishery Management Council typically reviews Essential Fish Habitat Assessments developed by applicants and if certain conditions are met, will authorize such activities, either through an exempted fishing permit or through a letter of authorization.

- **US Fish and Wildlife Service**

  US Fish and Wildlife Service (USFWS) requires permitting and licensing for anyone who imports or exports animals or fish for propagation or sale with a value exceeding $25,000 per year. According to Tile 50, §14.21 of the regulations, activities involving the importation and exportation of shellfish for human or animal consumption, and shellfish, its live forms and larvae imported and/or exported for propagation (less than $25,000 in value per year), do not require permitting unless the species imported and/or exported are identified as Endangered. The proposed shellfish aquaculture program is expected not to involve importation or exportation activities requiring permitting or licensing under the USFWS regulations.

  However, the USFWS has regulatory control over any federally endangered wildlife species, such as marine mammals, which may be affected by shellfish aquaculture activities.

- **US Food and Drug Administration**

  The National Shellfish Sanitation Program (NSSP) is recognized by the US Food and Drug Administration (USDA) as a federal and state cooperative program for the sanitary control of shellfish produced and sold for human consumption. The NSSP has issued a Guide for the Control of Molluscan Shellfish, consisting of a Model Ordinance which is developed to ensure that shellfish produced in states complying with these guidelines are safe and sanitary. New York State is a participant in this program, and is a founding member of the Interstate Shellfish Sanitation Conference (ISSC) which also recognizes the NSSP, agreeing to enforce the Model Ordinance as minimally necessary for the sanitary control of shellfish.

  USDA Regulations applicable to shellfish aquaculture include Title 21 of the Code of Federal Regulations, Part 123- Fish and Fishery Products. Under this part "Fish" is defined to include "all mollusks." Regulations under this part

include requirements for Good Manufacturing Practice, Corrective Actions, Verification, Records, Training, Sanitation Control Procedures, Source Controls, and the development by "processors" of a Hazard Analysis and Hazard Analysis Critical Control Point (HACCP) plan. 21 CFR §123.6 includes the regulatory requirements for a shellfish Processor's site-specific HACCP, which must be developed and maintained identifying food safety hazards for each kind of fish and fishery product, and identifying the preventative measures which will control those hazards that can occur before, during and after harvest. New York State regulations under 6NYCRR Part 42 define the State's requirements for a site-specific HACCP,

The definition of a Processor applies to holders of a shellfish aquaculture lease, as "any person engaged in commercial, custom, or institutional processing of fish or fishery products, either in the United States or in a foreign country." [21 CFR §123.3(l)] Also, "processing" is defined to include "[h]andling, storing, preparing, heading, eviscerating, shucking, freezing, changing into different market forms, manufacturing, preserving, packing, labeling, dockside unloading, or holding." [21 CFR §123.3(k)(1)] Although these regulations do not apply to persons including those who are "[h]arvesting or transporting fish or fishery products, without otherwise engaging in processing" [21 CFR §123.3(k)(1)] it is anticipated that most, if not all, of the shellfish aquaculture leaseholders would be regulated under the "processor" definition.

- **US Environmental Protection Agency**

  The National Pollution Discharge Elimination System (NPDES, 33 U.S.C. § 1342) controls direct discharges from "point sources" (e.g., pipes and sewers). The administrative control mechanisms are NPDES permits issued by the EPA or state permits issued by an authorized state. The New York State Department of Environmental Conservation's State Pollution Discharge Elimination System (SPDES) is an authorized state program, discussed below with NYS programs. Permits for "point source discharges" are required where lessees process

harvested shellfish, either onboard a vessel or at an onshore facility. It should be noted that the USEPA is promulgating regulations relating to a program for permitting water pollutant discharges incidental to the normal operation of commercial and recreational vessels, including discharges such as those from seafood processing activities on board a shellfish harvesting vessel.

However, in June 2002, the USEPA and NYSDEC, acting under the authority derived from the CWA [33 USCA §§1322 (f)(3) & (4)], officially designated all of the navigable waters of the Peconic Estuary as a Vessel Waste No Discharge Zone (67 FR 39720) in an effort to reduce the amount of nutrient and pathogen loading from this source. This designation prohibits vessels from discharging *any* sewage, raw or treated, into the estuary, and requires vessels with holding tanks to use pump-out facilities. Therefore, lessees participating in the Suffolk County Lease Program will not be required to comply with SPDES requirements, by virtue of operating in the Peconic Estuary Vessel Waste No Discharge Zone, with all wastes disposed of at pump-out facilities. However, any on-shore operations associated with lessee aquaculture activities must comply with any applicable laws including, if necessary, SPDES requirements.

- **National Aquaculture Acts**
  - **National Aquaculture Act of 1980**

    The National Aquaculture Act of 1980 (16 U.S.C. 2801, et seq.) established a national policy which promotes the development of aquaculture in the US by creating a National Aquaculture Development Plan, an interagency Coordinating Group, and a National Aquaculture Information Center. The Act identified the Department of Agriculture as the lead agency for aquaculture, and also gave the National Oceanic and Atmospheric Administration (NOAA) authority to provide assistance for both public and private sector aquaculture. NOAA's authority includes the responsibility for considering potential impacts of planned marine aquaculture facilities on its trust resources through formal permit reviews

and consultations. However, in 2007 a bill was introduced in Congress amending the National Aquaculture Act of 1980 (Congressional Record: February 8, 2007 [Senate], Page S1781) to prohibit the issuing of permits for marine aquaculture facilities located within the federal Exclusive Economic Zone until the requirements for permits are enacted into law, superseding this Act. (See the National Offshore Aquaculture Act of 2007, below)

- **Proposed National Aquaculture Act of 2007**

  The Proposed National Offshore Aquaculture Act of 2007 (US S 1609; introduced in the Senate on June 13, 2007) is pending in the Senate's Commerce, Science & Transportation Committee, which if enacted, provides the necessary authority to the Secretary of Commerce for the establishing and implementing of a coordinated regulatory system, including permitting requirements, for offshore aquaculture in the United States Exclusive Economic Zone, which is generally a zone located outside of the seaward boundary of the State to a distance of 200 nautical miles from the shoreline. Although the Peconic and Gardiners Bays are under the jurisdiction of New York State, and not in the Exclusive Economic Zone, if this legislation is passed into law, it may provide a more coordinated set of procedures for federal agency reviews and permitting for the aquaculture industry as a whole, which may eventually be modeled by the State as part of future aquaculture regulations, in turn possibly affecting the County Lease Program sometime in the future.

2.7.2 New York State Requirements

- **NYS Environmental Conservation Law (ECL)**

  New York State Environmental Conservation Law (ECL) provides statutory authority to the NYSDEC for promulgating regulations for the use, protection and conservation of the state's natural resources. Article 11 of the ECL addresses the powers and duties of the NYSDEC relating to fish and wildlife, and fish and

wildlife management practices. Article 13 addresses marine fisheries and resource conservation within New York's Marine and Coastal districts (available at: *http://public.leginfo.state.ny.us/menugetf.cgi?commonquery=laws*, accessed September 18, 2007) including shellfish activities. Articles 11 and 13 of the ECL are identified by the ECL as the Fish and Wildlife Law. The primary statutory provisions governing shellfish aquaculture activities enacted within Articles 11 and 13 of the ECL are summarized in the following discussion.

- **Article 11, ECL § 11-0105**

  Article 11, ECL § 11-0105 provides that the State of New York owns all shellfish (and fish and wildlife) in the state, "except those legally acquired and held in private ownership." This provision also codifies the state's authority to regulate and control the taking and possession of shellfish for use and disposition.

  This provision is controlling law directly affecting the County's proposed Lease Program, whereby the State retains title to all shellfish in the state, including shellfish occupying the underwater lands ceded to the County under ECL § 13-0302, for purposes of controlling (through regulations) the taking, possessing, using, and disposing of these animals (and fish and wildlife) associated with these lands.

- **Article 11, ECL § 11-0107**

  This provision prohibits all persons from pursuing, taking, wounding, killing, and/or possessing shellfish (and fish and wildlife) except as permitted by the Fish and Wildlife Law (Articles 11 and 13 of the ECL). Additionally, no person is permitted to offer, sell, buy, and/or transport shellfish, or any part thereof, within the state, or coming from outside of the state, unless provided for under the Fish and Wildlife Law.

This provision affects the County's proposed Lease Program by designating the Fish and Wildlife Law (Articles 11 and 13 of the ECL) as the controlling law whereby the state (through regulations administered by the NYSDEC) controls the identified prohibited activities, including such activities related to shellfish aquaculture, which must be considered in drafting and administering future lease terms and conditions.

- **Article 11, ECL § 11-0111**

  This provision prohibits a county government from providing for the "protection, preservation or propagation of fish, game, wildlife, or shellfish within the county, or to prescribe or enforce collection of penalties for the violation thereof." The exception to this prohibition is where the Fish and Wildlife Law expressly authorizes a county government to exercise these powers. Therefore, as far as shellfish aquaculture activities within the State's jurisdiction are concerned, Suffolk County's authority over such activities is defined primarily under ECL § 13-0302, and also other provisions of the Fish and Wildlife Law (Articles 11 and 13 of the ECL), and regulations enabled under the Fish and Wildlife Law.

- **Article 11, ECL § 11-0303**

  This provision vests statutory and regulatory powers in the NYSDEC concerning fish and wildlife in the state. Although according to ECL § 11-0103, "fish" and "wildlife" do not by definition include shellfish, NYSDEC's authority and control must be considered within the County's Lease Program. This is of course because of the presence of certain fish and wildlife throughout the Peconic and Gardiners Bays.

- **Article 11, ECL § 11-0503**

  This provision of the Fish and Wildlife Law prohibits, among other acts, releasing deleterious or poisonous substances into any waters in quantities

injurious to "fish life, protected wildlife or waterfowl." This prohibition should be considered in drafting and administering future lease terms and conditions.

- **Article 11, ECL § 11-0515**

  Article 11, ECL § 11-0515, provides the authority to the NYSDEC to issue licenses for the collection, possession and sale of shellfish (and other listed biota) for propagation, banding, scientific, or exhibition purposes.

- **Article 11, ECL § 11-0517**

  Article 11, ECL § 11-0517, provides the authority to the NYSDEC to take, or allow others to take, shellfish (and other listed biota) for propagation purposes. This provision also allows the NYSDEC to remove, or allow others to remove, fish or shellfish which hinder the propagation of food fish and shellfish. According to the regulations, specifically 6NYCRR § 175.2 (d), "propagation" is defined as the "production of selected species by application of husbandry techniques in a controlled environment for commercial or other authorized purposes."

- **Article 13, ECL § 13-0302**

  Chapter 425 of the laws of 2004 repealed Chapter 990 of the laws of 1969 which gave the County the right to lease underwater lands in the Peconic and Gardiners bays ceded to the County by Chapter 385 of the laws of 1884. This also created ECL § 13-0302 which defines the underwater lands ceded to the County for a shellfish aquaculture program, and defines the requirements for developing the County's Lease Program. This provision also provides that if no leases are executed by the County by the end of 2010, the County's authority to lease the underwater lands will be extinguished.

- **Article 13, ECL § 13-0305**

Article 13, ECL § 13-0305 states that no party other than a lessee or the NYSDEC may mark or enclose underwater lands, or exclude the public, for planting shellfish. This provision also prohibits anyone from injuring or removing any monument, stake, or boundary marker delineating state-owned shellfish lands, unless approved by the NYSDEC.

- **Article 13, ECL § 13-0307**

Article 13, ECL § 13-0307 outlines and defines the State's authority to examine and certify underwater lands where sanitary conditions are such that shellfish may be taken for food. The NYSDEC is required to publish annual reports containing a description of the locations of Certified Shellfish Lands. Such an annual evaluation and certification may affect certain leased lands if sanitary conditions develop rending a determination that a leaseholder's shellfish occupy uncertified waters, and, therefore, cannot be taken for food consumption.

- **Article 13, ECL § 13-0309**

This provision, containing 15 subsections, provides the statutory requirements for the taking, handling and importing of shellfish. The NYSDEC is granted the authority to regulate and administer these statutory requirements including but not limited to harvesting methods, sanitary requirements for harvesting, harvesting times, harvesting seasons, harvesting limits, possession and transportation requirements, and certain permitting requirements.

Under §13-0309 (3) the use of mechanically powered dredging or scraping practices for harvesting shellfish "from public or unleased lands underwater," is prohibited, with certain stated exceptions. Additionally, pursuant to §13-0309 (13), possession of shellfish on a vessel equipped with mechanical devices will be considered presumptive evidence (under

certain defined conditions) for having harvested shellfish according to a prohibited manner. The NYSDEC's Marine Enforcement Unit and NYSDEC regulations identified below provide the necessary enforcement guidelines and penalties information for these and other violations of laws relating to shellfish activities. The NYSDEC will maintain its statutory and regulatory authority over lessee activities within the County's proposed Lease Program, through permitting requirements and general enforcement of regulations authorized under the State's statutes.

In addition to the prohibitions discussed for §13-0305, above, under §13-0309 (4), the interfering with, disturbing, taking away, or carrying away of shellfish lawfully possessed by another is strictly prohibited, as well as the removal of any stakes, buoys, or markers of another is prohibited. The possession of harvesting equipment "overboard on any such lands" of another is considered presumptive evidence of the prohibited acts within this subsection. Also, under §13-0309 (9), it is prohibited to "alter, damage, mutilate, move or carry away any buoy or marker placed by the department that is used to designate, mark or define the uncertified waters of the state." The NYSDEC will maintain its statutory and regulatory authority over lessee activities within the County's proposed Lease Program, relating to these prohibited acts.

- **Shellfish Permits Under the Fish and Wildlife Law**

There are ten sections under the Fish and Wildlife Law (see Article 13 of the ECL) defining specific shellfish-related activities requiring a permit from the NYSDEC. Each section contains statutory requirements for each permitted activity, including but not limited to: applicant criteria; permit fees; permit activity restrictions; shellfish type, size and quantity restrictions; allowable harvesting methods and restrictions; and NYSDEC enforcement actions. The ten sections and type of permits are listed below:

- § 13-0309 Permit for the Possession, Transportation, Taking, and Handling of Shellfish;
- § 13-0311 Digger's Permit to Take Shellfish for Commercial Purposes;
- § 13-0313 Shellfish Growers Bed Permit;
- § 13-0315 Shellfish Shipper's and Processor's Permit;
- § 13-0316 Marine Hatcheries; Off-Bottom and On-Bottom Culture Permits;
- § 13-0319 Shellfish Permits;
- § 13-0321 Taking and Importation of Shellfish for Transplanting and Other Purposes;
- § 13-0323 Oyster Permits;
- § 13-0325 Permit to Take, Harvest, Possess, and Transplant Hard Clams and License for Boat to Take Surf Clams; and
- § 13-0327 Permit to Transplant or Salvage Scallops

- **Article 13, ECL § 13-0317**

  Article 13, §13-0317 requires labeling or tagging of all shellfish distributed, transported, imported or exported.

- **Article 13, ECL § 13-0319**

  ECL, Title 3, § 13-0319, provides the authority to the NYSDEC to:

  > "adopt regulations with respect to the harvesting, transplanting, relaying, receiving, possessing, transporting, importing, exporting, processing, buying, selling, of or otherwise trafficking in shellfish; the labeling or tagging thereof; the keeping of records of shellfish received, transported and distributed; the construction, operation and maintenance of all shellfish handling, processing and distributing establishments, including facilities and

equipment and the cleaning, cleansing and water storage of shellfish."

- **Article 13, ECL § 13-0321**
  ECL, Title 3, §13-0321, provides the authority to the NYSDEC to allow the taking of shellfish from uncertified lands for propagation purposes (e.g., relaying), according to regulatory requirements, and permitting requirements (§13-0309).

- **Navigation Law**
  - Article 3 of the Navigation Law (NAV) states that the Commissioner (NYS Parks, Recreation and Historic Preservation, or NYSDEC in the Sixth Park Region) has jurisdiction over navigation on the "navigable waters" of the state. However, under Article 1 of the NAV, §2, defines "navigable waters" to be exclusive of all tidewaters bordering on or within Suffolk (and Nassau) County.

  - Article 4 of the NAV, §46-a permits a city or village to adopt, amend and enforce rules and regulations consistent with federal and state laws concerning the speed, operation, mooring, anchoring of, and removal of garbage from vessels "upon any waters within or bounding the appropriate city or village, including any waters within or bordering a village in the county of Nassau or Suffolk, to a distance of fifteen hundred feet of the shore." See Section 2.7.3 of this document for the corresponding Town and Village navigation laws.

These provisions of the NAV are important for the County's Lease Program, because a lessee in the program is not subject to the NAV, but must comply with local village and town codes pertaining to the navigation, operation and mooring of vessels as part of its business practices.

- **NYSDEC Programs and Regulations Relating to Shellfish Aquaculture**

  As stated previously, the ECL provides statutory authority to the NYSDEC for regulating the use, conservation and protection of the state's natural resources. Although the State ceded title and interest in the underwater lands in the Peconic and Gardiners Bays to the County for its proposed Shellfish Aquaculture Lease Program, the State retains ownership of all shellfish, fish and wildlife in the State, and the sovereign right to regulate and control activities associated with these natural resources (see ECL § 11-0515).

  The NYSDEC Bureau of Marine Resources, Division of Fish, Wildlife and Marine Resources, East Setauket, New York, administers the State's statutory and regulatory requirements relating to shellfish in the Peconic and Gardiners Bays. This office reviews permit applications, issues permits, monitors permit activities, and has the authority to revoke permits. The Bureau is divided into three program areas: shellfish; marine habitat protection; and crustaceans and finfish.

  The Shellfish Section is divided into two program units; the Shellfish Resource Management Unit, and the Shellfish Sanitation Unit. The Shellfish Resource Management Unit is responsible for the maintenance of the State's shellfish resources through permitting, setting shellfish species harvesting limits, species transplanting methods and aquaculture. The Marine Permit Office is within the Shellfish Resource Management Unit. The Shellfish Sanitation Program exercises its authority over the sanitary control practices relating to harvesting, handling and processing of shellfish. This program unit is responsible for administering shellfish-related regulations which ensure adequate public health protection for shellfish consumers.

  NYSDEC regulations affecting the County's proposed Lease Program for shellfish aquaculture activities also include those regulations under the State's Protection of Waters Program; the State's Environmental Quality Review Act; the State's Pollution Discharge Elimination System program; and NYSDEC Boat

Launching regulations. These NYSDEC regulatory programs and regulations are discussed below.

- **6NYCRR Part 175**

  The ECL identifies the statutory requirements, but does not define in detail the procedures, terms and conditions relating to applying for, and receiving special licenses and permits from the NYSDEC for collecting, possessing, transporting, processing, and other activities associated with fish, wildlife and shellfish. The regulations found in 6NYCRR Part 175 provides the regulatory terms and definitions, general requirements and uniform procedures for obtaining permits from the NYSDEC for fish, wildlife, and also for shellfish activities. In particular, 6NYCRR §175.1 (c) (11) applies to special licenses and permits authorized by the ECL for shellfish cultivation and harvesting activities. The listing below includes references to the applicable ECL statute and applicable regulation for each permit. These permits are administered by the Shellfish Resource Management Unit.

  - Permit for the Possession, Transportation, Taking, and Handling of Shellfish (ECL §13-0309) 6NYCRR Parts 43;
  - Diggers Permit to Take Shellfish for Commercial Purposes (ECL §13-0311);
  - Shellfish Growers Bed Permit (ECL §13-0313);
  - Shellfish Shipper's and Processor's Permit (ECL §13-0315, Classes A-G);
  - Marine Hatcheries, Off-Bottom and On-Bottom Culture Permits (ECL §13-0316), see also 6NYCRR Parts 43 & 48;
  - Shellfish Permits (ECL §13-0319), see also 6NYCRR Parts 45, 48 & 49;

- Permit for the Taking and Importation of Shellfish for Transplanting and Other Purposes (ECL §13-0321), see also 6NYCRR Parts 45 & 48;
- Oyster Permits (ECL §13-0323), see also 6NYCRR Part 49.2;
- Permits to Take, Harvest, Process, and Transplant Hard Clams and License for Boat to Take Surf Clams (ECL §13-0325), see also 6NYCRR Part 45; and
- Permit to Transport or Salvage Scallops (ECL §13-0327), see also 6NYCRR Parts 45 & 49.1.

- **Shellfish Resource Management Unit**

  Shellfish regulations, administered by the Shellfish Resource Management Unit include:

  - **6NYCRR Part 43 Surf Clam/Ocean Quahog Fishery Management**

    This regulation was promulgated to support the maintenance of viable surf clam and ocean quahog populations in selected areas of the Marine and Coastal District. This regulation provides controls through a permit system designed to limit mechanical harvesting activities, identify permitted harvesting seasons, and define harvesting quotas. It does not appear that this regulation would affect commercial shellfish aquaculture activities under the County's program.

  - **6NYCRR Part 45 Transplanting Shellfish**

    This regulation prohibits the removal of shellfish from State underwater lands, and the importation of shellfish to the State, for transplanting purposes without obtaining certain permits. These permits include: a Shellfish Transplant Permit; a Shellfish Transplant Harvester's Permit; and a Shellfish Digger's Permit. This regulation will apply to shellfish lease-holders in the County's proposed program. However, if the County

itself takes, transplants or imports shellfish, it is exempt from the permit requirements under this regulation.

- **6NYCRR Part 48 Marine Hatcheries, On-Bottom and Off-Bottom Culture of Marine Plant and Animal Life**

  This regulation directly relates to the County's Lease Program, requiring any person carrying out the activities of cultivation in a marine hatchery, or through on-bottom or off-bottom culturing activities, to obtain the NYSDEC's approval and necessary permits and follow the rules relating to tagging. This regulation also prohibits the sale or trade of marine life (i.e. shellfish) of less than the legal size.

  Additionally, 6NYCRR §48.3 (2) provides that the NYSDEC may prescribe any marine life permit conditions or limitations necessary to protect the public health and safety, and to provide for the continued viability of the State's marine resources.

- **6NYCRR Part 49 Shellfish Management**

  This regulation was promulgated to establish conservation and management measures: "necessary to promote and restore viability of sustainable bay scallop populations in Peconic bays and other waters of the Marine District," [6NYCRR §49.1(a)]; and "necessary to protect and sustain viable populations of oysters in the Marine District," [6NYCRR §49.2(a)]. The regulations applicable to the County's Lease Program relating to bay scallops include rules and sanctions against unintentional or unavoidable harvesting of immature scallops [6NYCRR §49.1(c)(5)] and requirements for permits when salvaging and/or transplanting scallops [6NYCRR §49.1(g)]. The regulations applicable to the County's Lease Program relating to oysters includes the requirement for permitting of oyster culture activities and transplanting activities [6NYCRR §49.2(b)(1) and (b)(3)].

- **Shellfish Sanitation Unit**

  The Shellfish Sanitation Unit, a subdivision of the NYSDEC Bureau of Marine Resources, Division of Fish, Wildlife and Marine Resources, regulates and controls the harvesting, handling and processing of shellfish for public consumption. The unit performs water quality monitoring, closures of unsanitary shellfish beds, and reporting to the public of shellfish sanitary conditions in the State's shellfish growing areas. Shellfish Sanitation Unit inspectors regularly inspect shellfish processing and wholesale shellfish dealers' facilities to ensure that they comply with State (and federal) requirements. As stated above in the discussion of USDA regulations applicable to shellfish aquaculture, New York State is a founding member of, and participant in, the Interstate Shellfish Sanitation Conference (ISSC), and as such, its regulations require a HACCP [6NYCRR §42.7(c)(1)] meeting or exceeding the federal standards found in 21 CFR §123.6. The key NYSDEC regulations relating to the certification of shellfish lands and the monitoring of sanitary shellfish activities are discussed below. These regulations will directly affect the proposed Suffolk County Lease Program.

  - **6NYCRR Parts 41 and 47**

    These two regulations concern the sanitary conditions of shellfish lands and the criteria for certification of shellfish lands. 6NYCRR Part 47 provides the guidelines whereby the NYSDEC, through regular sanitary surveys and water quality evaluations, designates shellfish lands where shellfish may be taken and used as food. These designated lands are called Certified Shellfish Lands. Under this regulatory scheme the NYSDEC issues annual notices published in newspapers widely distributed in the counties containing shellfish lands. NYSDEC is also authorized to issue more regular warnings, reclassify areas and close shellfish lands whenever it is determined that unsanitary conditions exist rendering shellfish hazardous for use as food. These regulations prohibit

any person from harvesting shellfish from uncertified lands for use as food. However, it should be noted that according to ECL §13-0321, the NYSDEC may allow the taking of shellfish from uncertified lands for propagation purposes, controlled through regulations and permitting.

6NYCRR Part 41, Sanitary Condition of Shellfish Land, provides the description of shellfish lands on a county by county basis. The regulatory descriptions include identification of certified lands, uncertified lands, and temporarily uncertified shellfish lands.

- **6NYCRR Part 42 Sanitary Control Over Shellfish**

  The regulatory provisions of this part apply to any aspect of commercial shellfish activities in the State including, but not limited to "growing, harvesting, processing, handling, microbiological cleansing, packing, repacking, receiving, storing, possessing, transporting, distribution, shipping, reshipping, and/or selling or offering for sale." [6NYCRR §42.3(a)]

  This part provides guidelines for all activities, including requirements for permitting/licensing, revocation of licenses/permits, facilities, waste handling and disposal, sanitary washing requirements, hazard identification, record keeping and penalties. Descriptions of permits, permit application process and fees are provided in 6NYCRR §42.4. Standard permit conditions are described in 6NYCRR §42.5. Detailed record-keeping requirements for "Dealers" include performing a hazard analysis, and based on the findings of this analysis, drafting a HACCP plan according to 6NYCRR §42.7(c)(1) and FDA requirements.

  Sanitary control regulations under this part cover the major aspects of commercial shellfish activities such as those relating to: facilities and structures (6NYCRR §42.8); water quality for treating and storing

shellfish (6NYCRR §42.9); receiving, handling, packing, processing, storing, and wastewater fixtures & disposal (6NYCRR §§42.10-12); shellfish harvesting, handling, labeling, and transporting (6NYCRR §§42.13-14); microbiological cleansing procedures (6NYCRR §§42.15-16); unsanitary shellfish identification, handling & treatment (6NYCRR §§42.17-18); and penalties (6NYCRR §42.8).

Also, according to 6NYCRR §42.13 (a) (11), "[n]o person shall throw, dump, discharge or permit or allow to run into the waters of certified shellfish lands any body waste, garbage, cinders, ashes, oils, sludge, contaminant or refuse of any kind."

- **Marine Enforcement Unit**

  The NYSDEC Marine Enforcement Unit is located in the same offices as the shellfish program in East Setauket, New York. This unit is responsible for protecting the State's marine resources through enforcing state and federal laws and regulations relating to habitat protection and natural resources protection. The Marine Enforcement Unit enforces the Fish and Wildlife Law (Articles 11 and 13 of the ECL, discussed above), and NYSDEC regulations promulgated under its authority granted by the Fish and Wildlife Law, relating to the recreational and commercial harvesting of shellfish, crustaceans and fish. The Marine Enforcement Unit will be actively involved with enforcement of the State's laws relating to shellfish aquaculture activities under the County's Proposed Lease Program.

- **NYSDEC Protection of Waters Program**

  New York State's ECL, Title 5 of Article 15 sets forth the policy of the State, preserving and protecting its waters, and implements NYSDEC regulations found in 6NYCRR Part 608 which defines the Protection of Waters Program. This program is charged with preventing undesirable activities on water bodies, with regulations that: preserve, protect and enhance present and potential value of

water resources; protect the public's health and welfare; and are consistent with the reasonable economic and social development of the State.

All waters of the state are classified based on existing or expected best usage of each water body. Certain waters of the state are protected based on their classification. The classification with the most restrictive protection standards is A or AA, assigned to waters used as a source of drinking water, and classification standard D is the least restrictive. The majority of the waters of the Peconic and Gardiners Bays in the area of the County's Proposed Lease Program are Class SA. Class SA waters are surface saline waters. The best usages of Class SA waters are shellfishing for market purposes, primary and secondary contact recreation, and fishing. (See 6 NYCRR Chapter X, §701)

Also, the NYSDEC Division of Environmental Permits Office for Region 1 (Building 40, Room 121, SUNY Stony Brook, New York) is the state's office in charge of its Protection of Waters Program for the Peconic and Gardiners Bays.

Title 5 of Article 15 of the ECL sets the policy in the state, and 6NYCRR Part 608 contains the applicable NYSDEC Protection of Waters regulations. The Protection of Waters Program regulations control all activities associated with state waters through a permitting system which designates five categories of activities which require permits. These activities include:

1. Disturbance of the Bed or Banks of a Protected Stream or Other Watercourse;
2. Construction, Reconstruction or Repair of Dams or Other Impoundment Structures;
3. Construction, Reconstruction or Expansion of Docking and Mooring Facilities;
4. Excavation or Placement of Fill in Navigable Waters and Their Adjacent and Contiguous Wetlands; and

5. Water Quality Certification for Placing Fill or Undertaking Activities Resulting in a Discharge to Waters of the United States.

Since some activities associated with shellfish aquaculture may require permitting through the State's Protection of Waters Program, lessees in the County's program will have to abide by the applicable regulations and obtain the necessary permits. For example, the increase need for onshore support services, such as processing facilities, may require improvements to existing docks or mooring facilities.

- **New York State Pollution Discharge Elimination System (SPDES)**

  Article 17, Title 8 of the ECL was enacted to protect and maintain the state's surface and groundwater resources. NYSDEC regulations found in 6NYCRR Part 750 implements the statutory mandates of the ECL. SPDES also implements the Federal Clean Water Act through the NYSDEC. The SPDES is broader in scope than that required by the Clean Water Act in that it controls point source discharges to groundwater as well as to surface water. For the private, commercial and industrial permit programs, New York State law requires a permit if a person constructs or uses an outlet or discharge pipe (i.e., "point source") which discharges wastewater into the surface waters or groundwaters of the state, or if the disposal system is a facility such as a sewage treatment plant.

  However, as stated previously, lessees in the Shellfish Cultivation Zone will not be required to comply with SPDES requirements, by virtue of operating in the Peconic Estuary Vessel Waste No Discharge Zone. As also previously noted, any on-shore operations associated with lessee aquaculture activities must comply any applicable laws, including if necessary, SPDES requirements.

- **Tidal Wetlands Program**

  The Tidal Wetlands Act, found in 6NYCRR Part 661, and authorized under Article 25 of the ECL, is designed to preserve and protect tidal wetlands and

adjacent areas (through a permit system) and to prevent habitat despoliation and destruction. Although the Proposed County Aquaculture Lease Program is defined under Article 13, ECL § 13-0302 to include underwater lands more than 1,000 feet from the shore (median high water mark), the waters of the Peconic and Gardiners Bays are classified under 6NYCRR Part 661 as a Littoral Zone (LZ); and therefore, NYSDEC regulations promulgated under the Tidal Wetlands Act would require this DGEIS to identify and mitigate any impacts as designated by the Tidal Wetlands Act that may be associated with the proposed lease program.

- **State Environmental Quality Review Act (SEQRA)**

  The provisions of SEQRA, found in 6NYCRR Part 617, requires all levels of government in New York State to fully disclose the potential impacts associated with a proposed action. This law is administered by the "lead agency," as designated during the SEQRA lead agency review process for each project. This DGEIS and its associated public review process is part of the County's compliance with SEQRA.

- **Water Quality Certification Program**

  The NYSDEC, Division of Environmental Permits, administers this program, also known as the "401 Certification Program." Pursuant to § 401 of the FCWA, any discharge to US waters requiring a federal permit must first apply and receive approval from the state. The 401 Certification Program is designed to ensure that federal actions comply with local water quality standards. Therefore, for the County's Lease Program, any lessee applying for a federal permit, such as from the ACOE, must include a water quality certification from the NYSDEC.

- **NYSDEC Boat Launching Regulations**

  NYSDEC Boat Launching Regulations, 6NYCRR Part 59, apply to "all boat-launching sites, fishing access sites, parking areas for fishermen and public fishing rights areas under the jurisdiction of the Division of Fish and Wildlife" and §§ 59.1 (c) & 59.1 (d) requires a permit for purposes other than boat

launching or fishing access, such as conducting business, buying, selling, hiring, leasing, vending of "any article or merchandise of any kind (NYSDEC Website, Part 59, 10/5/2007)."

- **New York State Department of State**

  Article 42 of New York State Executive Law contains the provisions of the State Waterfront Revitalization of Coastal Areas and Inland Waterways Act, to assure the consistency of state actions, and any appropriate federal actions, with any policies within the state's Coastal Management Program, regional coastal management programs, any special area management programs, and any Local Waterfront Revitalization Programs (NYS Legislature, Laws of New York, 9/18/2007). Also, the federal Coastal Zone Management Act (CZMA) of 1972, Codified in 15 CFR 930, includes the requirement that any federal agency activity within or adjacent to the coastal zone which affects any land or water use, or natural resources, shall be carried out in a manner consistent with the enforceable policies of approved state management programs (NYSDOS Website, Federal Consistency, 2/27/2008).

  Therefore, before any federal or state permit or approval can be granted to any applicant in the Suffolk County Lease Program, those permitting agencies must comply with the requirements set forth pursuant to the State Waterfront Revitalization of Coastal Areas and Inland Waterways Act, and the federal CZMA (NYSDOS Website, NYS Coastal Policies, 2/27/2008). Applicants seeking federal permits and/or approvals must submit a Federal Consistency Assessment Form, along with any specifically required supporting documentation, to the New York State Department of State (NYSDOS). The NYSDOS must then review the Federal Consistency Assessment Form and render a decision as to whether the federal action (issuing a permit or otherwise authorizing the applicant's proposed activity) will be consistent with New York State's coastal management policies (NYSDOS Website, State Consistency, 2/27/2008). The

specific application procedures and consistency approval timelines are provided in 15CFR Part 930, subpart D.

Also, according to the State Waterfront Revitalization of Coastal Areas and Inland Waterways Act, Codified in the regulations 19NYCRR § 600.1, New York State agency actions (permitting and/or approvals) with respect to applicants in the County's Lease Program, must first be considered according to SEQRA. If the action is Type I or Unlisted, the agency must submit a Coastal Assessment Form to the NYS Secretary of State prior to the agency's determination of significance according to SEQRA. State agency activities listed in an approved Local Waterfront Revitalization Program (LWRP) are also subject to consistency procedures (NYSDOS Website, Local Waterfront Revitalization Program, 9/11/1007). To date, the Town of Southold, the Town of East Hampton, the Village of Greenport and the Village of Sag Harbor have State-approved LWRPs which must be considered in the development of the County's Lease Program.

- **New York State Office of General Services**

  According to Public Lands Law, § 75 (NYS Legislature, Laws of New York, 9/18/2007), the Commissioner of General Services has authority over state-owned underwater lands, acting in the public interest, and in the use of these lands, consistent with the public interest, for purposes of: navigation; commerce; fishing; bathing; recreation; environmental protection; and access to the navigable waters of the State. Under this statutory authority, the Commissioner of General Services may dispose of state-owned underwater lands as: a grant in fee simple (i.e., the transfer of all property rights and interests), grant of an easement, grant of a license or permit, or grant of any other lesser interest. Rules and regulations promulgated by the Commissioner of General Services for its authority under Public Lands Law, §§10 and 75, are found in 6NYCRR Part 270 (OGS Website, Regulations, 9/18/2007).

As the sovereign owner of underwater lands on behalf of the people of the State of New York, and in coordination with other State agencies, the Office of General Services is authorized to issue water column leases and licenses for finfish aquaculture projects (OGS Website, Lands Underwater Program, 12/5/2007). However, since under the ECL §13-0302, the State Legislature ceded to Suffolk County all rights, title and interests in which the people of the State of New York had in the underwater lands under Gardiners and Peconic Bays, the Commissioner of General Services does not have jurisdiction over these underwater lands as long as Suffolk County retains its rights according to this provision of the ECL.

2.7.3 Local Laws and Codes Relating to Shellfish Aquaculture Activities

- **Town of Riverhead**

  The Code of the Town of Riverhead (Town of Riverhead Town Code, 10/8/2007), Chapter 47: Bays and Creeks; § 47-3 states that shellfish may be taken from Town waters for commercial purposes by a resident/taxpayer, having a valid NYSDEC Shellfish Digger's Permit, upon applying and obtaining a permit from the Town Clerk for a fee of $100. The permit expires on December 31st of the year of the permit's issuance date. A Temporary Resident permit is available for $30 for 30 days, $60 for 60 days, and $90 for 90 days. Commercial resident/taxpayer permit holders may take up to five bushels per day [§ 47-14 B. (1)].

- **Town of Southold**

  The Code of the Town of Southold (Town of Southold Town Code, 10/8/2007), Chapter 219, Article II: Shellfish Law of the Town of Southold; § 219-7 defines "shellfish" as clams, scallops, oysters, blue claw crabs, mussels, periwinkles, and conchs. Also, § 219-7 defines "Town Waters" as all "waters and lands under tidewater in any harbor, bay or creek, title to which and the right of fishing in which is vested in the Town of Southold and/or the Board of Trustees."

  According to §219-8 shellfish may be taken from Town waters for commercial purposes by a permanent resident, or person holding a temporary resident permit

($10), upon applying and obtaining a permit from the Town Clerk for a fee of $35. The permit expires on December 31st of the year of the permit's issuance date. Commercial permit holders may take up to: five bushels of scallops per day per person (10 bushel limit for multiple boat occupants/ permit holders) [§ 219-10 E]; 2,000 hard clams per day per person (4,000 hard clam limit for multiple boat occupants/ permit holders) [§ 219-11 E]; 10 bushels of mussels per day per person (20 bushel limit for multiple boat occupants/ permit holders) [§ 219-14 B]; and although no limit is provided in the Code, it states that the Board of Trustees may set limits for the taking of oysters.

Town Code § 96-1 states that "no person shall place any piles, stakes, buoys, piers, docks, bulkheads or other objects in or on any Town Waters or public lands under or adjacent to Town waters in the Town of Southold, nor shall any person remove sand, gravel or other materials from lands under Town waters" without applying for and receiving a permit from the Board of Trustees.

Also, Town Code § 157-6 states that no permanent mooring shall be placed in the waters of Fishers Island, within the Town of Southold to a distance of 1,500 feet from shore, unless authorized by a permit issued by the Fishers Island Harbor Committee Secretary/Clerk.

- **Town of Shelter Island**

  The Code of the Town of Shelter Island (Town of Shelter Island Town Code, 10/8/2007), Chapter 108: Shellfish; § 108-2 defines "shellfish" as "blue crabs, crabs, scallops, hard clams, lobsters, mussels of all kinds, oysters, periwinkles, razor clams, shrimp and soft clams." Also, § 108-2 defines "Town Lands" as "all waters and lands under tidewater in any harbor, bay, lake or creek, title to which land is vested in the Town of Shelter Island, and the right of fishing which is vested in the Town of Shelter Island."

Section 108-4 of the Town Code states that a person entitled to take shellfish must be a resident who has obtained a personal or commercial permit, and all other necessary permits. Each permit expires on the first of April following the date of issuance of the permit. The fee for the permit is $10. A resident-applicant holding a valid NYSDEC Shellfish Digger's Permit may take shellfish in commercial quantities.

Under the Town Code, § 108-4, commercial takings are restricted to five bushels per day of hard clams, soft clams, razor clams, and scallops; and one peck of oysters per day. Hard clams less than one-inch in thickness may only be taken for propagation purposes. Seed oysters may only be taken after receiving written permission from the Town Board. Scallops lacking an annual growth ring are prohibited from taking. The Code expressly prohibits vessels with more than one permit holder from taking more than the five bushel commercial taking limit.

Under the Town Code, § 90-5, a permit from the Town Board is required for any mooring in Town waters. Any permit application for mooring outside of the Town designated mooring fields requires approval through a public hearing before the Town Board.

Under the Town Code, § 53-7, a permit from the Town Clerk is required for use of the Town-owned docks at Congdon's Creek and Dering Harbor (vessels are restricted to less than 35 feet). Use of commercial docks apparently does not require a permit, unless an application is for the construction, alteration or modification of a commercial dock which requires a permit (§ 53-9).

Under the Town Code, § 53-16, a permit from the Town Board is required for any attachment to or embedding into lands underwater for water control structures, or other structures or floats within the Town's jurisdiction. A permit is also required from the Town Board for any moving or removing of any sands, gravel or other materials from Town underwater lands.

- **Town of Southampton**

  The Code of the Town of Southampton (Town of Southampton Town Code, 10/8/2007), Chapter 56 of the 1979 Code, amended in 1984, Chapter 278: Shellfish; § 278-3 defines "shellfish" as oysters, escallops, hard clams, soft clams, razor clams, crabs, shrimp, all kinds of mussels, skimmer or surf clams, periwinkles, conchs and quarterdeckers, also known as "slipper shells." Also, § 278-3 defines "Town Waters" as all "waters and lands below the mean high water mark in any bay, pond, lake, creek, or river in the Town of Southampton."

  Section 278-5 states that any qualified person may obtain a permit by applying, paying a fee and receiving approval from the Board of Trustees. In § 278-4 (D), shellfish may be taken for commercial purposes by any freeholder (landowner with a principal residence in Southampton) or resident holding a valid permit, and after paying a $100 permit fee. The permit expires on December 31st of the year of the permit's issuance date. A Temporary Resident permit is available for $10 for 30 days and $20 for 90 days. Commercial permit holders may take up to 10 bushels of escallops per day per person (20 bushel limit for multiple boat occupants/ permit holders) [§ 278-13(A)] and for all other shellfish, no limits for commercial permit holders [§ 278-13(B)].

  Section 278-13.1 states that the Trustees may, in their sole discretion, designate any lands under Town Waters as a "management zone" and may prohibit, restrict and regulate the taking of shellfish from any management zone. The designation of management zones shall be pursuant to a resolution passed by the Trustees, and published in designated newspapers.

  Section 111-13 (H) states that "no vessel shall be allowed to enter upon or use the facilities of a commercial fishing dock or basin operated by the Town of Southampton Parks and Recreation Department" unless the owner procures, and

maintains on the vessel for inspection, a permit from the Superintendent of Parks and Recreation.

Also, under § 111-30 (C), "[n]o person shall dig, dredge or otherwise change the bottom of any waters in the Town" without first obtaining a permit from the Town Trustees.

- **Town of East Hampton**

  The Code of the Town of East Hampton (Town of East Hampton Town Code, 10/8/2007), Chapter 213: Shellfish; § 213-5 defines "shellfish" as "blue crabs, conchs, crabs, escallops, hard clams, lobsters, mussels of all kinds, oysters, periwinkles, razor clams, shrimp, skimmers and soft clams." Also, § 213-5 defines "Town Waters" as "all waters and land below the mean high water in any harbor, bay, pond, lake, creek or river in the Town of East Hampton."

  Section 213-6 of the Town Code states that a person entitled to take shellfish must be a resident or taxpayer who has obtained a personal or commercial permit, and all other necessary permits. In § 213-7, a commercial permit is necessary for a person who takes shellfish or shellfish predators for use by others. Each permit commences on April 1 of the year issued, expiring on March 31 of the following year. Each applicant for a commercial permit must submit various forms of proof of residency and taxpayer status, and must hold a valid NYSDEC Shellfish Digger's Permit.

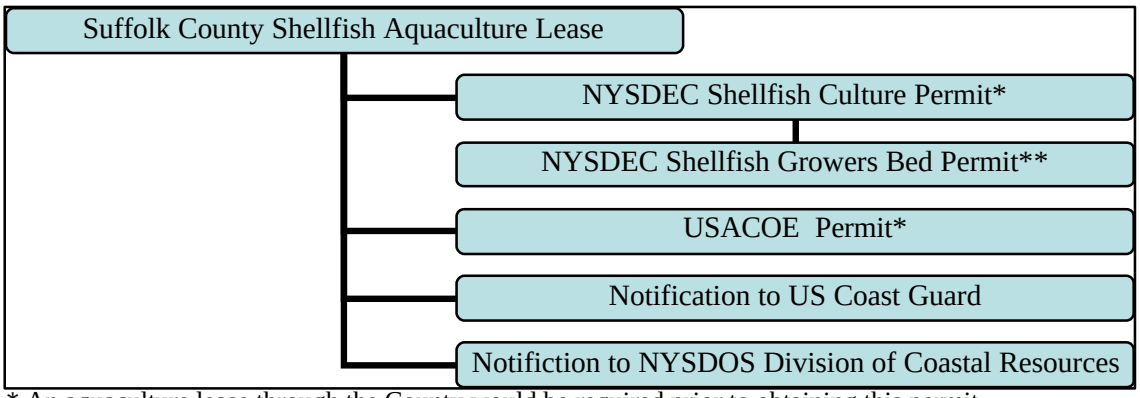
  Under the Town Code, commercial permit holders may take up to five bushels of escallops per day per person (10 bushel limit for multiple boat occupants/ permit holders) [§ 213-12(D)]; three bushels of hard clams per day [§ 213-13]; three bushels of soft clams per day [§ 213-16 (C)]; and for all other shellfish (other than lobsters), no daily limits for commercial permit holders [§ 213-17(B)].

Under §§ 246-3 (B) & (D), separate permits (with appropriate fees) are required each for mooring and/or placement of floats in Trustee or Town waters, through application and approval by the Town Clerk or Town Trustees where applicable. Use of commercial docks is subject to rules and regulations promulgated by the Town Board.

2.7.4 Permits and Notification Requirements for Shellfish Aquaculture

Leases obtained through the County will provide access to underwater lands only. Permits for shellfish cultivation and the placement of structures (e.g. buoys and markers) in navigable waters will need to be obtained by the lessee prior to conducting any cultivation operations on a lease site. The following table (Table 1), represents the basic permits and notification requirements an individual must obtain to conduct shellfish aquaculture under the proposed Lease Program. Additional permits (e.g. transplant permit, seed relay permit) may be required depending on the types of activities a lease holder may conduct as part of their operations.

Table 1. Minimal Permit/Notification Requirements for Shellfish Aquaculture on Leased Underwater Lands



* An aquaculture lease through the County would be required prior to obtaining this permit.

** Shellfish Growers Bed Permits apply onto to privately-owned underwater lands only (oyster grants) (J. Thiel, NYSDEC Bureau of Marine Resources, personal communication, October 2007).

2.8 Types of Aquaculture Activities

According to a fact sheet published by the Northeast Regional Aquaculture Center (NRAC) titled *Aquaculture Systems for the Northeast* (Buttner, Flimlin and Webster, 1992), there are basically two types of aquaculture practices: extensive

and intensive. Extensive culture involves production at densities not greatly exceeding those found in nature, such as an unfed pond or unmanaged bottom culture. This form of aquaculture requires little energy and effort on the part of the aquaculturist and consists mainly of purchasing nursery raised or collecting wild seed stock of a particular species and planting them on a leased or granted bottomland for grow out to harvestable sizes. Once the seed are planted there is very little maintenance involved in the operation until it is time to harvest the stock.

Intensive culture involves production at densities that greatly exceed those found in nature. This method usually involves considerably more labor, time and long term commitment than extensive culture.

Intensive culture usually consists of two phases, nursery and grow out. However, an aquaculture operation does not need to be involved with both phases to be considered intensive culture. For example, oysters being cultivated in off-bottom structures require constant maintenance to keep the structures free of fouling organisms and predators. Also, the biomass of the oysters being cultured in the structures is usually greater than what would normally be found in the wild of that given area.

The nursery phase covers shellfish seed, whether from hatchery or wild stock (Flimlin, 2002). Once obtained, the seed can be nurseried in land-based systems or in the field. Grow out covers the placement of these shellfish seed in the field where they grow to maturity.

2.8.1 Nurseries

2.8.1.1 Land-based Nurseries

Typically, there are two types of land based nursery facilities, the upweller and the raceway. The upweller is a vertical flow-through container that is used for smaller seed. A raceway is a long rectangular horizontal flow-through container in which seed can be grown to a sufficient size for planting in the field. While

hard clams and oysters can be grown for a time in upwellers, oysters must usually be moved into a field site for grow out: clams can be nurseried to larger sizes in a raceway system before planting in the field (Flimlin, 2002).

- Upweller systems –These systems usually consist of individual cylinders or boxes (silos) whose bottom is covered with a mesh material, in which the seed shellfish is placed. The silo is then placed in a large trough or tank so that water can be pumped through. Water is pumped from the estuary into the trough where it rises through the bottom mesh of the silo and exits through a length of pipe that joins the silo to the trough. This continuous flow carries plankton on which the seeds feed.
- Raceways – Once the seeds reach a certain size they may be taken from the silos and placed in raceways. Water is pumped onto one end of the raceway (which can be as long as 30 feet) and flows over the seed and drops off the other end. One advantage to this method is that raceways may be stacked, making much better use of limited waterfront ground space.

Once the seed organisms reach a size where they would be less likely to succumb to environmental constraints or predation, they can be moved to grow out sites until they reach harvestable size.

2.8.1.2 Field-Based Nurseries

Seed can also be raised in a field nursery, however, state, county and local jurisdictions and regulations may require potential culturists to ensure they can obtain proper permits and meet other requirements for growing shellfish in the field (Flimlin, 2002).

2.8.2 Grow-outs

Dependent on the species being cultivated, there are three different methods associated with the grow-out phase of aquaculture, in/on bottom, off-bottom and land-based. Off-bottom culture can be done near bottom, in the water column, or in a surface system. Several of these methods are described below:

2.8.2.1 In/On-Bottom

If the substratum or benthos is consistent with the parameters favorable for a particular species of shellfish, in or on bottom culture, in which the organisms are in contact with the sediment, can be considered. Proper and frequent maintenance is essential for commercial success of a bottom culture system (Buttner, Flimlin and Webster, 1992). Some species such as the hard clam (*Mercenaria mercenaria*) may require in bottom culturing during their later life stages as some studies have revealed that clam seed that were grown out in plastic mesh bags and no substrate resulted in stubby clams that grew much slower than their cohorts that were bottom planted.

2.8.2.2 Off-Bottom

Near Bottom Culture

Generally, this system involves cages or boxes of plastic mesh where the seed is kept just off the bottom, sometimes on racks. As the seeds grow it may be necessary to transfer them to enclosures with increasingly larger mesh. The larger mesh provides better water flow, delivering more food and oxygen while removing wastes (Buttner, Flimlin and Webster, 1992).

Water Column Culture

Several species of shellfish can be raised in containers suspended in the water column. This system can be used to culture bay scallops, mussels, and oysters and is a very common method used in the northern states although ice damage can be an issue. Also, a boat is needed for access, and a good anchoring system is essential (Buttner, Flimlin and Webster, 1992).

Surface Systems

This system usually contains small mesh containers that are used to float shellfish seed near the warmer, surface waters. Phytoplankton tend to be more abundant in shallow water and water flow is usually greater. Surface culture is normally used in the nursery phase of shellfish culture and, occasionally, in final grow out (Buttner, Flimlin and Webster, 1992).

2.8.2.2.1 Typical off-bottom systems

Floating upweller system *(FLUPSY)* - This system is a floating nursery raft with internal bays that hold racks of small shellfish in sieves. They can either be: tethered, open-ended rafts that face into the current and pivot, similar to weather vanes, as the current shifts or electrically powered and part of an existing dock or near shore. The later method is what is typically found in the project area. Water flowing through the system pushes plankton rich water up through the stacked sieves, allowing the shellfish to feed continuously. Most of the FLUPSY systems in the study area are electrically powered and are situated close to shore or are part of an existing dock.

Surface Floats – These systems typically have a rigid PVC frame which can hold up to six plastic mesh bags. These bags can either sit on a wire mesh bottom or can be cable tied onto the PVC frame. Floats are used for buoyancy and these systems are easy to deploy and move; and can be submerged to avoid winter ice. They are inexpensive and easy to build; however, they are limited to quiet sites and not suited for rough waters.

Rack and Bag - These systems are generally used for oysters and scallops, and racks are generally made of wood, plastic or non-corroding metals which resemble a bureau with drawers. These systems are normally suspended several feet off the bottom and are buoyed similar to lobster traps. These systems hold up well to rough weather.

Bottom longline – This system is a length of line that is anchored at both ends and several different types of culture systems can be attached to the lines – typically plastic mesh bags.

Surface floats and racks – This system is primarily a work surface whose floats can hold racks of bags, lantern nets or Dark Sea trays. This system provides a stable work surface and functions similar to a FLUPSY on the surface.

Dark Sea trays – Designed for bay scallops and oysters in single layers. These polyethylene trays are usually square with flattened corners and about 2 feet by 2 feet by 3 inches deep. The large mesh on all sides allows for good water circulation. Seed oysters can fit into smaller-mesh tray inserts. Diagonal ribs divide the tray bottom into four sections and the squared corners help prevent piling of the oysters. Trays get stacked over a central spindle and trays can be stacked 10-15 high which are held in place by posts in each corner. These stacks are hung by the spindle from longlines or rafts or can sit on legs on the bottom, similar to rack and bags. The center attachment keeps the stacks vertical.

Lantern nets – These cylindrical containers are made of nylon netting and are divided into sections and hung from floats. These nets were designed for bay scallops being gown in deep water. Each cage is made of knotted or woven mesh over a wire frame and access is by a hinged door along one side. The door is held closed with two clips which allows for rapid loading and unloading.

Land-based Systems

Land-based systems are used to culture early stages of shellfish. Economic success in using land-based systems for grow out has not been demonstrated, largely because of the high energy costs (Buttner, Flimlin and Webster, 1992).

2.9 Current Shellfish Aquaculture Activities in Peconic and Gardiners Bays

2.9.1 Species Cultivated

The hard clam and the oyster are the two species of shellfish that currently and historically have played an important role in the maritime tradition of aquaculture in Peconic Bay and Gardiners Bay. In addition to the hard clam and oyster, several other species (i.e., bay scallop, sea scallop, blue mussel, soft clam, razor clam) are currently being grown on an experimental basis that involves some sort of off-bottom activity.

Up until the early 1980s, when aquacutlurists began experimenting with off-bottom culture methods, the majority of oyster aquaculture operations in Peconic Bay and Gardiners Bay was performed by transferring oysters from other areas along the east coast of the United States into Peconic Bay and Gardiners Bay for grow-out. Once the oysters matured they were moved to areas in the Great South Bay, Raritan Bay, and other areas around New York Harbor for fattening prior to being brought to market (Timmons et al., 2004). The transfer and grow out were achieved by planting the oysters similar to the in/on bottom activity explained above.

Current hard clam aquaculture in Peconic Bay and Gardiners Bay involves two different methods: cultivating clams (only on private oyster grants), and shellfish transplanting (private oyster grants and TMAUAs). Several private oyster grant owners have been planting and harvesting hard clams under permits being issued by the NYSDEC. The shellfish transplant program entails an aquaculture activity known as relaying, which is the transplanting of shellfish from uncertified waters into clean waters for depuration.

2.9.2 Harvest Methods

The NYSDEC permitting process regulates methods of harvesting and the regulations vary dependent on whether the site to be cultivated is under private or public ownership. Harvesting of shellfish on public underwater land is restricted to hand-operated methods and private underwater land grants have been permitted to use mechanical methods. This Shellfish Lease Program will allow access to the underwater land, but does not regulate harvest methods, which is regulated by NYSDEC. However, regulating harvest methods is a possible means of mitigating the impacts associated with the implementation of the Lease Program; therefore, this DGEIS also analyzes these harvesting methodologies and associated impacts in Section 4.1 of this document.

Historically and currently there are two methods of shellfish harvesting being utilized in Peconic Bay and Gardiners Bay: non-mechanical (hand operated) and mechanical methods, such as dredges. Non-mechanical may include the use of rakes and tongs, as well as direct hand harvest. Mechanical harvesting includes such devices as towed dredges, patent tongs, escalator dredges, dry dredges, and suction dredges. All of these methods are discussed in greater detail in Section 4.1.2.2 of this document.

Section 3
Underwater and Surface Water Uses

3.1 Legal Jurisdictions

3.1.1 Federal Jurisdiction

United States Environmental Protection Agency

The USEPA's mission is to safeguard human health by protecting the integrity of the environment. The USEPA pursues this goal by promulgating regulations and participating in national environmental protection programs and by administering funding to states and municipalities for the development and implementation of environmental plans, policies, projects, and programs. The USEPA sponsors a number of programs that advocate the protection of natural resources such as surface water quality, including various Clean Water Act (CWA) programs, and publishes a variety of environmental protection and planning guidance documents to provide technical support and educational assistance to the public.

As stated in Section 2, USEPA and NYSDEC designated all of the navigable waters of the Peconic Estuary as a Vessel Waste No Discharge Zone, prohibiting vessels from discharging *any* sewage, raw or treated, into the estuary, and requiring vessels with holding tanks to use pump-out facilities. Therefore, lessees in the Shellfish Cultivation Zone will not be required to comply with SPDES requirements, by virtue of operating in the Peconic Estuary Vessel Waste No Discharge Zone, with all wastes disposed of at pump-out facilities.

US Department of Interior

There are two agencies within the US Department of Interior which are directly involved with shellfish aquaculture-related activities. These agencies are the USFWS and the National Park Service (NPS).

The USFWS has jurisdiction over the protection of migratory birds, federally-listed endangered species, marine mammals, and freshwater and andromous fish. The USFWS's responsibilities include, but are not limited to, management and operation of the National Wildlife Refuge System and numerous national fish hatcheries, fishery resource offices and wildlife field stations; enforcement of national wildlife laws; and restoration of wetlands and implementation of wetlands protection regulations. The USFWS has regulatory control over federally endangered wildlife species, such as sea turtles and marine mammals, which may be affected by shellfish aquaculture activities. Also, the USFWS manages and operates the Morton National Wildlife Refuge located in the Town of Southampton, on the peninsula which separates Little Peconic Bay from Noyack Bay (also known as Jessups Neck), and the Conscience Point National Wildlife Refuge, located in North Sea

The involvement of the NPS is limited to those areas contained within local Historic District boundaries, as well as properties in, or likely to be nominated for inclusion in the National Register of Historic Places. Since the boundaries of the Shellfish Cultivation Zone are located 1,000 feet offshore, it is not expected that the Shellfish Cultivation Zone contains any local Historic Districts.

United States Army Corps of Engineers (USACOE)

The USACOE has regulatory jurisdiction over all construction or filling activities taking place in the waters and wetlands of the United States. The enabling legislation granting authority to the agency includes § 10 of the Rivers and Harbors Act of 1899, § 404 of the CWA and § 103 of the Marine Protection, Research and Sanctuaries Act of 1972. Section 404 governs the permitting process for discharge of dredged or filled material. The USACOE also retains primary authority over federal flood and coastal erosion projects. As stated in Section 2 above, the USACOE has a newly created Nationwide Permit, NWP 48, for existing commercial shellfish aquaculture activities; while new commercial

shellfish aquaculture activities require individual permits, to be reviewed by the USACOE's New York District Aquaculture Programs unit.

National Oceanic and Atmospheric Administration (NOAA)

The overall mission of NOAA is to assess and forecast alterations in environmental conditions and to conserve and appropriately manage the coastal and marine resources of the United States. There are several divisions and offices within NOAA which are important for shellfish aquaculture activities.

The Office of Ocean and Coastal Resources Management is responsible for administering the Federal Coastal Zone Management Program, authorized under the Coastal Zone Management Act (CZMA) of 1972. According to the CZMA, any federal agency activity within or adjacent to the coastal zone of a state, affecting any land or water use, or natural resources, shall be carried out in a manner consistent with the enforceable policies of the state's approved management program.

The National Weather Service is responsible for issuing weather forecasts and coastal storm warnings. The National Ocean Service is responsible for conducting bathymetric surveys and preparing nautical charts used by boaters for navigation; for publishing tide tables; and for determining changes in sea level.

In order to implement its many marine resource management objectives, NOAA also created the National Marine Fisheries Service (NMFS), which is responsible for rebuilding and maintaining the health of coastal marine habitats. The NMFS, and its local council, the Mid Atlantic Fishery Management Council, are responsible for reviewing and commenting on federal state and local actions, most likely including the Suffolk County Aquaculture Lease Program. The Mid Atlantic Fishery Management Council typically reviews Essential Fish Habitat Assessments developed by applicants and if certain conditions are met, will authorize such activities, either through an exempted fishing permit or through a

letter of authorization. Also, as stated in Section 2, above, NMFS reviews USACOE permit applications to determine whether the proposed permit activities may affect endangered marine species, particularly sea turtles in the Peconic Estuary.

United States Coast Guard (USCG)

The USCG maintains an important presence in Long Island's coastal waters and provides a variety of invaluable services which promote the safety and security of the nation's waters. The Coast Guard is responsible for: patrolling off-shore areas; enforcing maritime laws, including recreational vessel and commercial shipping controls and illegal drug trade interdiction; responding to oil and hazardous materials spills; performing emergency searches and rescues; and performing military duties during times of war. Within the Peconic Estuary, the USCG is responsible for undertaking general law enforcement activities, such as imposing fines and/or penalties for reckless or negligent vessel operation and conducting marine inspections of recreational boat safety equipment. Permits issued by the USACOE for the marking of structures used for shellfish aquaculture, such as buoys and anchoring devices for cages, will be conditioned on compliance with the Coast Guard's Aids to Navigation regulations (Code of Federal Regulations, CFR Titles 33 and 46).

U.S. Food and Drug Administration (USFDA)

The USFDA, within the Public Health Service of the Department of Health and Human Services, participates in a federal/state cooperative program, the National Shellfish Sanitation Program (NSSP), for the sanitary control of shellfish produced and sold for human consumption. It is the USFDA's primary role to conduct systematic surveys of state laws and regulations, to ensure that state shellfish sanitation programs meet uniform minimum requirements, which are contained in the NSSP's Guide for the Control of Molluscan Shellfish, including the NSSP Model Ordinance. Under this program, the states have the responsibility for development of laws, regulatory schemes and enforcement

strategies, meeting or exceeding these minimum requirements. New York State is a participant in this program, and is a founding member of the Interstate Shellfish Sanitation Conference (ISSC) which also recognizes the NSSP, agreeing to enforce the Model Ordinance as minimally necessary for the sanitary control of shellfish. The NYSDEC is the regulatory agency charged with the implementation and enforcement of the provisions of the NSSP in New York.

3.1.2 New York State's Jurisdictional Authority over Navigable Waters and Submerged Lands

The Public Trust Doctrine

It is recognized in the US that a state has a sovereign right to hold in public trust lands, waters and living resources for the benefit of all people, under the legal doctrine known as the Public Trust Doctrine (NYSDOS, South Shore Estuary Reserve Technical Report, 1997). The New York Court of Appeals holds that it is an incident of state sovereignty which cannot be surrendered, alienated or delegated, except for some public purpose, or some reasonable use for the public's benefit. This doctrine was codified, in part, into State law in 1992, with an amendment to the Public Lands Law, in Article 6 Section 75 (New York State Legislature, Laws of New York, 9/18/2007). The legislative intent stated for enacting this amendment was to ensure consistency with the public's interest in the reasonable use and responsible management of the common resources of the State, including its waterways, for navigation, commerce, fishing, bathing, recreation, environmental protection, aesthetic qualities, and public access to the navigable waters and submerged lands. The Office of General Services grants, leases, and otherwise permits use of state-owned underwater lands, as authorized by the Public Lands Law.

The State's jurisdiction and ownership of offshore waters and submerged lands beneath these waters are also defined in Section 7-a, Article 2 of the State Law (Id. 9/18/2007). This law defines the State's jurisdiction as extending to waters

offshore from the coasts, including all submerged lands beneath the offshore waters. The State ownership of offshore waters and submerged lands excludes locations held by any other person by virtue of a valid and effective instrument of conveyance, or by operation by law (subsection 2, section 7-a, Article 2 of the State Law), and is stated not to impair the "exercise of legislative jurisdiction by the United States…" over offshore waters and submerged lands owned by the US.

Chapter 425 of the Laws of 2004 repealed Chapter 990 of the Laws of 1969, creating ECL § 13-0302, whereby the State ceded its interests to the County, granting it the right to lease underwater lands in the Peconic Bay and Gardiners Bay for a shellfish aquaculture program. This provision also provides that if no leases are executed by the County by the end of 2010, the County's authority to lease the underwater lands will be extinguished, and the lands revert to the State.

Control over Navigable Waters by Local Governments in Suffolk County

The State has the sole authority and control over navigable waters, and local governments have only limited authority to regulate surface water activities, as delegated to them by the State Legislature. The Navigation Law (NYS Legislature, Laws of New York, 9/18/2007) defines its jurisdiction over "navigable waters of the state" to mean "all lakes, rivers, streams and waters within the boundaries of the state and not privately owned, which are navigable in fact or upon which vessels are operated, *except all tidewaters bordering on and lying within the boundaries of Nassau and Suffolk County*" (Subsection 2 of Section 46-a of the NYS Navigation Law, italics added). Thus, the Navigation Law excludes from its definition of "navigable waters" State coastal waters within Suffolk and Nassau Counties, which includes the Peconic Estuary. Town's and local government's authority over surface water activities in the Peconic Estuary are discussed below.

New York State Department of Environmental Conservation

The NYSDEC's primary regulatory responsibilities relative to shellfish aquaculture activities includes: implementation and enforcement of the National Shellfish Sanitation Program; regulatory control and administration of the Fish and Wildlife Law; regulatory control and administration of the State's Protection of Waters Program; regulation and administration of the State's programs in compliance with the federal CWA, such as the SPDES program; and the regulation and administration of SEQRA.

One of the NYSDEC's important duties under the NSSP is the classification of all shellfish beds on the basis of regular water quality analyses. The NYSDEC's obligations under the NSSP and the Fish and Wildlife Law also include: administering the permit program for commercial shellfishing, enforcing shellfish sanitation regulations; enforcing pollution discharge regulations; enforcing shellfish harvesting restrictions and prohibitions with the assistance of the town and village, and the County, agencies; and providing access to shellfish growing areas. Identification of the controlling regulations and the NYSDEC regulatory programs are more fully discussed in Section 2.7.2 New York State Requirements, above.

The NYSDEC Protection of Waters Program regulations found in 6NYCRR Part 608 were promulgated to prevent undesirable activities on water bodies, complying with the statutory goals for the preservation, protection and enhancement of the State's water resources. NYSDEC Division of Environmental Permits Office for Region 1 (Stony Brook, New York) is the State's office in charge of its Protection of Waters Program for the Peconic and Gardiners Bays.

NYSDEC regulations for SPDES, which implements the Federal Clean Water Act through the NYSDEC, are found in 6NYCRR Part 750. However, as stated previously in Section 2, lessees in the Shellfish Cultivation Zone will not be

required to comply with SPDES requirements, by virtue of operating in the Peconic Estuary Vessel Waste No Discharge Zone.

The provisions of SEQRA, found in 6NYCRR Part 617, require all levels of government in New York State to fully disclose the potential impacts associated with a proposed action. This law is administered by the "lead agency," as designated during the SEQRA lead agency review process for each project. This DGEIS is part of the County's compliance with SEQRA.

New York State Department of State

As the State's designated coastal management agency, the NYSDOS, through the Division of Coastal Resources and Waterfront Revitalization, is responsible for administering the New York State Coastal Management Program as well as coordinating activities essential to the program's implementation. Major responsibilities of the NYSDOS include the review and certification of proposed State or federal activities for consistency with the State's CMP. Actions that are deemed to be inconsistent with the CMP are not permitted to proceed. Additionally, NYSDOS provides assistance to communities for the preparation of Local Waterfront Revitalization Programs (LWRPs) and Harbor Management Plans (HMPs). NYSDOS, in coordination with the NYSDEC, also administers the State's Significant Habitat Program.

3.1.3 Towns and Local Governments in Suffolk County

Towns and incorporated villages within Suffolk County are granted the authority to adopt, amend and enforce their own laws, rules and regulations over vessels (including commercial vessels) on the tidal waters over lands adjacent to and within the town's and village's geographical boundaries, up to a distance of 1,500 feet from shore. These local rules may control the operation, speed, anchoring and mooring of vessels (and other specified related activities) within such geographical boundaries. The statutory authority enabling these local

governmental entities can be found in New York's Town Law and Navigation Law, discussed below.

According to New York State Town Law, Article 9, Section 130, subsection 17, towns in Suffolk County (and Nassau County) may regulate the speed and operation of vessels, and the mooring and anchoring of all vessels (and other specified activities) in all tidal waters over lands within the geographical boundaries of such towns, to a distance of 1,500 feet from shore. However, the law's restrictions prohibit the "1,500-foot rule" from extending into the jurisdiction of another town, or into the jurisdiction of an incorporated village within a town. The law also prohibits a town's rulemaking from interfering with access to federally designated and maintained shipping channels.

Incorporated villages within the boundaries of Suffolk County are vested with jurisdiction to regulate the speed and operation of vessels, and the mooring and anchoring of all vessels(and other specified activities) in all tidal waters over lands within the geographical boundaries of such cities and villages, to a distance of 1,500 feet from shore. This jurisdiction is granted through subdivision one of Section 46-a of the NYS Navigation Law.

The Study Area includes the Towns of Riverhead, Southold, Southampton, Shelter Island, and East Hampton, and the Incorporated Villages of Greenport, North Haven, Sag Harbor, and Dering Harbor. The town boundary lines are shared within the Peconic Bay and Gardiners Bay areas. However, it should be noted that within the Peconic Estuary, all of the town boundary lines extend beyond the 1,500 foot town jurisdictional limit. Therefore, the enforcement of federal regulations regarding vessel operations, speed, moorings, and anchoring past the 1,500 jurisdictional limit of each town are likely regulated by US Coast Guard.

Also, as stated in Section 2 above, according to the State Waterfront Revitalization of Coastal Areas and Inland Waterways Act, New York State agency actions (permitting and/or approvals) with respect to applicants in the County's Lease Program, must first be considered according to SEQRA. If the action is Type I or Unlisted, the agency must submit a Coastal Assessment Form to the NYS Secretary of State prior to the agency's determination of significance according to SEQRA. State agency activities listed in an approved Local Waterfront Revitalization Program (LWRP) are also subject to consistency procedures. To date, the Town of Southold (Town of Southold LWRP, 10/8/2007), the Town of East Hampton (Town of East Hampton LWRP, 10/8/2007), the Village of Greenport and the Village of Sag Harbor have State-approved LWRP's which must be considered in the development of the County's Lease Program.

Control Over Submerged Lands by Local Governments in Suffolk County

The towns located in the study area include Riverhead, Southold, Southampton, Shelter Island, and East Hampton; of which all but Riverhead were formed by British governors during the 17th Century. These British governors granted land patents, conferring ownership from the Crown for the right to form incorporated municipal entities, know as Towns. According to John Aldred, from the Town of East Hampton, the Town Trustees acted in all matters of governance well into and perhaps beyond the 19th century at which time there was a division of responsibility. The Trustees governed the land, waterways and submerged lands held as common lands, which did not include lands held by others pursuant to a then pre-existing deed or grant; and a Town Board which governed all other town matters. These patents were specific as to the lands granted, and the nature and the extent of powers vested into the newly created towns. When the United States was forming, New York State's Constitution of 1777 recognized these patents, and other applications of English Common Law, until further actions by the legislature modified these legal traditions. The town patents were again recognized, and authorized to continue as part of the Act of 1788, which divided

the State into counties, and counties into towns. Suffolk County, of course, was also pre-existing, having been organized in 1683, and recognized in the Act of 1788. The Town of Riverhead was later formed from the Town of Southold in 1792. Some of the towns in the study area retain the bifurcated governmental structure of a Board of Trustees and a Town Board, while others combined the two entities. Incorporated villages, such as the Village of Greenport and the Village of Sag Harbor, were later formed during the 19th Century.

The patents granted to the towns in the study area include:

- East Hampton- Incorporated under the Governor Nicoll Patent on March 13, 1666 and replaced by the Dongen Patent in 1686;
- Shelter Island- Granted under the Governor Nicoll Patent on May 31, 1666, organized with Southold until 1730, and incorporated on March 7, 1788;
- Southampton- Incorporated under the Governor Andros Patent on November 1, 1676; and
- Southold- Incorporated under the Governor Andros Patent on October 30, 1676.

This local history is important in understanding the complicated nature of jurisdictional control of the Peconic Bay and Gardiners Bay study area. The towns still retain jurisdiction over submerged lands, including portions of such lands beneath the tidal waters/navigable waters based on grants. Some of this was ceded to the incorporated villages. The towns have their own codes relating to commercial shellfishing within the jurisdictional boundaries. Private grants relating to oyster collection exist outside of these common areas are also controlled by the towns. New York State, under the Public Trust Doctrine, codified in Section 75, Article 6 of the Public Lands Law (New York State Legislature, Laws of the State of New York, 10/8/2007), has sovereignty over public lands, waters and living resources, but excludes from its jurisdiction the patent lands beneath town tidewaters. Outside of these areas, the State has its

own laws relating to shellfishing. These State and local laws are discussed further below.

Towns, and incorporated villages within these towns are empowered by State laws (Town Law and Navigation Law) to regulate vessels, and activities relating to vessels, in the tidal waters located within jurisdictional boundaries, up to 1,500 feet from the shorelines. This is important because these various rules affect the operation, mooring and anchoring of vessels for commercial shellfishing, separately from the ownership of the submerged lands, and the laws relating to activities on the bottom.

Suffolk County holds title to certain submerged lands due to the return of oyster grant land to the County through either tax foreclosures or eminent domain.

3.2 Ownership of underwater lands

3.2.1 Oyster Grants

Beginning in the mid 1880s underwater lands in the Peconic and Gardiners Bays were granted by the County to private individuals for the purpose of oyster cultivation. Oyster grant lands consisted of four-acre parcels which were issued in perpetuity, as long as annual property taxes were paid by the grant holder.

Since its conception in 1884, significant amendments (1896, 1906 and 1923) were made to the Chapter 385 legislation including: increasing the acreage from four to 25 acres (1896), specifying ten bushels of oysters per acre as a minimum to be planted by each grantee within one year (1896); and extending the one year cultivation stipulation to three years (1906). Also, in lieu of automatic reversion, the amendment of 1906 required an order of the Supreme Court, based on a finding of bad faith on the part of the grantee, to effect the reversion. The 1923 amendment altered the description of the land ceded to the County to include "lands underwater of Gardiner's Bay and the Peconic Bays and the tributaries there of" (L1923, ch 191). During the period of 1885-1914, a total of 45,081.5 acres of underwater lands were granted by the County, accounting for

approximately 40% of the total area of the bays (Suffolk County Department of Planning, 2002). Over time, however, the majority of these lands have reverted back to the County because of non-payment of taxes.

In 2006 through the end of 2007 in an effort to determine the approximate size and location of existing oyster grant parcels, a full title search of the 555 underwater land parcels within the Peconic and Gardiners Bays was conducted by Suffolk County Division of Real Property Acquisition and Management. According to the title search**,** there are 65 tax map parcels which encompass 75 privately held oyster grant parcels mapped within the study area, totaling approximately 5822.1 acres of underwater land. Fifteen of the mapped oyster grants currently have title conflicts, which total 1,165.5 acres (Suffolk County Department of Planning, 2008). The majority of the oyster grants are situated seaward of the 1,000 foot shoreline buffer zone. However, some appear to entirely or partially lie within the 1,000-foot shoreline buffer. The majority of the oyster grants lie within the waters surrounding Shelter Island. The following table represents the location and size of the private oyster grants to date. The map ID for each oyster grant parcel in Table 2 corresponds to the numbering system depicted on Figure 4.

Table 2. Existing Privately-owned Tax Map Parcels in the Peconic Estuary and Number of Oyster Grants on Each Parcel, as of February 2008

Map ID	Location	Acreage	Number of Grants	Other Species Cultivated
1	Great Peconic Bay	225	1	
2	North Race	40	1	
3	Little Peconic Bay	334	6	
4	Hog Neck Bay	60	1	
5	Little Peconic Bay	263	1	
6	Southold Bay	357	1	
7	Southold Bay	31	2	
8	Southold Bay	30	1	Hard clam
9	Southold Bay	13	1	
10	Southold Bay	37	1	Hard clam
11	Pipes Cove	199	2	

12	Pipes Cove	15	1	Hard clam, bay scallop
13	Orient Harbor	124	1	
14	Gardiners Bay	78	1	
15	Gardiners Bay	197	1	
16	Gardiners Bay	60	1	
17	Great Peconic Bay	35	1	
18	Great Peconic Bay	82	1	
19	Great Peconic Bay	101	1	
20	Great Peconic Bay	71	1	
21	Gardiners Bay	1	1	
22	Gardiners Bay	106	1	
23	Napeague Bay	118	1	
24	Napeague Bay	58	1	
25	Gardiners Bay	32	1	
26	Gardiners Bay	65	1	
27	Gardiners Bay	100	1	
28	Gardiners Bay	86	1	
29	Shelter Island Sound	6	1	
30	Shelter Island Sound	33	1	
31	Shelter Island Sound	6	1	
32	Shelter Island Sound	23	1	
33	Shelter Island Sound	39	1	
34	Deering Harbor	8	1	
35	Sag Harbor Cove	0. 58	1	
36	Shelter Island Sound	50	1	
37	Pipes Cove	3	1	Hard clam, bay scallop
38	Gardiners Bay	115	1	
39	Gardiners Bay	298	1	
40	Gardiners Bay	285	1	
41	Gardiners Bay	246	3	
42	Gardiners Bay	83	1	
43	Gardiners Bay	205	1	Hard clam, bay scallop
44	Southold Bay	57	2	
45	North Race	71	1	
46	Southold Bay	18	1	
47	Shelter Island Sound	6	1	

48	Shelter Island Sound	2	1	
49	Shelter Island Sound	144	1	
50	Flanders Bay	40	1	Hard clam, bay scallop
51*	Great Peconic Bay	3	1	
52*	Little Peconic Bay	28	1	
53*	Little Peconic Bay	27	1	
54*	Great Peconic Bay	3	1	
55*	Great Peconic Bay	50	1	
56*	Great Peconic Bay	74	1	
57*	Great Peconic Bay	191	1	
58*	Little Peconic Bay	477	1	
59*	Great Peconic Bay	19	1	
60*	Little Peconic Bay	5	1	
61*	Gardiners Bay	60	1	
62*	Southold Bay	6	1	
63*	Gardiners Bay	126.5	1	
64*	Gardiners Bay	47	1	
65*	Napeague Bay	49	1	

* Oyster grant parcels with title conflicts Source: Suffolk County Department of Planning, 2008

3.2.2 Temporary Marine Area Use Assignments

In 1982, New York State Department of Environmental Conservation (NYSDEC) developed the Temporary Marine Area Use Assignment (TMAUA) program under an agreement with the New York State Office of General Services (NYSOGS) and a Memorandum of Understanding with Suffolk County. The TMAUA program was designed to promote small scale off-bottom shellfish cultivation in state-owned underwater lands in the Marine and Coastal District. This program was developed as an interim program until a lease program could be developed by Suffolk County. NYSDEC is granted the authority to permit on-bottom and off-bottom shellfish culture in the Peconic and Gardiners Bays under the Environmental Conservation Law (ECL), Section 13-0316 and Part 48 of 6NYCRR. Although NYSDEC has the authority to permit on-bottom shellfish

cultivation within the Peconic Estuary, only off-bottom permits are currently administered in the TMAUA program.

Approximately 150 acres of the State-owned underwater lands in the Peconic and Gardiners Bays that have never been granted for oyster culture are currently used as temporary assignments. In order to be consistent with the provisions of New York State Law, the NYSDEC intended that all of the temporary use assignments be issued a minimum of 1,000 feet from the shoreline, although some currently issued assignments appear to fall within this buffer. Assignments consist of circular plots generally 5-acres in size, with a 250-foot radius from the central point. Permit holders are authorized to culture shellfish species such as oysters, hard clams and scallops, which must be contained in off-bottom culture gear only (i.e., racks and bags, cages). According to NYSDEC, assignments are not issued in areas which support established commercial fishing, crustacean or shellfish activities, or in areas that support current or traditional bay scallop harvesting.

To obtain a temporary assignment, applicants must submit a request to NYSDEC Bureau of Marine Resources with the desired location of the culture site and species to be cultivated. All applications are reviewed by NYSDEC, US Army Corps of Engineers, the US Coast Guard, NYS Department of State and Suffolk County. Public notices for each application are issued to the New York State Shellfish Advisory Committee, the local Town Supervisor, Town Trustees, and other interested parties. In addition, all applications are subject to a 30-day public comment period. TMAUA applications that receive significant negative comment during the public comment period are denied, or the location is adjusted to one acceptable to all involved parties (Debra Barnes, NYSDEC Bureau of Marine Fisheries, personal communication, May 2007). The application review process for a temporary assignment takes approximately 3-6 months, and in some cases up to one year. Temporary use assignments are issued on an annual basis and require an annual renewal process. Special permits (i.e., shellfish culture permit) must be obtained through NYSDEC by the applicant prior to cultivating shellfish on the temporary assignment.

At present, there are 32 temporary assignments issued to private individuals and/or commercial businesses (Table 3). The temporary assignments account for approximately 150 acres of the Peconic Bays. Two of the temporary assignments holders have applications yet to be approved by NYSDEC and are in "pending" status. Almost half of the temporary assignments are situated within the Town of Southold, with 15 assignments. Twelve temporary assignments fall within the Town of Southampton, and four are located within the Town of Riverhead. There are currently no temporary assignments within the Towns of East Hampton and Shelter Island. There was interest by baymen from East Hampton to obtain temporary assignments within East Hampton Town's jurisdictional boundary, but opposition from the baymen associations during the public comment period dissuaded NYSDEC from issuing the permits (Debra Barnes, NYSDEC Bureau of Marine Fisheries, personal communication, June 2007). The following table (Table 2) represents the current temporary assignments within the Peconic Estuary issued by NYSDEC, as of May 2007.

In 2001, NYSDEC conducted a survey of all Temporary Assignment permit holders regarding their shellfish culture practices and concerns. Of the approximately 30 permit holders, thirteen responded. According to the survey, nearly all responding permit holders reported growing oysters (85%) while only about 35% were actively growing hard clams and scallops (Timmons, et al., 2004). Over 50% indicated that the 5 acre-plot was sufficient for their cultivation needs, and 35% felt it was too little. The map ID for each TMAUA parcel corresponds to the numbering system depicted on Figure 4.

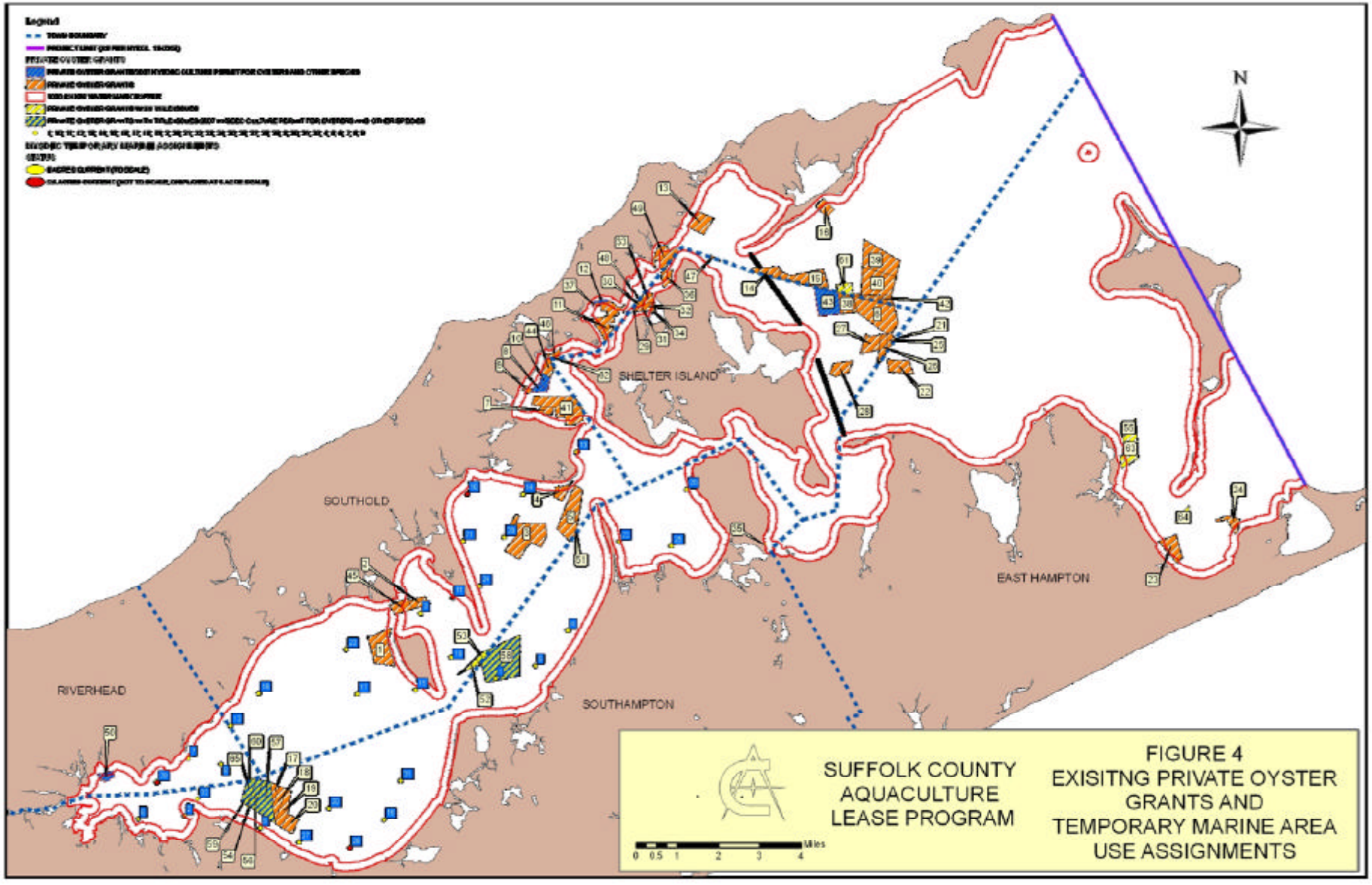
Table 3. Current NYSDEC Temporary Marine Area Use Assignments in Peconic and Gardiners Bays

Map ID	Date Issued	Species Cultivated[1]	Radius (ft)	Gear Permitted	Comments
1	1/2/1985	HC, EO	250	70 - 8'x8'x7' wood racks	Raritan Bay relay site
2	7/21/1993	HC, EO, BM, SC	250	150 – 4'x4'x11" vinyl coated wire mesh cages	
3	9/12/1995	HC, EO, BS, BM, SC	250	250 – 4'x7'x1" vinyl coated wire mesh	
4	11/13/1995	EO	250	400 - 36"x18"x3.5" plastic cages	
5	11/13/1995	EO	250	400 – 36"x18"x3.5" high plastic cages	
6	6/2/99 (original) 1/5/06 (re-issued)	EO, HC, BS	250	50 - 3'x3'x3' vinyl coated wire mesh cages	
7	8/18/2000	EO, HC, BS	250	300 - 36"x18"x2" plastic mesh cages	
8	10/6/2000	EO, HC, SC, BM, BS, RC	250	100 - 6'x10'x5' cages 500 - 36"x20"x2.5" plastic mesh bags	
9	10/10/2000	EO, HC, SC, BM, BS, RC	250	100 - 6'x10'x5' cages 500 - 36"x20"x2.5" plastic mesh bags 10 - 10'x6' upweller rafts with 3'x3' trays	
10, 11	1/2/2001	EO, HC, SC, BM, BS	187 each	300 - 6'x3'x4' wire mesh cages at each site	
12	4/5/2001	EO, HC, BM, BS	250	200 - 2.5'x3'x4.5' steel and plastic mesh cages	
13	7/24/2001	EO, BS	250	200 - 3'x3'x3' vinyl coated wire mesh cages	
14	7/29/2002	EO, HC, BM, BS, SC	250	400 - 6'x3'x4' wire mesh and wood cages each containing up to 12 poly mesh shellfish bags	
15	10/7/2002	EO, HC, SC, BS	250	500 - 3'x3'x2' plastic mesh cages	
16	7/16/99 (original) 7/7/03 (re-issued)	EO, HC, BS	250	50 - 3'x3'x3' vinyl coated mesh cages	
17	4/9/2004	EO, BS	250	60 – 50"x36.5"x36.5" cages	
18	4/26/2004	EO, BS	250	70 - 50"x36.5"x36.5" cages	

19	7/25/97 (original) 1/27/05 (re-issued)	EO, HC, BS	250	200 - 54"x36"x24" steel and plastic mesh cages	
20	9/14/2005	EO, HC, BS	250	200 - 42"x36"x36" steel and plastic cages	
21	10/3/2006	EO, HC, BS	250	250 - 3'x18"x3" cages	
22	11/6/2006	EO, HC, BS, BM, SC	250	300 - 4.5'x4.5'x2' cages	
23	11/6/2006	EO, HC, BS, BM, SC	250	300 - 4.5'x4.5'x2' cages	
24	1/10/2008	EO, HC, BS	250	200 - 42"x36"x36" steel and plastic cages	
25	1/17/2008	EO	250	250 - 4'x3'x3" mesh cages	
26	pending	EO	250	10 - 4.5'x3'x2' mesh cages	
27	1/10/2008	EO, BS	250	1,056 - 2'x3'x3" shellfish bags on long lines	
28, 29	9/9/2004	EO	180 each (2.5 ac ea)	100 - 3'x3'x3' cages	
30	1/10/08	EO, BS, HC, BM, SS	250	1,200 - 30"x30"x96" cages; 400 - 20"x8' lantern nets; 500 - 20"x24" pearl nets ; and up to 15,000 - 20"x40"x3" shellfish bags	
31	pending	EO	250	75- 4'x4'x4" mesh cages	
32	pending	EO	250	100- 3'x4'x4' cages	

[1]EO – Eastern oyster, HC– Hard clam , SC – Soft clam, BS – Bay scallop, SS – Sea scallop, BM – Blue mussel, RC – Razor clam

Source: NYSDEC, Bureau of Marine Resources, 2008


Legend
N
SHELTER ISLAND
SOUTHOLD
EAST HAMPTON
RIVERHEAD
SOUTHAMPTON
SUFFOLK COUNTY
AQUACULTURE
LEASE PROGRAM
FIGURE 4
EXISITNG PRIVATE OYSTER
GRANTS AND
TEMPORARY MARINE AREA
USE ASSIGNMENTS
Miles
0 0.5 1 2 3 4

3.3 Other Shellfish Aquaculture Programs

3.3.1 State Relay Programs

NYSDEC administers a hard clam relay program in which clams harvested from the uncertified waters of Raritan Bay, Staten Island, are transplanted into the clean waters of the Peconic Estuary for natural depuration. During the months of April through October, hard clams are harvested from Raritan Bay and transplanted to off-bottom culture racks in Little Peconic Bay. The clams remain in the estuary for at least 21 days until they are free of bacteria accumulated from the uncertified waters and safe for market consumption.

In 2002, clams in Raritan Bay were diagnosed with Quahog Parasite Unknown (QPX), a protozoan parasite detrimental to hard clams, causing significant mortalities to the clam bed. As a result, NYSDEC cancelled the Raritan Bay relay program in order to prevent the potential introduction of the disease to the waters of the Peconic Bays. After an extensive monitoring program showed a significant drop in the overall prevalence of QPX in Raritan Bay, NYSDEC reopened 2,600 acres of the 10,400 acres to transplant harvest in May 2005.

The current relay site in the Peconic Estuary is located on a TMAUA site in Little Peconic Bay that has been receiving relay clams from Raritan Bay since the start of the program in 1987. Clams are also transplanted to an adjacent oyster grant parcel. Until a closure of the digging site in Raritan Bay in 2002 because of the presence of QPX, the larger clams (chowders) transported to the oyster grant parcel were permitted to be planted on bottom, but the majority of the clams were held in off-bottom racks for the natural depuration process. When relay to the Peconic Estuary was resumed in 2005 all relayed clams were required to be placed off-bottom in racks or cages (Debra Barnes, NYSDEC Bureau of Marine Fisheries, personal communication, November 2007). In the past, other relay sites in the Peconic included NYSDEC-issued temporary assignments and oyster grants. Hard clams were transplanted to oyster grant lands located in Southold

Bay until 2002, where they were held in off-bottom culture cages (Debra Barnes, NYSDEC Bureau of Marine Fisheries, personal communication, June 2007).

3.3.2 East-End Town Aquaculture Programs

Town of Riverhead

The Town of Riverhead currently operates a clam raft program located within the tidal creek channel at Jamesport Town Beach. The program was first initiated in 1984, as an aquaculture demonstration project for the grow-out of hard clams. The Town currently conducts a clam seeding program in East Creek, where approximately 300,000 seed clams are cultured on an annual basis. The program was developed by the Town as a public project for recreational harvesters (David Lessard, Town of Riverhead, personal communication, June 2007). Clams from this project are broadcast to Town waters, within 1,000 feet of the shoreline.

The Town of Riverhead has license agreements with two commercial oyster companies, AEROS Cultured Oyster Company and Twin Fork Oyster Company, which allows for oyster cultivation within the waters of East Creek. Both companies are permitted under their agreement to install oyster nursery systems consisting of floating upwellers systems (FLUPSY).

Town of East Hampton

The Town of East Hampton has been involved with shellfish aquaculture programs for the past 20 years, and currently operates a shellfish hatchery in Fort Pond Bay, Montauk. The hatchery was created in 1989 for the purpose of establishing a shellfish seeding program to restock public beds within the Town and surrounding State waters. Approximately ten million seed shellfish, consisting of clams, oysters and bay scallops, are produced annually at the hatchery, ten percent of which are used to seed State waters (East Hampton Town Shellfish Hatchery Website, May 2007).

Reared shellfish are transported from the hatchery to the juvenile nursery system located in Three Mile Harbor. Off-bottom grow-out systems consisting of rafted trays and suspended nets are placed in Napeague Harbor in Amagansett in late summer and fall. The clams reach a harvestable size within three to five years, the oysters within two to three years, and the scallops in one year.

During the mid 1980s, NYSDEC-sponsored clam transplant projects involving the transplant of hundreds of bushels of clams from areas permanently closed to shellfishing (e.g., Little Neck Bay, Queens, NY) to Town waters were undertaken by the Town (Larry Penny, Town of East Hampton, personal communication, May 2007).

From 2000 through 2007 (excluding 2005), the East Hampton Town Trustees jointly participated in approximately six oyster transplant projects from Oyster Pond in Montauk. In 2006, and 2007, 300 and 400 bushels respectively of adult oysters native to East Hampton were transplanted from Oyster Pond to Accabonac Harbor.

From 2003 to 2006, the East Hampton Town Trustees established a seed clam grow out project in Trustee-owned waters. Approximately 350,000 clams (>1 cm in length) were distributed equally on an annual basis in Napeague Harbor and Accabonac Harbor in off-bottom aquaculture gear. However, due to a high mortality rate (25-50% prior to deployment), this project was terminated in 2007 (John Aldred, Town of East Hampton, personal communication, May 2007).

The Town Trustees also worked with Multi Aquaculture Systems, a fish hatchery in Amagansett that raises fluke, flounder and sea bass. Beginning in 2003, the Town supported a program in which flounder raised in aquaculture tanks were released to local waters in an effort to help rejuvenate depleted fish stocks. The program was suspended in 2006 due

to permit approval disputes between NYSDEC, the Town and Multi Aquaculture Systems.

According to Policy 10A (Aquaculture/Mariculture) of East Hampton's recently adopted LWRP, the Town encourages aquaculture and mariculture which benefits overall public stocks of living marine resources, but discourages aquaculture or mariculture inconsistent with maintaining healthy stocks and habitats. These guidelines reflect the concerns of the Town about the use of public waters and bottomlands for private benefit, and a cautionary approach to environmental problems arising from aquaculture in other regions. The Town's policy encourages public aquaculture that enhances stocks and discourages large scale private aquaculture/mariculture, particularly finfish aquaculture.

Town of Southampton

The Town of Southampton Trustees are currently involved with several spawner sanctuary programs throughout the Town in partnership with The Nature Conservancy (TNC). Currently, there are nine Town-designated shellfish spawner sanctuaries within the inland waters of the Peconic Estuary. These sites are described below.

Scallop spawner sanctuaries are located in Scallop Pond, Sag Harbor Cove, Sebonac Creek, and West Neck Creek. Scallop seed purchased and provided by TNC, is planted in off-bottom culture gear in Scallop Pond. When the scallops reach a size of approximately 1 to 2 inches, they are distributed throughout Sag Harbor Cove, and Tiana Bay (located outside of the Peconic Estuary), in equal amounts. Approximately 500,000 scallops were planted in Scallop Pond in 2007, an increase from 200,000 in 2006 (Ed Warner, Town of Southampton, personal communication, May 2007). In 2006, approximately 50,000 scallops were placed in the waters of Sag Harbor Cove. As part of this program, scallop spat is

collected by the Town during spawning to determine the effectiveness of natural reproduction in the cove waters. In Sebonac Creek, scallops provided by TNC are placed within existing eelgrass beds, where survival rate is greatest.

Hard clam spawner sanctuaries, also in partnership with TNC, are located in the south side of Mill Creek, North Sea Harbor and Red Creek Pond. In addition, the Town has designated a hard clam sanctuary in Cold Spring Pond. Clams for the Cold Spring Pond sanctuary are purchased through the Cornell Cooperative Extension in Southold.

In addition to the spawner sanctuaries within the Peconic Estuary, Southampton Town and TNC established nine spawner sanctuaries in Town waters along the south shore. The Town is currently seeking to obtain a permit from NYSDEC to transfer a portion of the natural scallop stock in a small inland pond on a golf course to the waters near West Neck Creek (Ed Warner, Town of Southampton, personal communication, June 2007).

Town of Southold

Since 1980, the Town of Southold has been actively involved in restoring the shellfish resource in local waters through aquaculture. By 1988, the Town cultivated over one million hard clams and released them to various tidal creeks throughout the town (Town of Southold, 2004). The amount of hard clams cultivated by the Town increased to two million in 1990. In 1991, the Town established a Hatchery Program in cooperation with the Cornell Cooperative Extension (CCE) Marine Science Program. Presently, all aquaculture programs within the Town of Southold are administered through the CCE's Marine Program.

In January 2000, the Cornell Cooperative Extension developed the Southold Project in Aquaculture Training (SPAT) in an effort to reseed local public waters with cultivated oysters, clams and scallops. Under this program, local resident volunteers are trained to grow the shellfish which will later be released into local waters. For a fee, volunteers are provided with 1,000 to 2,000 seed, aquaculture gear (ADPI type cages) and training. Shellfish cultivation may take place at the volunteers' own waterfront or in the SPAT community garden, located in the canals of Cedar Beach Creek. Each volunteer has the potential to grow 50,000 to 100,000 shellfish. The volunteers are permitted to harvest 50% of the adults for non-resale use, but the remaining 50% must be released into local waters. Presently, there are approximately 200 families within the Town that participate in the program (Kim Tetrault, Cornell Cooperative Extension, personal communication, June 2007).

The hatchery produces in the order of two million each of clams, oysters, and scallops. Seeds are cultivated in flow-through containers (e.g. tanks and upwellers) at the Cornell Cooperative Extension's hatchery at Cedar Beach County Park. After the larval stage, the shellfish are moved outside of the hatchery into upweller systems until they are large enough to be transferred to the creek or bay.

Approximately 80 to 100 private "gardens" are used by program participants to raise their spat. Most of these gardens are located at boating docks along the North Shore, from Mattituck to Orient (Kim Tetrault, Cornell Cooperative Extension, personal communication, June 2007).

The SPAT program is limited to recreational shellfish cultivation only. Commercial shellfish harvesting is not overseen by the SPAT program,

and commercial shellfish harvesters are not permitted to receive seed from the hatchery.

The Town of Southold's LWRP policies pertaining to Marine Zone II uses classifies mariculture or aquaculture operations as a permissible activity and encourages such operations

Town of Shelter Island

Since the 1970s, the Town of Shelter Island has conducted a hard clam seeding program within the inland waters of Coecles Harbor and West Neck Harbor. This program was designed to improve the success of natural shellfish reproduction within the Town's waters. The Town designates approximately $12,000 annually towards the purchase of seed from the Cornell Cooperative Extension in Southold (Ed Bausman, Town of Shelter Island, personal communication, 2007).

A hard clam spawner sanctuary developed in partnership with The Nature Conservancy (TNC) and NOAA, and designed to reduce the potential impacts from brown tide in local waters, has been established by the Town Trustees in the waters of West Neck Bay.

3.3.3 Private Organization Programs

The Nature Conservancy

The Nature Conservancy has established several aquaculture programs throughout the Peconic Estuary as well as in the south shore bays. These programs have been established with the intent of improving water quality through the use of filter feeders for the purposes of preventing the onset of brown tide. Partners include the Town of Southampton, the Town of Shelter Island, NYSDEC, and the Peconic Estuary Program. In addition, TNC owns an oyster grant for the bottomlands in Pipes Cove.

Five spawner sanctuaries have been created by TNC in an effort to restore shellfish populations and to restore water clarity and quality.

Approximately 200-acres of bottomlands in Pipes Cove have been established as spawner sanctuaries by TNC, in partnership with the National Oceanic and Atmospheric Administration (NOAA). After being raised to the adult stage by volunteers, shellfish are released into these waters that are off-limits to shellfish harvesting. Approximately 500,000 clams and 100,000 scallops have been planted on TNC-owned bottomlands.

TNC also owns 13,000 acres of bottomlands in Great South Bay where they have established ten spawner sanctuaries which have been stocked with over 700,000 adult clams. In addition, a shellfish nursery program has been developed, which includes the restoration of bay scallop populations in Great South Bay and Shinnecock Bay.

Peconic Land Trust

Peconic Land Trust (PLT) owns and operates the Shellfisher Preserve, located at the former Shelter Island Oyster Company facility on Great Hog Neck in Southold. In 1996, PLT acquired the facility and began working with Cornell Cooperative Extension Marine Program to manage the 14-acre facility for shellfish aquaculture research and education, and to provide waterfront access to small-scale aquaculture companies.

Peconic Baykeeper, Inc.

Peconic Baykeeper, Inc. received 289 acres of underwater land located in Great Peconic Bay just northwest of the Shinnecock Canal from Mr. Skip Tollefsen. Peconic Baykeeper believes that the oyster grant parcels it owns would be appropriate for conducting experiments relating to aquaculture, such as field experiments on off-bottom shellfish culture, water quality, benthic impact and mechanical harvesting impacts. Peconic Baykeeper believes that such an experimental or research use of underwater land would be valuable for assessing aquaculture and would be

consistent with their mission to sustain and enhance fisheries in the estuary.

Mariculture Technologies

In 1986, NYSOGS issued an Open Ocean Water Column Lease to Mariculture Technologies, Inc. for 200 acres located 0.28 miles off the southeastern shore of Plum Island and 2.1 miles offshore of Orient Point. This lease, the first of its kind issued in the United States, was issued for a term of 40 years for the purposes of raising summer flounder (fluke) in net pens (Mariculture, 1995). Mariculture Technologies received grant monies from the National Marine Fisheries Services (NMFS) to test the feasibility of net-pen summer flounder grow-out at the lease site. To date, only 12 acres of the 200-acre site have been used for fluke farming. The last time that the lease was held by Mariculture Technologies was in the year 2000 (Josh Thiel, NYSDEC Bureau of Marine Fisheries, personal communication, June 2007).

Winergy Power LLC, a company devoted to developing offshore wind energy projects, acquired Mariculture Technologies water column aquaculture lease and is proposing to construct a wind farm on the site consisting of either three 3.6 megawatt (MW) wind-turbine generator towers or two 5.0 MW wind-turbine generator towers to operate over a period of 10 years. This proposal is currently in the public comment review process.

In addition, Winergy has applied for a TMAUA from NYSDEC to perform off-bottom shellfish aquaculture (Josh Thiel, NYSDEC Bureau of Marine Fisheries, personal communication, June 2007). However, the NYSDEC has suspended review of the application until completion of the environmental review of the proposed wind farm project.

3.4 Institutional Programs

In 2002, Southampton College, Cornell Cooperative Extension, and Suffolk County began the four-year *Restoration of Peconic Bay Scallop Populations and Fisheries* project. This project was created in an effort to restore the native bay scallop population in East End waters to pre-brown tide levels. The restoration project is located on a 5-acre underwater site in Orient Harbor, Southold. To date, one million scallops (1/2 inches in shell height) have been placed in lantern nets, and another five to ten million scallops (up to 3/8 inches in shell height) have been planted for the project. The one million scallops held in the nets are free-planted each year after spawning has occurred. This project represents the largest bay scallop restoration effort in the United States.

In addition, the NYSDEC, LIU Southampton College, Cornell Cooperative Extension, The Nature Conservancy and the Town of East Hampton collaborated on a State Wildlife Grant (SWG) *Bay Scallop Spawner Sanctuary Study* in Northwest Harbor during 2005 and 2006. East Hampton (Hatchery and Town Trustees) and Suffolk County are embarking on a *Three Year Bay Scallop Restoration Project* in 2008 (J. Aldred, Town of East Hampton personnel communication, 2008).

THIS PAGE INTENTIONALLY LEFT BLANK

Section 4

Environmental Setting, Impacts and Mitigation

This section describes the relevant components of the environmental setting and identifies and describes potentially significant adverse impacts. Practical mitigation measures that would avoid or minimize the adverse impacts are also discussed.

4.1 Natural Resources

Information presented on existing conditions and settings of the study area is based on existing information and interviews with knowledgeable individuals.

4.1.1 Existing conditions/setting

4.1.1.1 Circulation, Currents and Wave Action

The circulation patterns within the Peconic Estuary are determined by the tidal currents and density differences generated by the mixing of freshwater and seawater (Barnes et al., 1991). A general ebb/flood current pattern exists with minor pulsing suspected as wind-derived within Flanders Bay and Great Peconic Bay, and Northwest Harbor (EEA, 1999). Circulation is horizontal and is caused almost entirely by tidal flow, which greatly exceeds freshwater input (SCDHS, 1992). Tidal flushing rates within the estuary decrease from east to west. Ebb flow past Robins Island is less than flood flow, because of how flow is controlled in the Shinnecock Canal (which connects Great Peconic Bay with Shinnecock Bay). The canal lock allows only one-way ebb flow southward into Shinnecock Bay, with no flood tide flow. This means there are two ebb flow exits from Great Peconic Bay, but only one flood tide entrance. The estimated flushing time for the western portion of the estuary is 56 days, and 22 days for the eastern portion of the estuary (Balla et al., 2005).

Tidal currents tend to be variable throughout the estuary. Tidal flow enters the Peconic Estuary from the ocean waters east of Gardiners Bay. Shelter Island

obstructs the tidal flow to the western portion of the estuary. Tidal current velocities can reach 1 m/sec (2 knots) and 0.9 m/s, respectively, in the channels north and south of Shelter Island (Hardy, 1976). Tidal currents within the estuary are strongest in the South Race between Cow Neck and the southern portion of Robins Island, which separates Little Peconic Bay from Great Peconic Bay. In this location, spring flood currents may reach 1.2 m/s (2.4 knots) (Hardy, 1976). Tidal flow also increases in the North Race, north of Robins Island; however, the flow rate is less than the South Race due to shallower waters and a less direct route for tidal flow. Average flow velocity within Flanders Bay was 2.3 cm/s with a maximum velocity of 9.55 cm/s; and 6.4 cm/s with a maximum velocity of 12 cm/s in Great Peconic Bay during a seven day measurement period conducted in mid-August 1998 (EEA, 1999). Measurements taken from Cornelius Point in late-July through early-August showed that a clear ebb/flood current exists, with an average velocity reading of 24 cm/s (EEA, 1999). The average velocity reading recorded for Northwest Harbor was 4.4 cm/s, with a maximum velocity of 47 cm/s (EEA, 1996).

The mean tidal range in the estuary generally decreases slightly from west to east, as follows: 0.82 meters (2.69 feet) in Flanders Bay, 0.76 meter (2.49 feet) in Great Peconic Bay, and 0.73 meter (2.40 feet) in Gardiners Bay (NYSDOS, 2002). It takes approximately three hours for the tide to travel from Gardiners Bay to western Flanders Bay.

Because of limited fetch, wave heights in the estuary are generally below two meters (Hardy, 1976). Wave heights in Flanders, Peconic and Gardiners Bays are limited by the generally shallow depth of the system and the short fetches. In Napeague Bay, while fetches can be longer, water depths still remain a factor. The greatest impacts are from nor'easters, due to the general orientation of the system, which provides longer fetches to the northeast.

Adult hard clams grow best in currents with a velocity of 7.5 cm/s, while larvae are found in currents of 12 to 130 cm/s (Stanley and DeWitt, 1983). Blue mussels prefer sheltered environments with low currents, as densely stacked beds of mussels may become unstable and dislodged in areas of strong wave action (Newell, 1989). Currents ranging from less than 1 cm/s to 0.21 cm/s are best suited for growth of juvenile scallops, which ceases at a velocity of 12 cm/s (Fay et al., 1983). Water currents are less influential on scallops once they reach the adult stage. EOBRT (2007) citing Newell and Langdon (1996) and Grizzle et al. (1992), note that water flow influences oyster growth rate, with excessive flow moving food particles past the shellfish before they can be extracted (Newell and Langdon), and too slow a flow providing insufficient food particles (Grizzle et al.). Shellfish aquaculture farmers should consider water flow when locating a grow-out site, and should avoid waters in excessively high energy areas (e.g., straits, areas of high wave action) or in low energy areas where particle delivery to the shellfish might be problematic.

4.1.1.2. Water Quality

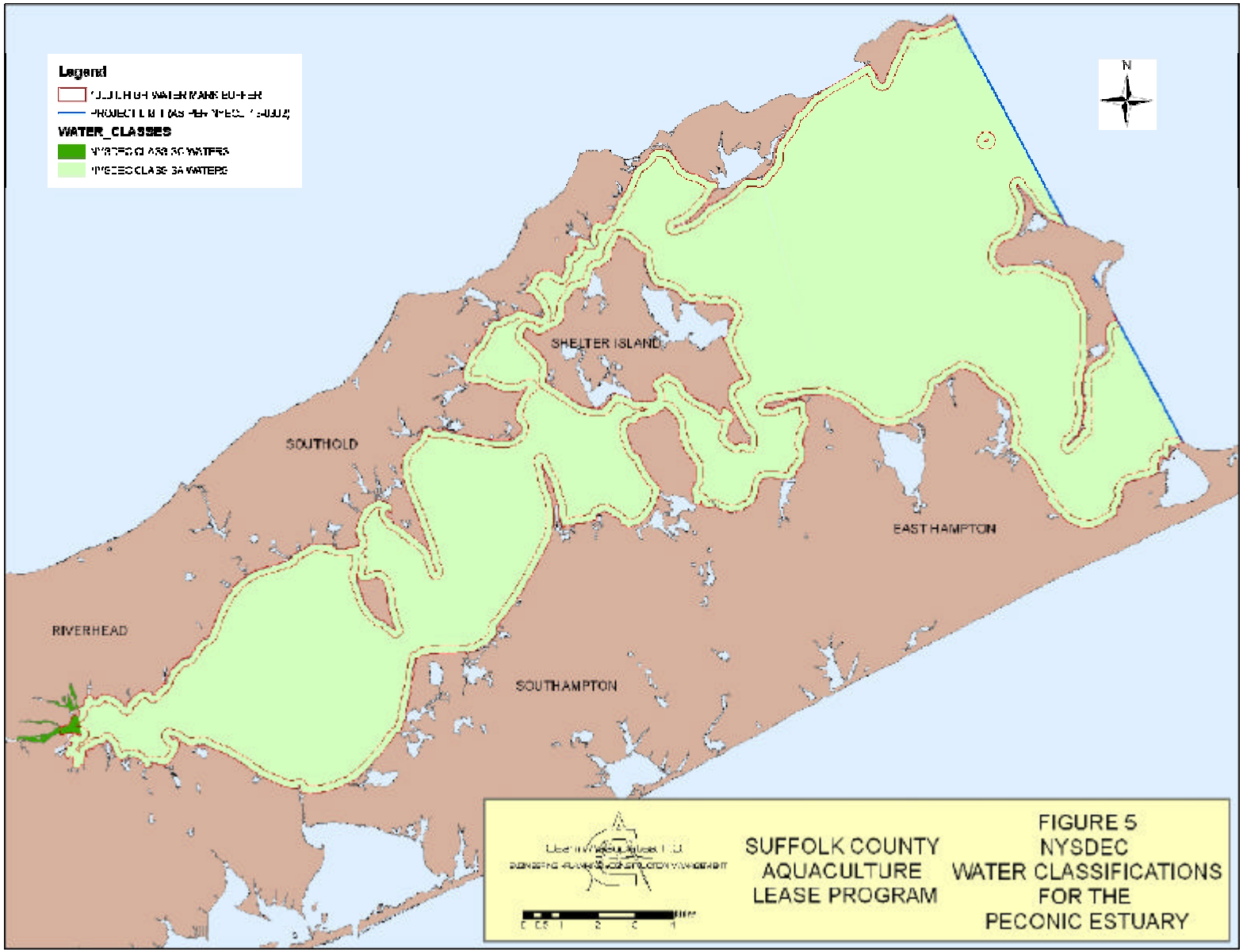
Water quality monitoring is routinely conducted throughout the estuary by Suffolk County Department of Health Services (SCDHS). Water samples are analyzed for a suite of nitrogen components (ammonia, nitrate and nitrite, total nitrogen, and total dissolved nitrogen), phosphorous components (total phosphorous, total dissolved phosphorous, ortho-phosphate), total suspended solids, chlorophyll-a, coliform bacteria (total and fecal), and brown tide (*Aureococcus*). Also measured at each station are: secchi depth, temperature, dissolved oxygen, salinity, and photosynthetically active radiation (PAR) at incremental depths (SCDHS, 2007). The results of the water quality samples are compared to the NYSDEC water quality regulations according to Title 6, Chapter X Sections 700-706 (last amended August 4, 1999).

<u>Water Classification</u>

All waters located within the state of New York are classified by NYSDEC to denote their best uses based on water quality monitoring. Best uses include:

source of drinking water, swimming, boating, fishing, and shellfishing. Saline waters may be classified as SA, SB, SC, I, and SD waters, with SA waters being the highest quality of saline waters.

The majority of the Peconic Estuary (97%) is classified as Class SA waters (6NYCRR, §924.6). The best usages of Class SA waters are shellfishing for market purposes, primary and secondary contact recreation, and fishing (6NYCRR, §701.10). The western portion of the estuary (specifically, the western portion of Flanders Bay including the tidal Peconic River, Meetinghouse Creek, and East Creek) has become critically stressed due to low tidal exchange and pollution inputs (Balla, et al 2005). Flanders Bay West, defined in 6NYCRR §921.4 as the tidal waters lying between a line from the southern point of Indian Island to the northwestern boundary of Reeves Bay and from a line due south from the mouth of Sawmill Creek, is classified as Class SC waters. The best usage of Class SC waters is for fishing. Water quality of Class SC waters is suitable for fish propagation and survival, as well as for primary and secondary contact recreation, although other factors may limit the use for recreational purposes (6NYCRR §701.12). Only a small portion of class SC waters in Flanders Bay West are situated within the Shellfish Cultivation Zone (Figure 5).


Legend
WATER_CLASSES
N
SHELTER ISLAND
SOUTHOLD
EAST HAMPTON
RIVERHEAD
SOUTHAMPTON
SUFFOLK COUNTY
AQUACULTURE
LEASE PROGRAM
FIGURE 5
NYSDEC
WATER CLASSIFICATIONS
FOR THE
PECONIC ESTUARY

Shellfish Harvest Classification

The New York Commissioner of Environmental Conservation classifies the certification of approximately 121,000 acres throughout the Peconic Estuary for the taking of shellfish based on NYSDEC regulations (6NYCRR, Part 47, *Certification of Shellfish Lands*) and the requirements of the National Shellfish Sanitation Program (NSSP), as discussed earlier in Section 2. Shellfish harvesting areas are designated as certified (open), uncertified (closed) or conditionally or seasonally certified. Shellfish areas may be deemed uncertified based on water quality monitoring results, the presence of known sources of pollutants, weather conditions, or regulatory decisions.

Fecal coliform bacteria are used as indicators of the potential presence of human pathogens in shellfish and, therefore, are used to determine the closure of a shellfish harvesting area for the protection of public health. Bacteria and viruses present in the water column can become concentrated in shellfish through their filter feeding process. Coliform bacteria levels tend to increase as a result of contaminated stormwater runoff from developed areas, and runoff contaminated by waterfowl and other wildlife. Improperly treated effluent from wastewater treatment plants can also contribute to coliform loadings. Illegally discharged wastes from boats, and failing septic systems are also potential contributors of coliforms, but their contributions are likely quite limited and localized. NYSDEC compares the amount of coliform detected in the water quality samples to strict bacteriological standards assigned by the NSSP for open shellfish areas. According to the NSSP guidelines, the geometric mean for fecal coliform for a certified (open) shellfish harvesting area should not exceed 14 FC/100ml, and the 90th percentile value should not exceed 49 FC/100ml. An area is immediately closed if a single fecal coliform sample is found to exceed 70 mpn/100 ml.

Shellfish closures due to impaired water quality are generally classified into three sub-categories: year-round closures; seasonal closures; and conditional closures. Year-round closures are shellfish harvest areas that do not meet NSSP standards

during any time of the year. Seasonal closures do not meet NSSP standards during a certain time of the year, such as during the summer season when recreational uses of the estuary increases. Conditionally and seasonally closed areas may be opened by the NYSDEC when conditions warrant. Seasonal openings are generally from mid-December through mid-April, when nonpoint source pollution is reduced (EPA, 2006). Conditional areas may be suspended, revised, or canceled at any time if any condition is found to exist which may be a threat to public health. The shellfish harvest areas (or portions thereof) that are situated within the Shellfish Cultivation Zone are discussed below.

Year-round uncertified shellfish harvesting areas due to impaired water quality are located within the western portion of Flanders Bay; Shelter Island Sound, between Greenport and Dering Harbor, and in Northwest Harbor near the Sag Harbor Inlet. Many of the sheltered and poorly flushed tidal creeks and embayments throughout the Estuary are also classified as uncertified shellfishing areas. Approximately 836 acres within the study area are closed year-round to harvesting due to substandard water quality conditions.

The following area descriptions are closure limits of the uncertified shellfish areas, as described in Chapter 1, Part 41 of the Sanitary Condition for Shellfish Lands that are situated within the study area:

- Flanders Bay (west): all of the waters lying westerly and northerly of a line extending northeasterly from the northernmost tip of Goose Creek Point (exposed at mean high water) to the southernmost tip of Simmons Point (exposed at mean high water); and all of Reeves Bay.
- Shelter Island Sound: all that area of Shelter Island Sound and Dering Harbor south and east of a line extending southwesterly from the westernmost point of land at Dering Point, Shelter Island to the southernmost point of land at Fanning Point, Southold and continuing southeasterly to the westernmost corner of the ferry dock at Shelter Island.

The closure extends westward from the Shelter Island ferry dock to the foot of Island View Lane, Southold (local names, local landmarks).

- Sag Harbor: all of the waters lying westerly of a line extending northerly along the breakwater located at the entrance to Sag Harbor (local landmark) and thence continuing northerly from the northern end of the breakwater to the north-easternmost extremity of the timber bulkhead protecting the shoreline adjacent to East Harbor Drive, North Haven (local landmark); and easterly of the westernmost portions of the fixed bridge connecting North Haven Peninsula and Sag Harbor (local landmark).

The uncertified waters of Dering Harbor (with the exception of Chase Creek) are designated as conditional and will remain open to shellfish harvesting provided that the Shelter Island Heights STP continues normal operations and successful treatment activities. Uncertified waters in Great Peconic Bay are located within a 300-yard radius of the bulkhead at the entrance to Brushs Creek, which abuts the 1,000-foot shoreline buffer zone (study area boundary).

Administrative closures are permanent shellfish harvesting closures issued to areas where there is the possibility of pollutant discharge into the estuary, such as near STP outfalls or high density mooring areas. Administrative closures serve as buffer zones between point source pollutants (i.e., STP outfalls) and the closest shellfish areas. Approximately 1,000 acres within the Peconic Estuary are administratively closed (Balla, et al 2005). Administrative closures associated with STPs exist in Flanders Bay, Shelter Island Sound near Dering Harbor and Sag Harbor, and in Gardiners Bay around the entire perimeter of Plum Island.

Emergency closures may be issued by NYSDEC if excessive stormwater runoff enters a waterbody, usually based on a rainfall event of more than three inches within 48 hours (NYSDEC website, www.dec.ny.gov/outdoor/7765.html, accessed on June 11, 2007). This type of closure is often assigned with little or no notice. Shellfish harvesters are encouraged to contact the NYSDEC hotline for

posted closures and reopenings prior to harvesting an area suspected to have been affected by three or more inches of rain.

If annual water quality data analyses show that the sanitary condition of a shellfish harvesting area has changed, NYSDEC may reclassify the area (NYSDEC website, www.dec.ny.gov/outdoor/7765.html, accessed on June 11, 2007). NYSDEC also has the authority to close popular mooring areas to shellfishing prior to, during, and following several popular boating holidays during the summer months due to the possibility of a large crowd of boaters discharging vessel wastes into the water. The acreage of each shellfish area in the Peconic Estuary closed to harvesting is presented in Table 4.

Table 4. Acreage of Shellfish Closures within the Peconic Estuary

Location	Total Acreage	Acreage within Study Area
Flanders Bay (west)	1,130	467
Shelter Island Sound	396	60
Sag Harbor	156	25
Brushs Point, Southold	38	0
Plum Island	1,501	227

Pollutants can enter the estuarine waters through both point and non-point sources. Non-point sources are the most significant contributors of pathogens to the Peconic Estuary and can result in the closure of a shellfish area. Non-point sources include stormwater runoff containing waterfowl, wildlife, domestic pet and livestock wastes, and the direct deposition of waterfowl waste.

Point-source discharges also have the potential to contribute pathogens to the Peconic Estuary system. Point-sources entering the estuarine waters include effluent from sewage treatment plants (STP), municipal separate storm sewer systems (MS4s), and duck farms. The following are point sources that currently discharge treated effluent into the estuary:

- Calverton Enterprise Park STP (formerly Grumman Aerospace)
- The Brookhaven National Laboratory STP
- The Riverhead STP
- Sag Harbor STP
- Shelter Island Heights STP
- Plum Island STP
- Atlantis Marine World Aquarium
- Corwin Duck Farm, Meetinghouse Creek
- Various Municipal Storm Sewer Systems (MS4)

The STPs listed above employ year-round sodium hypochlorite (Shelter Island Heights) or ultraviolet (Riverhead, Sag Harbor, and Brookhaven National Laboratory) disinfection, which kills coliforms, but not necessarily all viruses (EPA, 2006). The freshwater Peconic River receives discharged wastes from the Calverton Enterprise Park and the Brookhaven National Laboratory STP. An upgrade is planned for the Calverton STP, which would provide nitrogen removal and redirection of the discharge to groundwater outside of the Peconic Estuary watershed (EPA, 2006). The tidal portion of the Peconic River receives effluent from the Riverhead STP and the Riverhead/Southampton Scavenger Waste Facility, combined. The Sag Harbor STP outfall is located immediately outside of the mouth of Sag Harbor. The Shelter Island Heights STP discharges effluent to Shelter Island Sound near Dering Harbor. The impact on the estuary from the Plum Island STP discharge is considered *de minimus* due to its location and highly circulated waters (SCDHS, 2007).

Atlantis Marine World discharges effluent treated with either ozone or chlorine to the tidal Peconic River at a rate of approximately 2,000 gallons per day. The Corwin Duck Farm, which is the only remaining duck farm located within the Peconic Estuary watershed, currently holds a State Pollution Discharge Elimination System (SPDES) permit that prohibits discharge of processing waste except in the case of a 10 year, 24-hour rainfall event (Battelle, 2006).

As of 2003, the MS4s serving the Towns of Riverhead and Southampton were required to have a National Pollutant Discharge Elimination System (NPDES) permit and a management plan that would prevent polluted stormwater from being discharged into nearby water bodies (SCDHS, 2007).

Nitrogen entering the estuary in excess amounts may also adversely affect water quality. On an estuary-wide basis, the largest input of nitrogen is from non-point atmospheric deposition, followed by groundwater (Table 5).

Table 5. Baseline Annual Total Nitrogen (TN) Load System-wide

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	3,015,041
Groundwater	2,175,061
Creeks and Rivers	66,242
STPs	53,689
Stormwater	47,361

Source: SCDHS 2007

Turbidity

Turbidity levels indicate the amount of suspended solids present in the water column. High turbidity levels reduce the clarity of the water and interfere with light penetration which, over prolonged periods of time, can degrade an estuarine ecosystem. Brown tide-caused turbidity has been suggested as a contributing factor in the decline of eelgrass within the Peconic Estuary (Cosper et al. 1987). Excessive turbidity can be attributed to weather (e.g. storms, wind); shoreline erosion; soil erosion from construction and agricultural activities; recreational water activities that agitate bottom sediments (e.g. personal watercraft); dredging activities; mechanical shellfish harvesting techniques; excessive algal growth; and high levels of detritus. Clams and other filter feeders are directly affected by high turbidity, as it can disturb the filter-feeding process.

Turbidity levels in the Peconic Estuary system tend to decrease from Flanders Bay to Shelter Island, as a result of increased tidal flushing in the eastern portion of the Estuary (Balla et al., 2005). Water quality measurements conducted throughout the estuary as part of the Peconic Estuary Program Eelgrass Habitat Criteria Study (1999) found that turbidity levels noticeably increased in Flanders Bay and Great Peconic Bay during weekend recreational periods (EEA, 1999). According to the 1999 PEP Eelgrass Study, turbidity measurements in Flanders Bay increased approximately 10 Formazine Turbidity Units (FTU) (for a maximum of 14 FTU),and by 25 FTU in Great Peconic Bay (from 0.0 FTUs to 25 FTUs) during a summer weekend recreational period.

Nutrients

Nutrients, which enter the estuary through point and non-point sources, are vital for the growth of plants and animals. Excessive amounts of nutrients, however, can result in algal blooms, dissolved oxygen deficiency, decreased water clarity, and may alter the ecological balance. Flux from bay bottom sediments that have become enriched from these sources may release nutrients into the water column. Point sources, which include sewage treatment plant and other outfall pipes, can often be treated at or near the point of release, although this is often difficult and/or expensive. Non-point sources, including surface runoff, groundwater inflow, sediment flux, and atmospheric deposition, are more intractable because of their diffuse nature.

The introduction of nitrogen, which is considered the nutrient limiting biological production in temperate estuaries, to the entire Peconic system is primarily through atmospheric deposition (56%), and groundwater (41%), with STPs, tributaries and stormwater each providing about 1% for a total nitrogen (TN) loading of almost 5.4 million lbs per year (SCDHS, 2007). In western Flanders Bay and lower Sawmill Creek, however, almost 80% is from groundwater, about 8% from atmospheric deposition, 7% from Sawmill Creek, and 6% from stormwater, for a total annual loading of 33,363 lbs total nitrogen (TN). The

annual TN load for the lower Peconic River and tidal tributaries is 211,072 lbs distributed among atmospheric deposition (1%), groundwater (55%), Little River (1%), Peconic River (19%), stormwater (2%), and the Riverhead STP (22%) (SCDHS 2007, Table 6). Because of the diffuse nature of atmospheric deposition (*i.e.*, it is spread out throughout the entire estuary), its effect on the estuarine ecosystem is less acute than the effect of the STP and tributaries in the western estuary. The effect of groundwater is, perhaps, more problematic, as it contains nitrates contributed by a watershed that has been, and in some areas remains, highly agricultural in nature, and is also affected by leachate from private wastewater treatment (septic) systems. The balance of nutrients in an estuary depends on input from all sources, how much is taken up by plants or recycled in the sediments, and how much is exchanged with the ocean during tidal flow.

Table 6. Baseline Nitrogen Load Summary

	Total Annual TN Load (lbs)		
Nitrogen Source	**Lower Peconic River and Tidal Tributaries**	**Western Flanders Bay and lower Sawmill Cr.**	**System-wide**
Atmospheric deposition	2,590	2,724	3,015,041
Groundwater	115,672	26,539	2,175,031
Little River	2,181		
Peconic River	40,146		
Stormwater	3,140	1,919	47,361
Riverhead STP	47,353		
Sawmill Creek		2,181	
STPs			53,689
Creeks and Rivers			66,242
Total*	**211,072**	**33,363**	**5,357,364**

*May not add due to rounding Source: SCDHS, 2007

While vessel waste discharge can also contribute nutrients to the estuary, its contribution is likely quite small. In June 2002, USEPA and NYSDEC officially designated all of the navigable waters of the Peconic Estuary as a Vessel Waste

No Discharge Zone (67 FR 39720) in an effort to reduce the amount of nutrient loading from this source. This designation prohibits vessels from discharging any sewage, raw or treated, into the estuary, and requires vessels with holding tanks to use pump-out facilities. The No Discharge Zone will improve estuarine water quality, benefiting sensitive natural resources such as shellfish beds and finfish nurseries. This is locally important in areas throughout the estuary that receive a high-density of boaters during the summer boating season (e.g. marinas and popular mooring areas).

Data collected by the SCDHS from mainstem stations along the length of the Peconic Estuary (Figure 6) reveal that the highest nitrogen levels are found in the western estuary, decreasing toward the east (Figure 7), and that they have been declining over the last two decades (Nuzzi 2005) as is graphically displayed in Figure 8. There is a downward trend in total nitrogen at all main stem stations from 1986 through 2005, with the slope decreasing from west to east, until the level approaches that of the boundary. The major decline has been in dissolved organic nitrogen (DON), while dissolved inorganic nitrogen (DIN) has remained relatively stable. A closer look at the DIN reveals that ammonia has been decreasing as nitrate plus nitrite (NO_x) has been increasing. DON exhibits interannual variation, and may be associated with sediment flux. Fulweiler et al. (2007) have suggested climate change as a potential driver of changes in sediment chemistry.

Figure 6. Peconic Estuary Program Mainstem (170, 130, 113, 114, 116) and Peconic River (240, Meetinghouse Creek (220), Northwest Harbor (118), and West Neck Bay (119) Stations (figure courtesy of E. Dettmann USEPA)

Figure 7. Spatial Distribution of Nitrogen along the Mainstem Stations. Mean Nitrogen Values 1986 – 2004

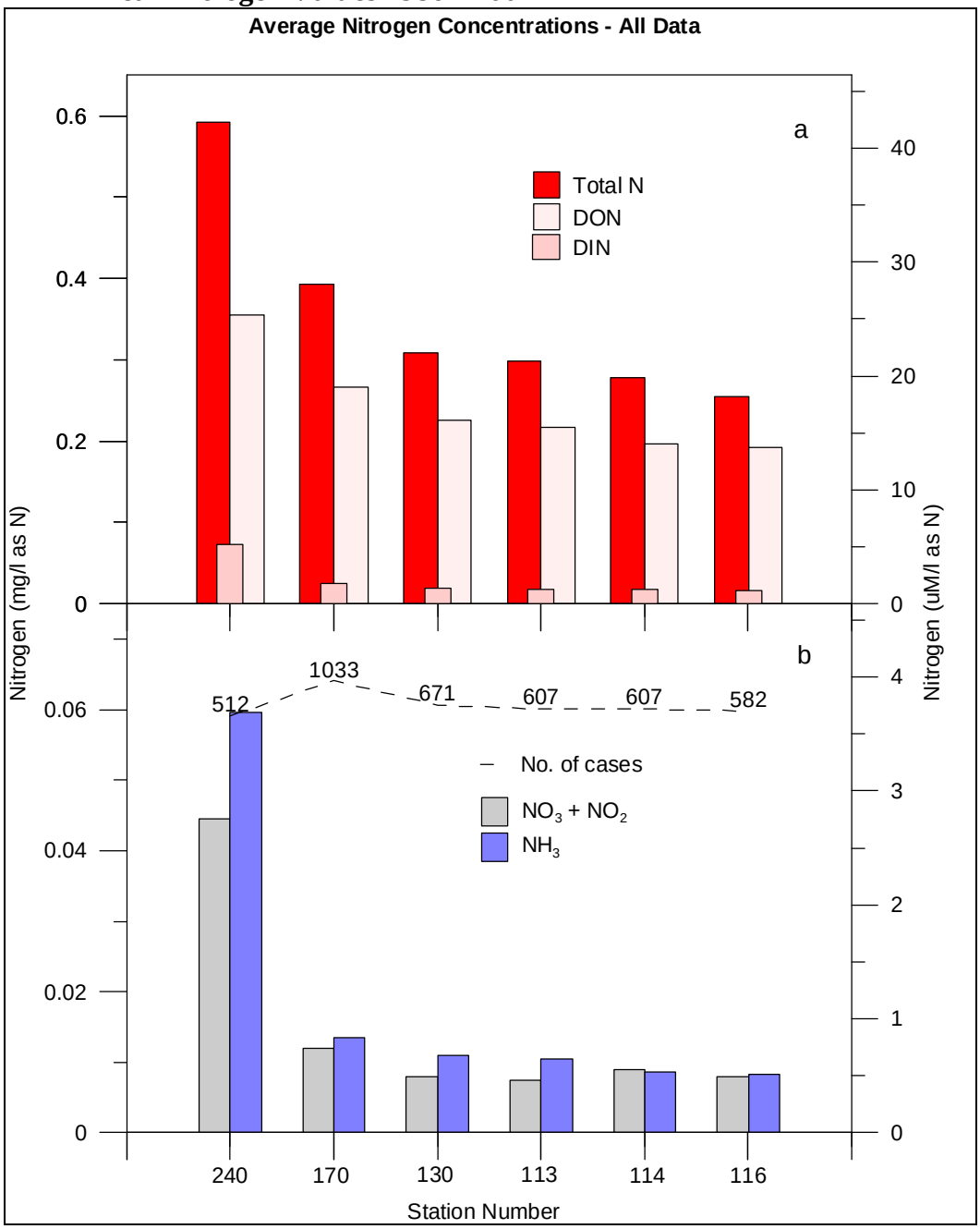
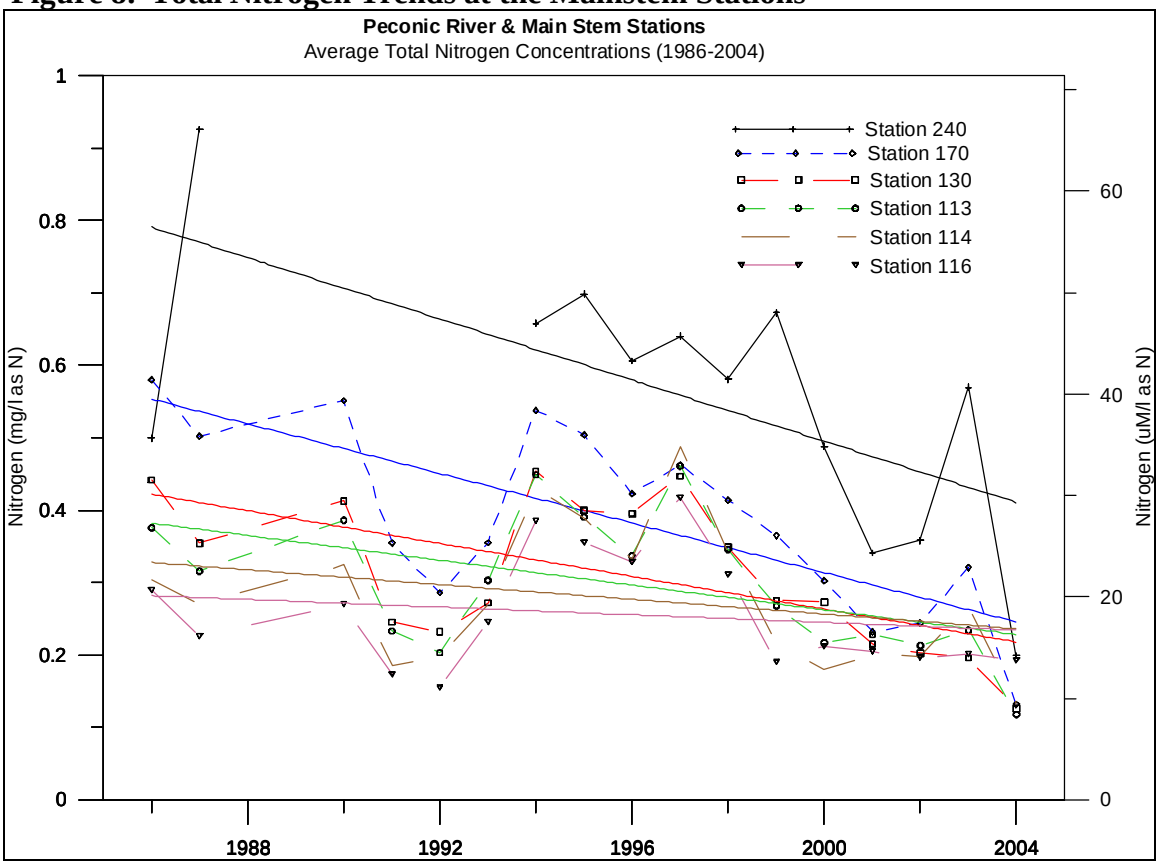


Figure 8. Total Nitrogen Trends at the Mainstem Stations



Nutrient levels in the tributaries are quite different, especially for those that were, or remain associated with duck farms: Terrys Creek, Sawmill Creek and Meetinghouse Creek (Table 7). These creeks have been included on the NYSDEC 2002 Clean Water Act Section 303(d) list, and listed as impaired on the State's Priority Waterbodies List (SCDHS 2007).

Table 7. Nutrient Statistics at Tributaries Presently (Meetinghouse Creek) or Previously Associated with Duck Farms. Mean, maximum, and minimum values in mg/L (as N or P) (Derived from SCDHS unpublished data)

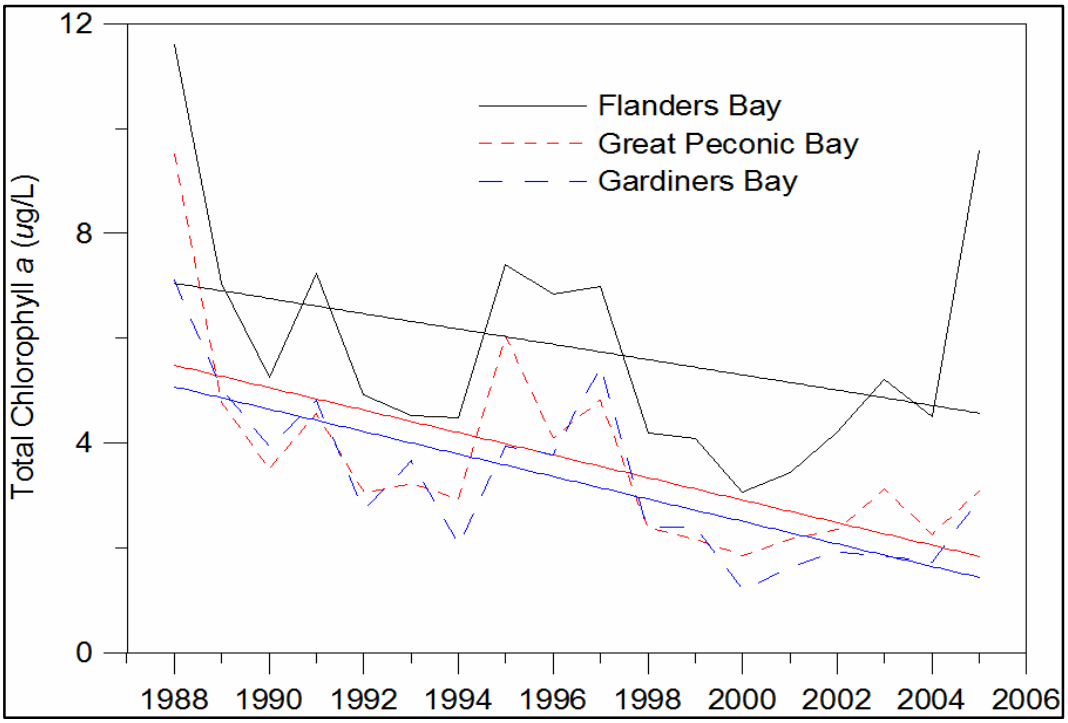
Embayment	Statistic	NH3	NO_2+NO_3	TN	DIN	DON	TP	TDP	o-PHOS
Terry's Creek	Mean	0.053	2.09	2.42	2.14	0.35	0.161	0.128	0.259
	Max	0.240	3.42	4.0	3.52	2.1	0.720	0.670	0.610
	Min	0.005	0.100	0.76	0.138	0	0.015	0.015	0.005
Sawmill Creek	Mean	0.421	0.598	1.27	1.02	0.48	0.192	0.062	0.122
	Max	3.85	4.21	7.64	5.57	1.45	2.20	0.267	0.460
	Min	0.003	0.032	0.05	0.036	0.06	0.015	0.005	0.003
Meetinghouse Creek (Station 220)	Mean	1.061	0.541	2.595	1.59	0.74	0.293	0.203	0.130
	Max	9.30	4.46	12.9	12.57	8.1	1.86	1.59	1.24
	Min	0.016	0.003	0.14	0.003	0	0.001	0.001	0.003
Meetinghouse Creek (Station 41)	Mean	0.276	7.25	8.15	7.55	0.16	0.233	0.022	----
	Max	1.60	10.4	19.8	10.7	1.35	10.5	0.488	----
	Min	0.005	0.314	1.12	0.614	0	0.005	0.005	----
Crescent Duck Farm (Station 4)	Mean	9.09	6.29	16.0	15.3	0.81	1.27	0.971	0.913
	Max	44.0	35.1	59.8	59.8	10.2	14.0	3.03	3.21
	Min	0.010	0.154	0.41	0.164	0	0.005	0.005	0.005

Chlorophyll-*a*

Chlorophyll-*a* is an indicator of the amount of algae present in the water column and is directly related to nutrient levels in the estuary. Chlorophyll-*a* levels decrease from the western portion of the estuary (3.4 - 4.0 ug/l) towards the eastern portion of the estuary (approximately 2.9 ug/l) during both the summer and growing seasons (EEA, 1999). This is not unexpected since nitrogen levels also decrease. However, this has not prevented occasional phytoplankton blooms from occurring, as is indicated in Figure 9. Although the "brown tide" bloom of *Aureococcus anophagefferens* that decimated the bay scallop population in the estuary in 1985-87, 1991, and 1995, has not recurred since then, there have been blooms of the dinoflagellate, *Cochlodinium polykrikoides* over the last several years (Nuzzi 2004; Gobler et al. 2008). *C. polykrikoides* is a harmful alga responsible for shellfish mortalities in the Peconic Estuary during 2006 (Gobler et al. 2008).

A decreasing trend in chlorophyll-*a* is seen throughout the main stem stations. Figure 9 represents an example of the decreasing trend from Flanders Bay (Station 170). Similar stations east of Flanders Bay exhibit similar values. Except for occasional blooms, chlorophyll levels remain below 10 *u*g/l.

Figure 9. Annual Mean Total Chlorophyll-*a* Levels in the Peconic Estuary as represented by Flanders Bay (westernmost station), Great Peconic Bay (central station), and Gardiners Bay (easternmost station). Major peaks are related to brown tide (*Aureococcus anophagefferens*) events (1988, 1991, 1995), cause(s) of 1996 and 1997 peaks are unidentified, 2005 peak was caused by the dinoflagellate *Cochlodinium polykrikoides*. Trend lines are linear fits.



Salinity and Temperature

The salinity of the Peconic Estuary is controlled by the contribution of freshwater from the Peconic River (the largest single source) and other tributaries, groundwater discharge, precipitation and evaporation, and by the introduction of higher salinity water from its external boundary. The mean surface salinity for the estuary calculated from the SCDHS PEP main stem stations and the mouth of the Peconic River (east to west they are Peconic River, Flanders Bay, Great Peconic

Bay, Little Peconic Bay, Paradise Point, Northwest Harbor, and Gardiners Bay) for the years 1986 -- 2005 (Table 8, unpublished data) is 28.24 parts per thousand (ppt), increasing from 26.78 in Flanders Bay to 28.93 in Gardiners Bay. This is slightly lower than the values of 27.1 ppt and 29.4 ppt previously reported by Hardy (1976). Diurnal variations were found to approach 2 ppt by both Hardy and the SCDHS (unpublished).

Table 8. Salinity in the Peconic River (240), and Mainstem Stations (Flanders Bay, 170; Great Peconic Bay, 130; Little Peconic Bay, 113; Shelter Island Sound, 114; Northwest Harbor, 118, Gardiners Bay, 116) Stations, 1986-2005.

Location	Station ID	Mean	Max	Min	Median
Peconic River	240	23.24	30.49	3.84	24.00
Flanders Bay	170	26.78	30.21	20.42	24.02
Great Peconic Bay	130	28.00	30.65	23.51	28.15
Little Peconic Bay	113	28.29	30.72	25.30	28.41
Shelter Island Sound	114	28.60	30.82	20.70	28.72
Northwest Harbor	118	28.86	31.10	20.10	28.99
Gardiners Bay	116	28.93	30.90	21.60	29.01

Source: SCDHS, unpublished

The optimum salinity for clams is between 24 and 28 ppt (Hadley and Coen, undated), although they can be found in salinities ranging from 4 to greater than 35 ppt (Eversole 1987). A study conducted by H.C. Davis in 1958 found that the minimum salinity at which fertilized hard clam eggs develop into the larval stage is 22.5 ppt. Once the clams reached the larval stage, the clam survival rate increased at a lower salinity level of 20.0 ppt, but decreased at levels below 17.5 ppt. Chanely (1957) found that larger (5.0 to 21.5 mm) juvenile clams were tolerant of lower salinity levels, surviving at levels down to 12.5 ppt. Clams close their valves during reduced salinity, and prevent exposure to extreme salinity fluctuations by maintaining valve closure for days (Eversole 1987, Baker et al. 2002), but cannot tolerate salinities above 40 ppt (Baker et al. 2002).

Salinity requirements of the Eastern oyster, *Crassostrea virginica* are discussed by the Eastern Oyster Biological Review Team (EOBRT, 2007). *C. virginica* can tolerate salinities from 0 – 42 practical salinity units (psu), but requires a salinity of at least 10 psu to grow, with little or no growth below 5 psu, and optimal growth between 14 – 28 psu (Quast et al. 1998; Shumway 1996, as cited by EOBRT). However, oyster populations in a number of estuaries, including Chesapeake Bay, are now limited to areas that are sub-optimal due to the presence of MSX in higher salinity areas (Mann and Evans, 2004). MSX infection is sustained at a consistent salinity above 15 ppt, and kills most oysters when the salinity is above 18 – 20 ppt (EOBRT, 2007). Previous studies found the minimum salinity required by the Eastern oyster *Crassostrea virginica* to be 6.0 to 7.5 ppt (Loosanoff, 1948; and Butler, 1949), and that the optimum salinity range for development of larvae appears to be governed by the salinity at which the parent oysters developed gonads (Davis, 1958). When Peconic Bay and Long Island Sound oysters developed gonads at a salinity of 26-27 ppt, optimum salinity for egg development was about 22.5 ppt., and larvae grew best at 17.5 ppt.

Temperature in this region is controlled predominantly by seasonal weather changes and, to a lesser degree, by the mixing of water masses, especially at the eastern (Block Island Sound) and western (Peconic River) boundaries. All, of course, are climatologically related. The mean surface temperature for the estuary calculated from the SCDHS PEP main stem stations for the years 1986 - 2005 (Table 9, unpublished data) is 13.9 ºC, decreasing from a mean of 15.2 degrees in Flanders Bay to 13.4 degrees in Gardiners Bay.

Because the estuary is shallow, there is not a great differential between surface and bottom temperatures (generally less than one degree). Mean surface and bottom temperatures in Flanders Bay (average depth 8.4 ft.) were 15.2 and 16.0 respectively. In the deeper waters off Paradise Point (Station 114, average depth 68.9 ft.), the surface and bottom means were 13.7 and 13.0, respectively. Average

bottom salinities at these stations were 26.33 ppt in Flanders Bay, and 28.49 off Paradise Point.

Table 9. Mean Surface and Bottom Salinity, Temperature, and Dissolved Oxygen (DO) at the Mainstem Stations, 1986 - 2005. Includes only dates when both surface (S) and bottom (B) data are available. The minimum number of paired values is 396.

Location	Station ID	Salinity (ppt)		Temperature (°C)		DO (mg/l)	
Peconic River		S	B	S	B	S	B
Flanders Bay	170	26.62	26.33	15.7	16.1	8.3	8.1
Great Peconic Bay	130	27.86	26.94	13.7	13.3	8.7	8.3
Little Peconic Bay	113	28.11	27.73	13.5	13.2	8.5	8.5
Shelter Island Sound	114	28.44	28.49	13.5	13.0	8.6	8.4
Northwest Harbor	118	28.67	28.01	13.3	13.1	8.6	8.6
Gardiners Bay	116	28.75	28.43	12.9	12.6	8.7	8.7

Source: SCDHS, unpublished

The optimum temperature for hard clam growth is about 20ºC. Adult clams can survive at temperatures below freezing for short durations as long as the clam is in an area of flowing water or sediment; however, death will occur when 60% of the water in their tissues freezes (Baker et al., 2002). Growth decreases at 31ºC, above which it ceases. According to Whetstone et al. (2005) optimum spawning temperature is 26ºC, while MacKenzie et al. (2002) suggest 24ºC as optimum. Whetstone et al. also note that growth rate varies within clam populations, possibly due to genetic differences, and that selective breeding to establish faster growing populations would be beneficial.

Eastern oysters *(C. virginica*) are found in a temperature range of -2 – 36ºC (Butler 1954; Galtsoff 1964). Growth rate decreases with decreasing water temperature down to about 5ºC when growth ceases (Ingle and Dawson 1952; Galtsoff 1964). Ingle (1950) has shown that *C. virginica* grows considerably faster in Florida waters, where the mean water temperature was 28ºC, ranging from 26 – 30.5 degrees, than in northern waters. Spawning is related to

temperature and salinity and will thus show interannual variation (Loosanoff and Engle 1940; Lutz et al. 1970). Loosanoff (1950) has shown spawning in Long Island Sound to occur at temperatures ranging from 16.4 – 18.5 degrees Celsius, and larval settlement in Long Island Sound has been shown to occur at temperatures as low as 16.9ºC (Loosanoff and Engle 1940), although Ryder (1885), in his classic paper on spat collecting noted that the most favorable range seemed to be 20 - 26ºC. Hofstetter (1977) reports 17.5ºC as the minimum temperature for the growth of oyster larvae. Growth of the Chilean oyster (*Ostrea chilensis*) was found to be positively correlated with both temperature and phytoplankton abundance, and negatively correlated with particulate inorganic matter (Toro et al. 1999). A model developed by Ferreira et al. (1998), however, suggests that the carrying capacity of a small Irish embayment for *C. gigas* was determined more by the availability of particulate matter than by phytoplankton. A similar relationship between temperature and growth rate has been found for *O. edulis* and *Crassostrea gigas* (Spencer and Gough 1978; Utting 1988). Toro et al. (1999) point out that the positive correlation may not be causal in that "water temperature may strongly co-vary with seasonal phytoplankton abundance and or chlorophyll *a* (Kautsky 1982; Toro et al. 1995; Toro 1996)."

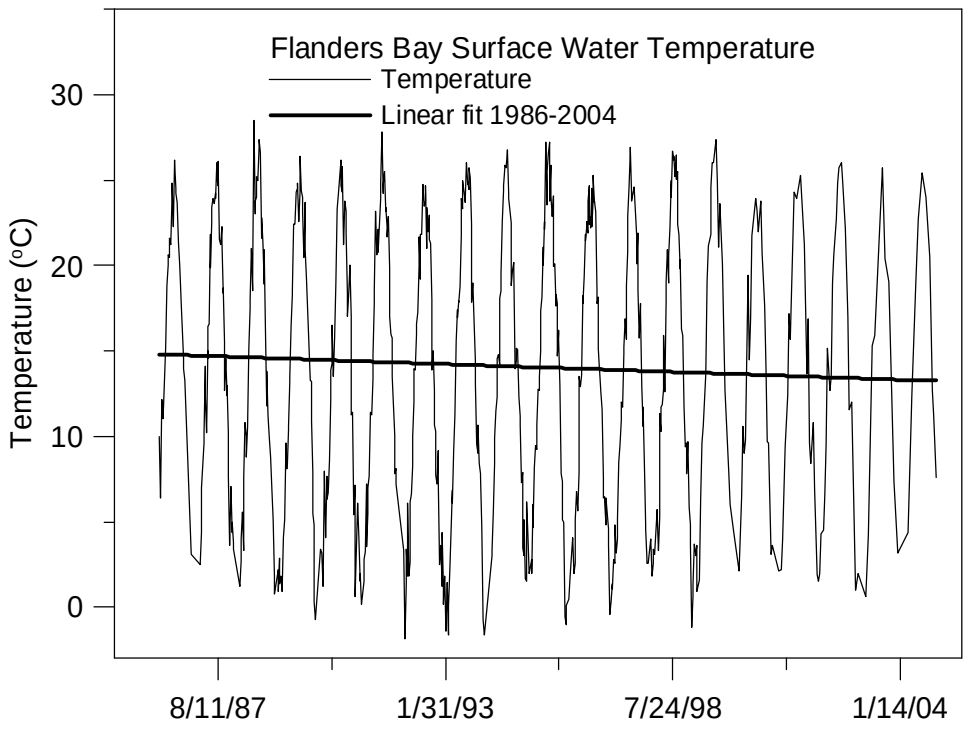
Blue mussels can tolerate low temperatures, and can even survive being frozen in ice for up to eight months (Seed, 1976), but cannot recover once 65% of its body tissue freezes (Newell, 1989). Scallops are typically found in water temperatures ranging from 10-18ºC (Mullen and Moring, 1986), although larvae prefer warmer temperatures ranging from 20-25ºC (Fay et al., 1983).

Recent studies on the Mediterranean mussel (*Mytilus galloprovincialis*) suggest that, as the species lives close to its thermal tolerance level, even a small degree of warming will elicit stress responses (Anestis et al. 2007). Wang and Overgaard (2007) citing the work of Portner and Kunst (2007) note that a "pejus" (defined as "turning worse") temperature exists that is narrower than the critical temperatures, and which can result in population declines prior to reaching critical temperatures.

Thus, the geographical redistribution of species with climate change would not be unexpected; begging the question of what effect increased water temperatures might be having on specific Peconic shellfish and finfish populations, including the bay scallop and winter flounder (Keller and Klein-MacPhee, 2000).

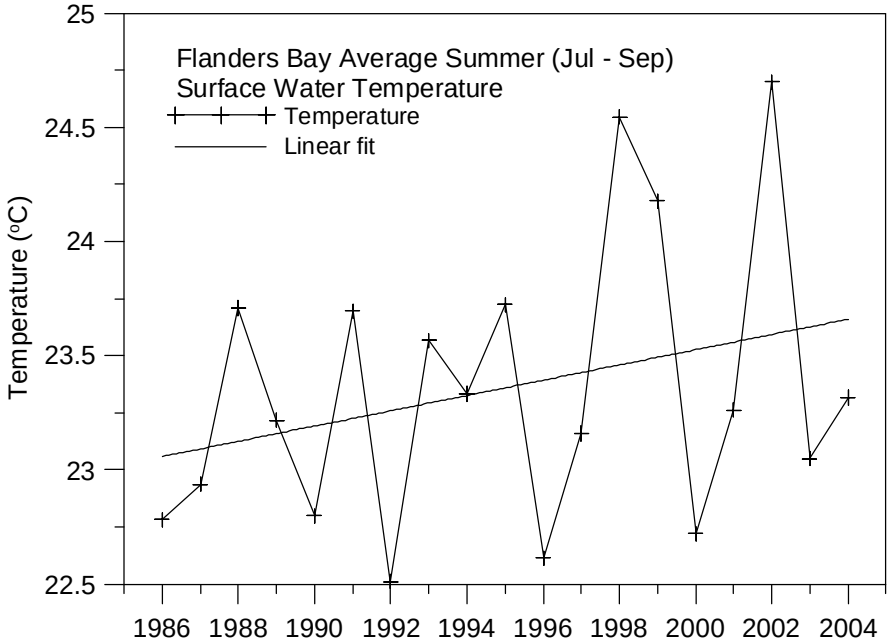
The long term increase in global temperature is not exhibited over the short term (1986 – 2004) in the Peconic Estuary (Figure 10).

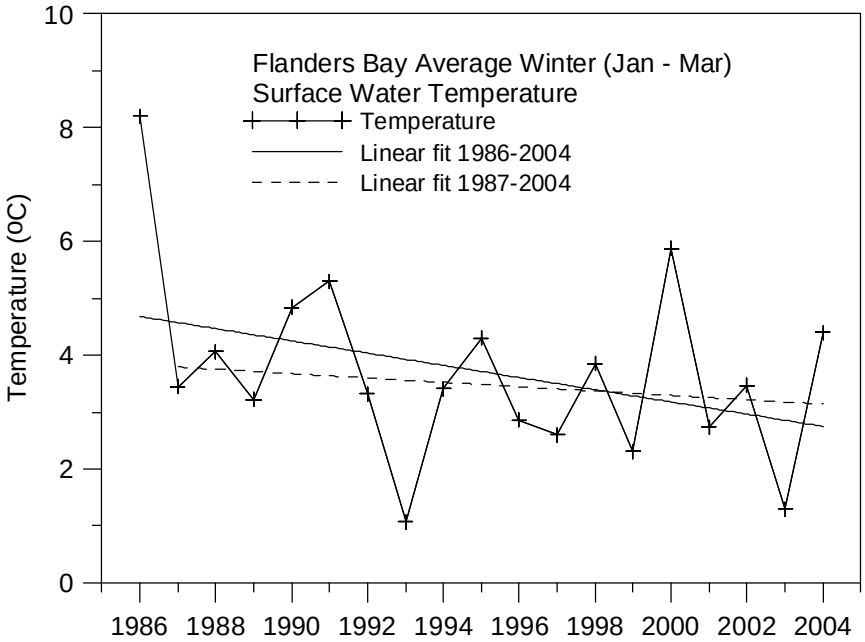
Figure 10. Flanders Bay Surface Water Temperatures, 1986 – 2004 (SCDHS data)



Although average summer (July – September) surface water temperature exhibits an increasing trend over the 1986 – 2004 period, the opposite is noted for average winter (January – March) temperatures (Figure 11).

Figure 11. Average Summer (top) and Winter (bottom) Surface Water Temperature in Flanders Bay, 1986 – 2004. A winter declining trend (dashed line) remains even with the removal of the unusually high 1986 winter value. (SCDHS data).

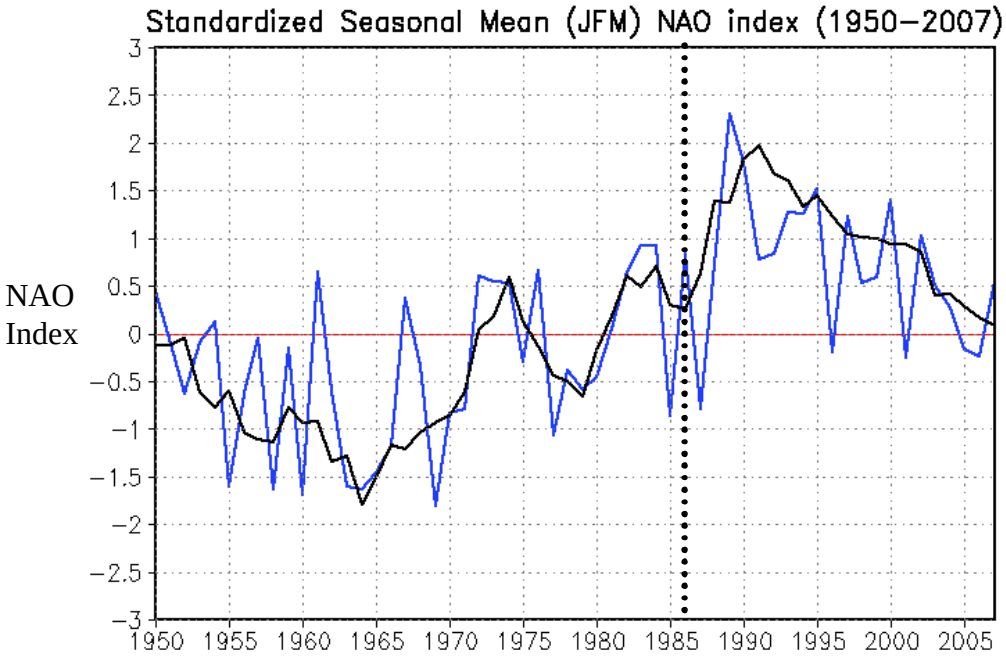




From data available through 1996, Smayda et al (2004) noted a warming trend in lower Narragansett Bay (Rhode Island) beginning in the early 1960s, with the mean annual temperature and North Atlantic Oscillation (NAO) exhibiting

parallel cycles and trends, and a moderate positive correlation during the winter (January – March). A comparison of average winter surface water temperature in Flanders Bay (refer to Figure 10) and NAO index (Figure 12) also reveals a parallel trend (decreasing) in both from 1986 – 2004.

Figure 12. Standardized Seasonal (January – March) Mean NAO Index, 1950 – 2007 (NOAA 2007). Note the decreasing trend after 1986.



The cyclical nature of the NAO, even in the quasi long-term, is apparent from the above figure. The duration of the declining trend, and its effect on estuarine ecology, remain to be seen. It's apparent however, from Smayda et al (2004) that, in Narragansett Bay, there is an inverse relationship between the NAO index and chlorophyll *a* from 1973 through 1996, which is opposite that seen in the Peconic Estuary, from 1986 through 2004, where chlorophyll-*a* has been declining along with the NAO index. Smayda et al. also note a decline in the numbers of the Arctic-Boreal diatom *Detonula confervacea* (formerly the second most abundant species in Narragansett Bay) linked to the warming trend, and shifts in annual bloom patterns of the common and abundant diatom *Skeletonema costatum.*

Although there is no concomitant data set for the Peconic Estuary, there are indications that the importance of diatoms in this system has also diminished, along with the previously more common winter-spring bloom that has been replaced by a summer-fall bloom (Nuzzi, personal communication). Recent late summer-early fall blooms in the Peconic Estuary have been dominated by the harmful dinoflagellate *Cochlodinium polykrikoides* (Gobler et al. 2008). Gobler et al. have demonstrated the ability of this organism to increase finfish and shellfish (bay scallops and oysters) mortality, and to reduce growth rates in surviving scallops.

Bloom timing, magnitude, and composition are of major importance relative to shellfish nutrition, growth and survival. Even absent harmful species, incorrect bloom phasing or size relative to shellfish needs (*e.g.*, gonadal development, larval growth, etc.) can result in poor, or no setting or growth. Shellfish aquaculture, which is not likely to rely on organism fecundity, may also ameliorate other problems by circumventing sensitive (larval and early juvenile) stages.

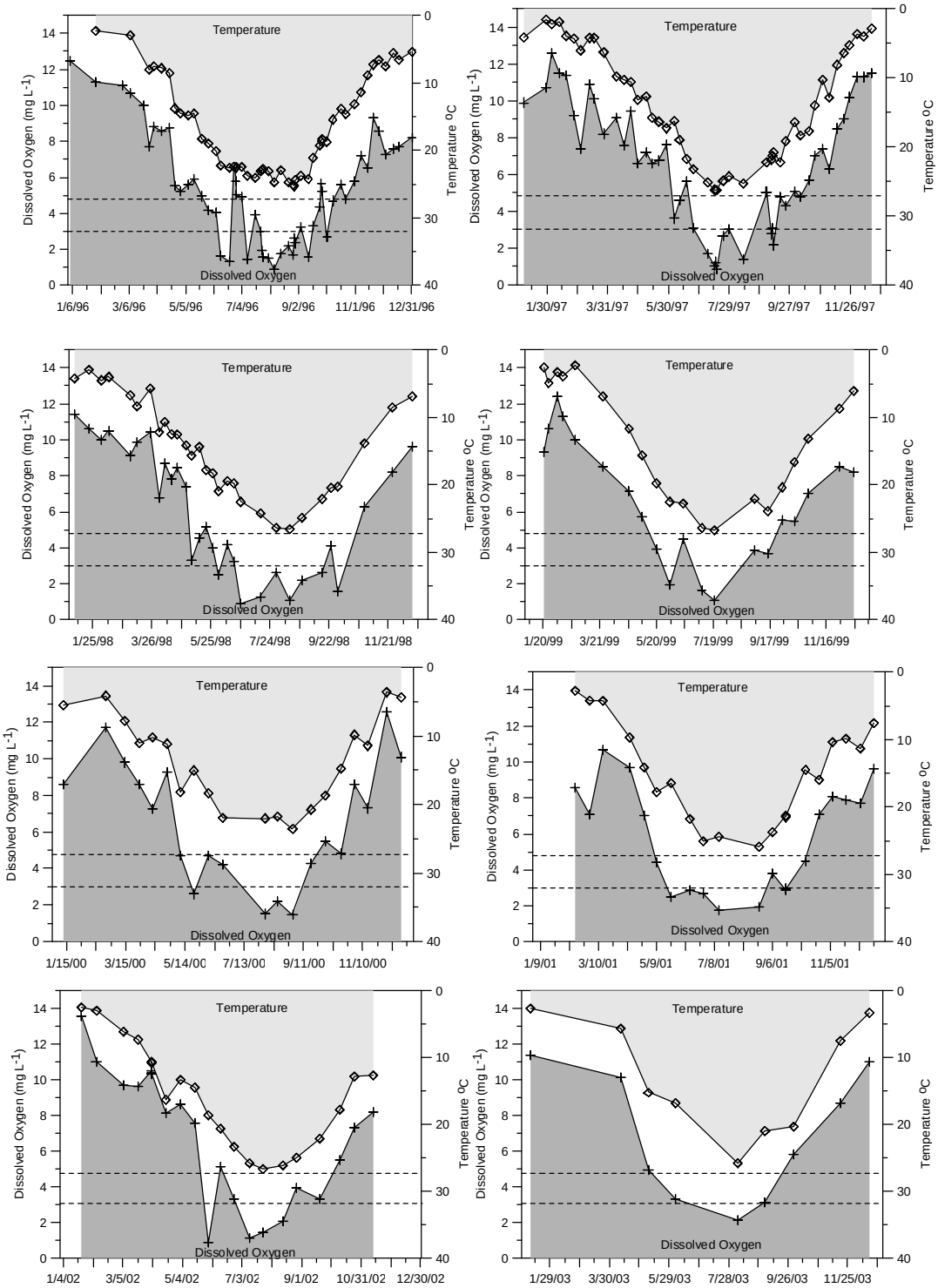
Dissolved oxygen

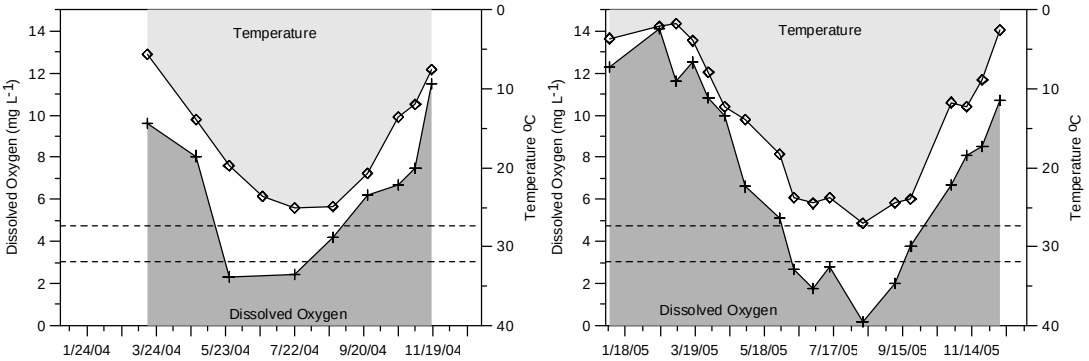
Dissolved oxygen (DO) concentrations throughout the estuary are predominantly regulated by the biological activity in the water and sediment. DO concentrations are lowered through bacterial decomposition of dead and dying vegetation, and night-time respiration by aquatic plants, resulting in lowest DO concentrations during early morning prior to the initiation of photosynthesis. Excessively low levels of DO can be detrimental to aquatic life, even over short periods of time. Large algae blooms resulting from elevated nutrient (especially nitrogen) levels are especially problematic. While hypoxia rarely occurs in the surface waters of the open estuary, primarily because of tidal and atmospheric exchange, it is not uncommon for the more enclosed, shallow tributary waters to experience surface hypoxia and bottom anoxia.

The historic DO water quality standard of 5.0 mg/L set by the NYSDEC has been reevaluated to allow for occasional violations for short periods of time. In accordance with proposed NYS recommendations, DO values may dip below 4.8 mg/l for limited periods of time, "with allowable excursion down to, but never less than 3.0 mg/l."

The western portion of the Peconic Estuary, specifically the lower Peconic River, the bottom waters of western Flanders Bay, and the tidal tributaries (Sawmill Creek, Meetinghouse Creek, East Creek) often violate the DO standards (SCDHS 2007). This is especially true during the summer months when both water temperature and chlorophyll levels are high (Tetra Tech 1998). DO levels below 3 mg/l have been recorded in the tidal creeks and Peconic River (SCDHS 2007). DO levels in Meetinghouse Creek, which has highly organic sediment and subject to duck farm effluent and high inputs of nitrogen from an agricultural watershed, have fallen below 3 mg/L every summer from 1996 - 2005 (Figure 13), and probably prior and subsequent to those dates (Nuzzi 2007). Even the bottom waters of Flanders Bay have experienced occasional hypoxia (SCDHS).

Figure 13. Annual Variation of Dissolved Oxygen and Temperature in the Near-bottom Waters of Meetinghouse Creek 1996-2005. r = -0.89 for 397 paired values (p = <.0001). In accordance with NYS and EPA standards, D.O. values may dip below 4.8 mg L^{-1} (upper dashed line) for limited periods of time, "with allowable excursions down to, but never less than 3.0 mg L^{-1}" (lower dashed line). Source: Nuzzi, 2007





Optimum growth in hard clams occurs when the DO is above 4.0 (Whetstone et al. 2005) or 4.2 (Baker et al. 2002) mg/L and, while hypoxic (low) or anoxic (zero) levels of DO can be tolerated for extended periods as a result of anaerobic respiration, growth ceases (Baker et al. 2002). Stanley and Dewitt (1983) found survival of clams for three weeks at 1 mg/l DO. Scallops are tolerant of DO concentrations down to a level of 1.5 ppm (Fay et al., 1983).

4.1.1.3. Finfish

In the mid 1980s through the mid 1990s, NYSDEC conducted a nine year study on the marine finfish and crustacean resources of the Peconic Estuary. A small-mesh otter trawl was towed in a grid-pattern extending from Flanders Bay to the western portion of Shelter Island Sound, collecting a total of 3,657 tow samples. The study identified 74 species of fish representing 41 families. During the 1987-1995 study period, six species of fish (bay anchovy, winter flounder, weakfish, windowpane, Atlantic silverside and scup) accounted for 88 percent of the total number of finfish caught. In addition, eight species of macroinvertebrates were caught incidentally to finfish trawl surveys. Table 10 represents the marine species caught in the Peconic Bays during the NYSDEC survey.

Table 10. Finfish Observed in Peconic Bays During NYSDEC Survey

FAMILY	SPECIES	COMMON NAME
Carcharhinidae	*Mustelus canis*	Smooth dogfish
	Carchrahinus plumbeus	Sandbar shark
Rajidae	*Raja eglanteria*	Clearnose skate
	Raja erinacea	Little skate
	Raja laevis	Barndoor skate
	Raja ocellata	Winter skate
Dasyatidae	*Dasyatis centroura*	Roughtail stingray
Myliobatidae	*Rhinoptera bonasus*	Cownose ray
Anguillidae	*Anguilla rostrata*	American eel
Congridae	*Conger oceanicus*	Conger eel
Clupeidae	*Brevoortia tyrannus*	Atlantic menhaden
Engraulidae	*Anchoa hepsetus*	Striped anchovy
	Anchoa mitchilli	Bay anchovy
Synodontidae	*Synodus foetens*	Inshore lizardfish
Gadidae	*Anchelyopus cimbrius*	Fourbeard rockling
	Gadus morhua	Atlantic cod
	Merluccius bilinearis	Silver hake
	Microgadus tomcod	Atlantic tomcod
	Pollachius virens	Pollock
	Urophycis chuss	Red hake
	Urophycis regia	Spotted hake
Batrachoididae	*Opsanus tau*	Oyster toadfish
Cyprinodontidae	*Fundulus diaphanus*	Banded killifish
Atherinidae	*Menidia menidia*	Atlantic silverside
Gasterostedidae	*Apeltes quadricus*	Fourspine stickleback
	Gasterosteus aculeatus	Threespine stickleback
Fistulariidae	*Fistularia tabacaria*	Bluespotted cornetfish
Syngnathidae	*Hippocampus erectus*	Line seahorse
	Sygnathus fuscus	Northern pipefish
Triglidae	*Prionotus carolinus*	Northern searobin
	Prionotus evolans	Striped searobin
Cottidae	*Myxocephalus aenaeus*	Grubby
	Myxocephalus scorpius	Shorthorn sculpin
	Myxocephalus octodecemspinosus	Long-horned sculpin
Percichthyidae	*Morone americana*	White perch
	Morone saxatilis	Striped bass
Serranidae	*Centropristis striata*	Black sea bass
Priancanthidae	*Pristigenys alta*	Short bigeye
Pomatomidae	*Pomatomus saltatrix*	Bluefish
Rachycentridae	*Rachycentron canadum*	Cobia
Echeneidae	*Encheneis naucrates*	Shark sucker

Carangidae	*Caranx bartholomaei*	Yellow jack
	Caranx crysos	Blue runner
	Caranx hippos	Crevalle jack
	Decapterus macarellus	Mackerel scad
	Selene vomer	Lookdown
	Trachurus lathami	Rough scad
	Alectis ciliaris	African pompano
Lutjanidae	*Lutjanus analis*	Mutton snapper
	Lutjanus griseus	Gray snapper
Sparidae	*Stemotomus chrysops*	Scup
Sciaenidae	*Bairdiella chrysoura*	Silver perch
	Cynoscion regalis	Weakfish
	Leiostomus xanthurus	Spot
	Menticirrhus saxatilis	Northern kingfish
Mullidae	*Upeneus parvus*	Dwarf goatfish
Sphyranenidae	*Sphyaena guachancho*	Guaguanche
Labridae	*Tautoga onitis*	Tautog (blackfish)
	Tautogolabrus adspersus	Cunner
Pholidae	*Pholis gunnellus*	Rock gunnel
Ammodytidae	*Ammodytes americanus*	American sand lance
Gobiidae	*Gobiosoma bosc*	Naked goby
	Gobiosoma ginsburgi	Seaboard goby
Scombridae	*Scomber scombrus*	Atlantic mackerel
Stromateidae	*Peprilus triacanthus*	Butterfish
Bothidae	*Etropus microstomus*	Smallmouth flounder
	Paralichthys dentatus	Summer flounder
	Paralichthys oblongus	Fourspot flounder
	Scophthalmus aquosus	Windowpane
Pleuronectidae	*Pleuronectes americanus*	Winter flounder
Soleidae	*Trinectes maculatus*	Hogchoker
Balistidae	*Aluterus schoepfi*	Orange filefish
	Balistes capriscus	Gray triggerfish
Teteraodontidae	*Sphoeroides maculatus*	Northern puffer

Source: Webber et al., 1998

4.1.1.4. Benthic Zone

Sediment Characteristics

The substrate of the Peconic Estuary generally consists of gravel and coarse to very coarse sands, with few areas dominated by medium sands, and fewer areas dominated by fine sand and silt (EEA, 1999). Lewis et al. (1997) reported that muddy sediments were typical in water depths greater than 7 meters. Most of

these muddy sediments were reported also containing shell and stone habitats (Flood and Cerrato, 2007), with the exception of lower Noyac Bay, lower Northwest Harbor, and central Great Peconic Bay (Lewis et al., 1997). Numerous rocks and ledges are found approximately 1 km offshore of Long Beach in Southold (Flood and Cerrato, 2007).

Beginning in 2003, a benthic mapping survey was conducted by Flood et al. on behalf of Suffolk County to assess the different bottom types throughout the estuary (termed the Phase I mapping project). The benthic survey was performed using side-scan sonar and multibeam mapping in Flanders Bay, northeast of Robins Island, Orient Harbor, east of Shelter Island, Northwest Harbor, and east of Gardiners Island. The results of the benthic survey showed that the morphology of the seafloor is unique in that it still maintains apparent glacial-aged topography, eroded glacial deposits, early post-glacial canyons and channels, widespread relict oyster reefs, modern migrating sand banks, restricted areas of modern mud accumulation, and active sand waves (Flood et al., 2006). Flood and Cerrato (2007) focused on benthic habitats of Great Peconic Bay West, Pipes Cove and Orient Delta using similar methods as the previous survey (termed the Phase II mapping project). The following is a summary of the findings of the benthic mapping surveys.

Multibeam backscatter showed that most areas of the estuary surveyed consist of coarse material (e.g., gravel and shell), with lesser areas dominated by muddy sediments with little shell. Lateral variability in sediment characteristics was evident in Flanders Bay, with possible sites of fine-grained sediment deposition. The seafloor of the central portion of Orient Harbor is flat with fine-grained sediment, although some large, round features indicate the presence of materials that may have been dropped on the seafloor. A prominent east-west ridge was mapped at the southwestern portion of Orient Harbor that has a deep trough to the north and more gradual slopes to the south. Southeast of Shelter Island, a broad ridge and complex topography southeast of the ridge were identified.

Symmetrical sand waves were reported for the channel in Northwest Harbor. Some sand waves appeared to be asymmetrical, suggesting that some net sediment transport is occurring. The benthic mapping northeast of Gardiners Island showed many irregularities in topography, including canyon-like features, and the presence of large, uncharted boulders. The seafloor north and east of Robins Island is generally smooth with a zone of more variable topography. Many dome-like features were observed, which were estimated to be former shellfish beds or other biogenic structures. A trough mapped in the area is believed to be part of an ancient river bed formed earlier than 8,500 years ago.

Faunal Assemblages

The overall benthic condition of the Peconic Estuary is rated "fair" by the USEPA (USEPA, 2007) as only a small percentage of benthic samples collected throughout the estuary were rated as "poor." Benthic samples with poor ratings (4 total) were collected from the central portion of Great Peconic Bay and Gardiners Bay, and from two inland waters along the south fork.

To distinguish whether estuary benthic habitats are degraded, the USEPA has developed benthic indices of environmental condition for estuaries that reflect changes in the diversity and population size of indicator species. A poor benthic index rating indicates that the benthic communities are less diverse than expected, are populated by more pollution-tolerant species than expected, and contain fewer pollution-sensitive species than expected. The expected diversity of an estuary is determined based on a statistical relationship of site diversity to site salinity. An estuary's benthic index is considered poor if less than 75% of the expected benthic diversity is present (USEPA, 2007).

During the 1990s, benthic samples were collected throughout the Peconic Estuary as part of two shellfish surveys conducted for the Peconic Estuary Program (PEP). Lewis et al. (1995) collected samples from the deep water areas of the Peconic Estuary, and Lewis and Rivara (1998) focused on the tributaries and embayments

of the estuary. The following represents the benthic fauna identified throughout the estuary during the two shellfish surveys.

Invertebrate tubes were observed in large quantities on the sediments in the deep water areas throughout the estuary (Lewis et al., 1997). Amphipod tubes were found in Flanders Bay and terrebellid tubes were found east of Flanders Bay. Several species of hairy cucumbers, most of which are not common to regional waters, were observed on soft muddy substrates throughout the entire Estuary. Abundant numbers of hydroids (*Halecium* spp.) were observed in the deeper waters surrounding Shelter Island and south of Robins Island (Lewis et al., 1997). Red chiton (*Ischnochiton ruber*), the bottom dwelling herbivore, was found predominantly in the deep waters of Hog Neck Bay, Southold Bay, and Shelter Island Sound (Lewis et al., 1997).

The long-clawed hermit crab (*Pagurus longicarpus*) was observed in low numbers throughout the deep waters of the estuary (Lewis et al., 1997). The flat-clawed hermit crab (*Pagurus pollicaris*) was observed only in the eastern deep waters of the estuary, predominantly east of Little Peconic Bay (Lewis et al., 1997).

Other benthic species reported throughout the estuary include the New England dog whelk (*Nassarius trivittatus*), blood arks (*Andadara ovalis*), jingle shells (*Anomia simplex*), and the near nut shell (*Nucula proxima*). The New England dog whelk and jingle shells, distributed throughout the deep waters of the estuary, were most abundant in Flanders Bay. Blood arks were observed distributed throughout the inshore portions of the estuary, with an increasing trend from west to east. The near nut shell was observed at a limited number of stations sampled during the deep water survey, but its abundance was underestimated as the size of the species is smaller than the spacing on the sample dredge (Lewis et al. 1997), Shellfish predators such as sea stars, crabs, knobbed and channeled whelk, moon snails, and oyster drills are dispersed throughout the estuary with no apparent trend. Brittle stars dominate the deep waters of Great Peconic Bay (Lewis et al.,

1997). Burrowing brittle stars (*Amphioplus abditus*) were found predominantly in the deep waters of Noyac Bay, the central and southern portion of Great Peconic Bay, and few other deep water areas throughout the estuary. Lewis et al. (1997) reported that some of the stations had such an abundance of burrowing brittle stars that it was used as a sediment characteristic. Common sea stars (*Asterias forbesii*), a significant predator of shellfish, were virtually absent during the deep water survey, found only in Flanders Bay, and were not observed during the tributary and embayment survey. Northern moon shells (*Lunatia heros*) were sparsely found in the deep waters of the estuary, specifically in the offshore waters east of Shelter Island (Lewis et al., 1997).

Lady crabs (*Ovalipes ocellatus*) were widely distributed in large numbers throughout the deep water areas of the estuary, and were the most abundant shellfish predator during the tributary and embayment survey. Lady crabs were most abundant in the central portion of the estuary, near Robins Island and in Hog Neck Bay. Rock crab (*Cancer irroratus*) abundance was found to be very low and limited to the deep waters of Gardiners Bay. Common spider crabs (*Libinia emarginata*) were limited to the eastern deep waters of the estuary, specifically in the deep waters of Shelter Island Sound. The black-fingered mud crab (*Dyspanopeus sayi*) was reported abundantly distributed throughout the entire estuary during the deep water survey and in lesser numbers during the tributary and embayment survey. The Atlantic horseshoe crab (*Limulus polyphemus*) was limitedly distributed throughout the estuary. Lewis et al. (1997) reported a significant decrease in horseshoe crab populations throughout the estuary since the NYSDEC 1979/1980 survey.

Keystone, and Other Important Benthic Species

Slipper shells (*Crepidula* sp.) are most abundant in the open waters of the estuary and in the deeper water areas east of Shelter Island, and are believed to be a significant competitor to hard clams (Lewis and Rivara, 1998; Lewis et al., 1997). Rare species, such as bivalves *Macoma balthica* and Morton's eggcockle

(*Laevicardium mortoni*), and short-spined brittle stars, are also found within the estuary (Lewis and Rivara, 1998).

Boring sponges (*Cliona celata*), which can create large holes in shellfish, especially oysters, were found distributed throughout the estuary with no obvious trends in distribution during the deep water survey conducted by Lewis et al. (1997).

Shellfish Abundance/Distribution from Previous Studies and Ground-truthing

The shellfish survey conducted by Lewis et al. (1997) assessed the presence of commercially-harvested shellfish resources existing in the deep water areas of the Peconic Estuary (Deep Water Survey), while the shellfish survey conducted by Lewis and Rivara (1998) concentrated on the tributaries and embayments of the estuary. An earlier shellfish survey of the deep waters of the Peconic Estuary was conducted by NYSDEC in 1979/1980 (Weber and Grahn, 1995). Sample locations from the NYSDEC survey were included as part of the sampling grid scheme used in the 1997 deep water survey to allow for comparisons in species abundance over time. The 1997 and 1998 shellfish surveys used comparable methodology so as to build a comprehensive picture of the entire estuary. The following discussion describes the shellfish abundance and distribution within the estuary as determined by the investigations.

Commercially-harvested shellfish resources were predominantly found within water depths of 1 to 6 ft (0.31 meters to 1.85 meters), which make up only 6.6% of the estuary (Lewis and Rivara, 1998). Hard clams (*Mercenaria mercenaria*) were found in a patchy distribution throughout the entire estuary, with higher numbers in tributaries and shallow embayments (particularly Northwest Harbor), and along the fringes of deeper waters in sand and shell/stone substrates. In terms of size, chowder clams were the most abundant within the estuary, while cherrystone clams were the least abundant. Littleneck clams were most abundant in waters east of Shelter Island. Atlantic surf clams (*Spisula solidissima*) were

generally found in Gardiners Bay, and in low numbers off Robins Island (Lewis et at., 1997). Razor clams (*Ensis directus*) were found in the eastern portion of the estuary, mainly in Northwest Harbor and Gardiners Bay (Lewis et al., 1997). The shallow waters northwest of the Shinnecock Canal entrance were naturally abundant in hard clams during the 1970s and 1980s; however this natural abundance has decreased over subsequent years (S. Tollefsen, private oyster grant holder, personal communication, July 2007).

Bay scallops were most abundant within the Peconic Estuary in the late 1970s and early 1980s (NYSDEC, 1982), but were severely impacted in the mid-1980s by the Brown Tide. Subsequent Brown Tide algal blooms further reduced bay scallop populations to near extinction (Tettelbach and Wenczel, 1993). Bay scallop populations have yet to recover, as evident during the Deep Water Survey and the Tributaries and Embayments Survey. Bay scallops were limited mainly to the waters surrounding Shelter Island.

Historically, the natural recruitment of oysters within the deep waters of the estuary was low, and survival rates may be greater in some of the tributaries and embayments of the estuary (Lewis et al., 1997). Oysters were virtually absent during PEP (1995 and 1997) and NYSDEC (1979/1980) shellfish surveys (Table 11). Only one oyster, found during the Tributaries and Embayment Survey near a facility that is part of East Hampton's aquaculture program, was collected. Oysters historically were the most valuable commercial species in the Peconic Estuary; however, these populations came from the seeding of bottom waters for grow-out, and were not natural stock (PEP, 2001).

Knobbed whelks (*Busycon carica*) and channeled whelks (*Busycon canaliculatum*) were common throughout the estuary, with greater abundance in deep waters. A significant decrease in total whelk abundance was observed when the Deep Water Survey was compared to the 1979/1980 NYSDEC survey. These whelk species prey upon clams and oysters.

Oyster drills (*Urosalpinx cinerea*) are present throughout the deep waters of the estuary, with increasing abundance from west to east (Lewis et al., 1997). Oyster drills, although not a commercially harvested shellfish species, prey directly on small shellfish, most notably the eastern oyster. Oyster drill abundance was significantly higher when compared to the 1979/1980 NYSDEC shellfish survey.

Table 11. Shellfish Species Recorded in the Peconic Estuary During the PEP Shellfish Surveys

Common Name	Scientific Name
Hard clam	*Mercenaria mercenaria*
Atlantic surf clam-	*Spisula solidissima*
Razor clam	*Ensis directus*
Atlantic bay scallop	*Argopecten irradians*
Eastern oyster	*Crassostrea virginica*
Knobbed whelk	*Busycon carica*
Channeled whelk	*Busycon canaliculatum*
New England dog whelk	*Nucella lapillus*
Oyster drill	*Urosalpinx cinerea*
Northern moon shell	*Lunatia heros*
Long-clawed hermit crab	*Pagurus longiscarpus*
Flat-clawed hermit crab	*Pagurus pollicaris*
Rock crab	*Cancer irroratus*
Black-fingered mud crab	*Dyspanopeus sayi*
Lady crab	*Ovalipes ocellatus*
Common spider crab	*Libinia emarginata*
Atlantic horseshoe crab	*Limulus polyphemus*
Blood ark	*Anadara ovalis*
Jingle shell	*Anomia simplex*
Near nut shell	*Nucula proxima*
Common slipper shell	*Crepidula fornicata*
Flat slipper shell	*Crepidula plana*

Source: Lewis et al., 1997; Lewis and Rivara, 1998

Benthic-Pelagic Coupling

Benthic-pelagic coupling, the cycling of nutrients between the sediments and the overlying water column, is very much affected by benthic species and numbers present. Shellfish, as filter feeders, mediate benthic-pelagic coupling by removing

particles, including phyto- and zooplankton, from the water column and depositing feces and pseudofeces onto the sediment. Further discussion of benthic-pelagic coupling can be found in Section 4.1.2, carrying capacity/phytoplankton depletion/nutrients.

4.1.1.5. Submerged Aquatic Vegetation (current and historic)

The importance of submerged aquatic vegetation (SAV) to aquatic ecosystems has been well documented. SAV beds (especially eelgrass meadows) provide numerous beneficial functions which include: a high level of primary production which forms the base of a rich food chain; provisions of nursery areas; shelter and protection for various species of finfish and invertebrates; provisions of a multi-level habitat, which increases species diversity and abundance compared to areas that lack vegetation; cycling of nutrients (e.g. nitrogen and phosphorous) from the surrounding environment, and the re-release of those nutrients through organic decay; stabilization of bottom sediments (for rooted SAV species, such as eelgrass); and moderation of currents and waves in the near-bottom zone, which promotes sedimentation of particles from the water column, inhibits resuspension of previously settled particles, and moderates water column turbidity. In a comparative evaluation of habitat value in a southern Rhode Island tidal estuary, however, Dealteris et al. (2004) concluded that modified rack and bag shellfish aquaculture gear had "substantially greater habitat value than a shallow non-vegetated seabed," and "habitat value at least equal to and possibly superior to submerged aquatic vegetation." The cultured shellfish was the oyster *Crassostrea virginica*, and the SAV was *Zostera marina*.

SAV identified throughout the Peconic Estuary for the purposes of this report includes not only rooted aquatic vegetation (e.g. eelgrass and widgeon grass), but also attached and unrooted aquatic vegetation (e.g. green fleece, rock weed, brushy redweed, lacy redweed, sea lettuce, kelp, etc.).

A field study conducted by Cashin Associates for SCDHS during a six week sampling period from mid-September through late-October 1994 surveyed SAVs at 214 stations throughout the Peconic Estuary. The survey identified 2 species of seagrasses (Phylum Spermatophyta), 22 types of red algae (Phylum Rhodophyta), 9 types of green algae (Phylum Chlorophyta), and 10 types of brown algae (Phylum Phaeophyta). At the time the study was conducted, Green fleece (*Codium fragile)* was the dominant SAV species in the estuary, both in terms of total area covered and total dry weight biomass. Green fleece appeared to have invaded areas previously known to have contained eelgrass meadows. Although it appeared likely that this displacement was the result of passive mechanisms, with the green fleece moving into areas that have been vacated by eelgrass, rather than through direct competition between the two species, the establishment of green fleece beds at a given location may hinder the future resurgence of eelgrass. SAV beds dominated by sea lettuce (*Ulva lactuca*), which is typical of high nutrient, brackish areas, were concentrated in the inner portions of the estuary, confined to the smaller tidal creeks and the shallow waters of the adjoining embayments, as well as in some areas of the mid-portion of the estuary. Table 12 shows the SAV identified within the estuary during the six week sampling period.

Table 12. Submerged Aquatic Vegetation Identified in Peconic Estuary

Botanical Name	**Common Name**
PHYLUM SPERMATOPHYTA (Sea Grasses)	
Zostera marina	Eelgrass
Ruppia maritima	Widgeon Grass
PHYLUM RHODOPHYTA (Red Algae)	
Euthora cristata	Lacy Redweed
Cystoclonium purpureum	Brushy Redweed
Polysiphonia denudata	Tubed Weeds
Polysiphonia subtilissima	Tubed Weeds
Polysiphonia spp.	Tubed Weeds
Ceramium diaphanum	Banded Weeds
Ceramium spp.	Banded Weeds
Chondrus crispus	Irish moss
Lomentaria baileyana	
Dasya pedicellata	Chenille Seaweed
Chondria spp.	Pod Weed
Agardhiella sublata	
Antithamnion spp.	
Grinnellia Americana	Grinnell's Pink Leaf
Gracilaria tikvahiae	
Spermothamnion spp.	
Champia parvula	Barrel Weed
Ahnfeltia plicata	Wire Weed
	Miscellaneous (unidentified)
PHYLUM CHLOROPHYTA (Green Algae)	
Codium fragile	Green Fleece
Ulva lactuca	Sea Lettuce
Entermorpha linza	Hollow Green Weeds
Entermorpha compressa	Hollow Green Weeds
Entermorpha clathrata	Hollow Green Weeds
Entermorpha intestinalis	Hollow Green Weeds
Entermorpha spp.	Hollow Green Weeds
Chaetomorpha melagonium	
Chaetomorpha linum	
PHYLUM PHAEOPHYTA (Brown Algae)	
Fucus spp.	Rockweed
Ascophyllum nodosum	Knotted Wrack
Sargassum filipendula	Gulfweed
Laminaria saccharina	Broad-leaf Kelp
Chorda filum	Smooth Cord Weed
Stilophora rhizodes	
Sphaerotrichia divaricata	Slippery Tangle Weed
Acrothrix novae-angliae	

Source: Cashin Associates, 1996a

The Cashin study revealed that eelgrass-dominated areas were characterized by high salinity, high water clarity and low temperatures; the sea lettuce-dominated areas were characterized by low salinity and underwater visibility, high water temperature and high nutrients levels. The areas dominated by Green fleece were associated with intermediate values of salinity, water temperature, and visibility.

Eelgrass beds located throughout the Peconic Estuary appear to have been undergoing a general decline for the past 70 years (Cashin Associates, 1996a) (Pickerell and Schott, 2005). In the early 1930s, approximately 75 percent of the eelgrass beds throughout the estuary (over 8,700 acres) suffered a catastrophic decline due to "wasting disease" (Pickerell et al., 2003), the primary cause of which is thought to be due to the presence of slim mold (*Labyrinthula zosterae*) (G. Rivara, Cornell Cooperative Extension of Suffolk County, personal communication, February 2008). Eelgrass beds in waters with salinity levels less than 12 to 15 ppt appeared to be immune to the effects of the wasting disease, and provided seed stocks for the subsequent recolonization (Thayer, et al., 1984).

In the late 1960s, eelgrass beds within the estuary recovered to levels so abundant, they were described as "nuisance" in some areas (EEA, 1999). These beds were nearly depleted in the mid 1980s during an extensive outbreak of Brown Tide (*Aureococcus anophagefferens*). Eelgrass beds in the eastern portion of the estuary were severely impacted as a result of the shading effect of high concentrations of *Aureococcus* in the water column (Dennison, et al., 1989). Historical declines of eelgrass beds in the middle and inner portions of the estuary not directly impacted by Brown Tide may have resulted from nutrient enrichment, combined with a slow water turnover rate, which may have caused blooms of phytoplankton and/or epiphytes that diminished the degree of light penetration (Dennison, et al., 1989).

Elevated concentrations of nitrates in the water column may also have a direct, adverse affect on eelgrass physiological function (Burkholder 1993; Burkholder, et al. 1992). Elevated nutrient levels can also enhance the growth of epiphytes on

eelgrass blades which can diminish the amount of light absorption by the eelgrass plants; and accelerate the growth of free-living green or red macroalgae, which can absorb nutrients more rapidly, out-competing eelgrass (Cashin Associates, 1996a).

Cashin Associates (1996a) found that eelgrass beds were most dense and abundant in the easternmost portion of the estuary (east of Shelter Island Sound), where green fleece was also prevalent. Moderately dense eelgrass beds were observed immediately north and south of Coecles Harbor Inlet (Cashin Associates, 1996a). An eelgrass study conducted by EEA, Inc. in 1999 revealed that eelgrass beds historically present 5-6 meters offshore from Cornelius Point at the northern tip of Shelter Island, declined to 20 meters from the shoreline; and were replaced by *C. fragile* and attached sargassum weed (*Sargassum filipendula*). EEA, Inc. also found that historic eelgrass beds in the shallow waters near Napeague Harbor significantly declined and were replaced by *C. fragile* and *Grassilaria* sp. According to Cashin (1996), the portion of the estuary west of Robins Island was absent of eelgrass but abundant in sea lettuce (*Ulva lactuca*). Some areas of sea lettuce-dominated SAV beds and eelgrass meadows were present in the mid-portion of the estuary (east of Robins Island to the eastern portion of Shelter Island Sound, including Hallock Bay). The eelgrass beds in the mid-portion of the estuary had a density and abundance lower than the composite average for the entire estuary (Cashin Associates, 1996a).

Presently, SAV within the estuary does not comprise large, continuous beds. Rather, they are distributed in a patchy formation, with areas of relatively or fully barren bottom interspersed with vegetated areas. Eelgrass beds are generally found in water depths of approximately 1 to 5 meters, depending on the clarity of the water. Some eelgrass beds have been identified at approximately 5 meters deep along the east side of Gardiners Island and at 4.5 meters near Orient Point (S. Schott, Cornell Cooperative Extension, personal communication, July 2007). In 2003, Tiner et al. mapped a total of 1,339 SAV beds throughout the estuary.

Eelgrass and "other algae" accounted for 2,660 acres, and green fleece (including mixtures with red algae) accounted for approximately 11 percent of the SAV acreage.

The estuarine waters in East Hampton are the most abundant in SAV acreage and in eelgrass, accounting for approximately 36 percent of the estuary's SAV beds. Eelgrass beds in Northwest Harbor have not shown a significant change from 1997 (Pickerell and Schott, 2005). Significant eelgrass beds are located in Southold Bay, Orient Harbor, Hallock Bay, along the southern shoreline of Long Beach, and along the eastern shorelines of Shelter Island and Gardiners Island. Eelgrass beds in Bullhead Bay and Orient Harbor have recently significantly declined in stem density, most likely the result of physical disturbances (i.e., ice scour, anchor ice, change in long-shore erosion/deposition patterns, and shellfishing activities); although, the exact factor(s) responsible for the sudden decline has not been identified (Pickerell and Schott, 2005). Eelgrass beds are predominantly located east of Shelter Island Sound, although, the eastern portion of Robins Island is likely to support eelgrass based on the physical characteristics of the area (Cashin, 1996a). Eelgrass beds west of Shelter Island are limited to only one known location, Bullhead Bay, located in the Town of Southampton. Bullhead Bay is one of the few eelgrass locations that have had a net increase in percent cover over recent years (Pickerell and Schott, 2005).

The total absence of eelgrass from the inner estuary and the relative abundance of sea lettuce are causes for concern, because this pattern of SAV distribution indicates an elevated level of environmental stress, with nutrient enrichment derived from human activities (as exacerbated by limited tidal flushing) probably being a primary causative factor.

Cornell Cooperative Extension (CCE), in cooperation with the Town of Southampton is presently conducting an eelgrass restoration project at Red Cedar Point in Flanders Bay. This restoration site is the only known area west of Shelter Island that supports eelgrass. CCE is also conducting eelgrass restoration projects

in the eastern portion of the estuary, specifically at Cornelius Point, North Haven, and Long Beach (Cornell Cooperative Extension of Suffolk County Marine Program website, accessed from http://counties.cce.cornell.edu/suffolk/habitat_restoration/seagrassli/index.html on January 7, 2008).

4.1.1.6. Shellfish Pathogens/Disease/Exotic Species

The most common shellfish diseases along the Atlantic coast include QPX (Quahog Parasite Unknown) in hard clams (*Mercenaria mercenaria*), and Dermo and MSX in oysters. Others include "juvenile oyster disease" (JOD) and "seaside organism" (SSO).

QPX, caused by a protistan parasite and limited to market and near-market sized clams, has caused mortalities of cultured clams in Canada, Massachusetts, New Jersey, and Virginia (Ragone Calvo and Burreson 2002), but was not detected in hatchery-produced seed clams (Ford et al. 1997). Ragone Calvo and Burreson found that "clams originating from South Carolina and Florida brood stocks had significantly higher prevalence of QPX and higher mortality than clams originating from Virginia, New Jersey and Massachusetts brood stocks," concluding that the geographic origin of the clam seed should be considered an important component of QPX disease avoidance/management strategies. No mortalities were reported in New Jersey after discontinuing the use of South Carolina seed, underscoring "the potential dangers of using non-local stocks in molluscan aquaculture" (Ford et al. 2002). Coen et al. (2004) have prepared a fact sheet summarizing the knowledge regarding QPX through 2004. Current work in the laboratory of Dr. Bassem Allam at SUNY Stony Brook School of Marine and Atmospheric Sciences focuses on QPX infection procedure (Dahl and Allam 2007), genetic variation (Qian et al. 2007), and the effects of starvation and macroalgal extracts (Buggé and Allam 2007).

Dermo and MSX are both caused by protozoan parasites; dermo by *Perkinsus marinus*, and MSX (**M**ultinucleate **S**phere **X** (unknown)) by *Haplosporidium*

nelsoni. The following is largely from the Eastern Oyster Biological Review team (EOBRT 2007) that has reviewed the literature on these diseases.

P. marinus infects first year oysters, killing up to 50% of the oysters that carry the infection into their second summer, and 80-90% by the third year. The range had been reported to be from Massachusetts to the Gulf of Mexico (Quick 1977), but has been extended to include Maine (Burreson and Ragone Calvo 1996, Ford 1996), probably as a result of the movement of infected seed oysters, and the Yucatan Peninsula (Burreson et al. 1994). The disease is reported to be associated with high salinity and temperature, and drought conditions (Burreson and Andrews 1988).

MSX was first reported in oysters from Delaware Bay in 1957 (Haskin et al. 1966) and by 1959 was found in the Chesapeake Bay waters of Virginia and Maryland (Andrews 1966). The EOBRT notes that while the mid-Atlantic region remains hardest hit, MSX has been reported from Maine to Florida, and that fluctuations in mortality are related to draught-caused local salinity increases (Barber et al. 1997, Burreson and Ragone Calvo 1996, Burreson and Andrews 1988). For infections to be sustained the salinity must be consistently above 15 ppt, and most of the oysters in the area will be killed at salinities above 18-20 ppt (EOBRT). Results of molecular analysis by Burreson et al. (2000) support previous speculation (Burreson, 1997) that the parasite was introduced to California populations of *C. gigas* from Japan, and from there to *C. virginica* populations on the east coast, "likely with known importations of *C. gigas*." They conclude "these results document greatly increased virulence in a naive host–parasite association and reinforce potential dangers of intentional, but improper, introductions of exotic marine organisms for aquaculture or resource restoration." The range of *H. nelsoni* has recently been found to extend throughout the Gulf of Mexico (Ulrich et al. 2007). Introduction of non-native *C. ariakensis* is one of the alternatives being considered by the U.S. Army Corps of Engineers and the states of Virginia and Maryland in an Environmental Impact Statement currently being

prepared for a program aimed at rejuvenating a seriously depleted oyster industry in the Chesapeake Bay. *C. ariakensis* does well at the higher salinities that promote both dermo and MSX, yet does not appear to be susceptible to these diseases. On the other hand, its potential susceptibility to other pathogens, its effect on native species and the ecosystem in general, are currently unknown. The introduction of non-reproductive triploid *C.* ariakensis to Bogue Sound, North Carolina revealed that this species appears to be highly sensitive to a previously unknown local pathogen, *Bonamia* sp. (Burreson et al. 2004) a fact that needs to be considered in its potential use for resource restoration and/or aquaculture, as does its apparent increased susceptibility to predation by various species of mud crabs, flatworms, and the blue crab (Newell et al. 2007). It's potential to become a nuisance species in some areas is also suggested.

Juvenile Oyster Disease affects eastern oysters generally <25 mm in shell height, and is of unknown etiology (Bricelj et al 1992). Utilization of disease resistant broodstock (individuals surviving the disease) has proven valuable in reducing the effect of JOD (Davis and Barber 1999, Barber et al. 1998). Recent research has shown that JOD's etiology is now known as bacterial, caused by *Roseovarius crassostreae* (Boettcher et al. 2005, 2006;Malloy et al., 2007), and suggestions have been made to change the name from JOD to ROD after the causative agent. JOD in Long Island waters has been recently discussed by Rivara and Czyzyk (2007), and Relyea (2007), and in waters off Fishers Island by Malinowski (2007).

SSO, like MSX, is caused by a haplosporidian protozoan (*Haplosporidium costale*). It has been found in *C. virginica* from Maine to the mouth of Chesapeake Bay, in waters over 25 ppt salinity (ICES 2004), killing up to 50% of infected stocks (Ford and Tripp 1996). A report on disease trends in fish and mollusks from 1998-2002 is available from the International Council for the Exploration of the Sea (ICES 2004).

Naylor et al. (2001) termed aquaculture a "gateway for exotic species" and urged adoption of World Conservation Union (IUCN 2000), and ICES (1994, 2003) guidelines for preventing the introduction of invasive species. More recently, a work plan for managing invasive species was drafted at the Convention on Biological Diversity sponsored by the United Nations Environment Programme (UNEP 2005), and a ten year summary of the status of introduction of exotic species in the north Atlantic has been provided by ICES (2007).

Common introduced species in this area that have become problematic include the fouling ascidian tunicates *Didemnum* sp. (Bullard et al. 2007) and *Bitryllus schlosseri,* probably introduced through oyster aquaculture in Maine in the early 1970s; *Botrylloides violaceus* and *Diplosoma listerianum* likely introduced by commercial and recreational vessels (Dijkstra et al. 2007); and the mainly soft-clam predator green crab *Carcinus maenas*, introduced to the Atlantic coast of North America during the mid-1800s in the Cape Cod area (Glude 1955).

Perhaps the most well known exotic macroalga in this area is *Codium fragile* ("oyster thief") likely brought to the northeast coast through oyster culture (Malinowski and Ramus 1973). C*odium*, by attaching to shells can impede shellfish movement and feeding, weakening them and increasing their susceptibility to predation. Dense growth can smother shellfish, and gas bubbles trapped under the growth can increase the buoyancy enough to float the shellfish off the bottom. Nevertheless, *Codium* has become a major macroalgae to Peconic Bay/Gardiners Bay system, and *Codium* beds are known to serve as habitat for scallops (Cashin, 1996a).

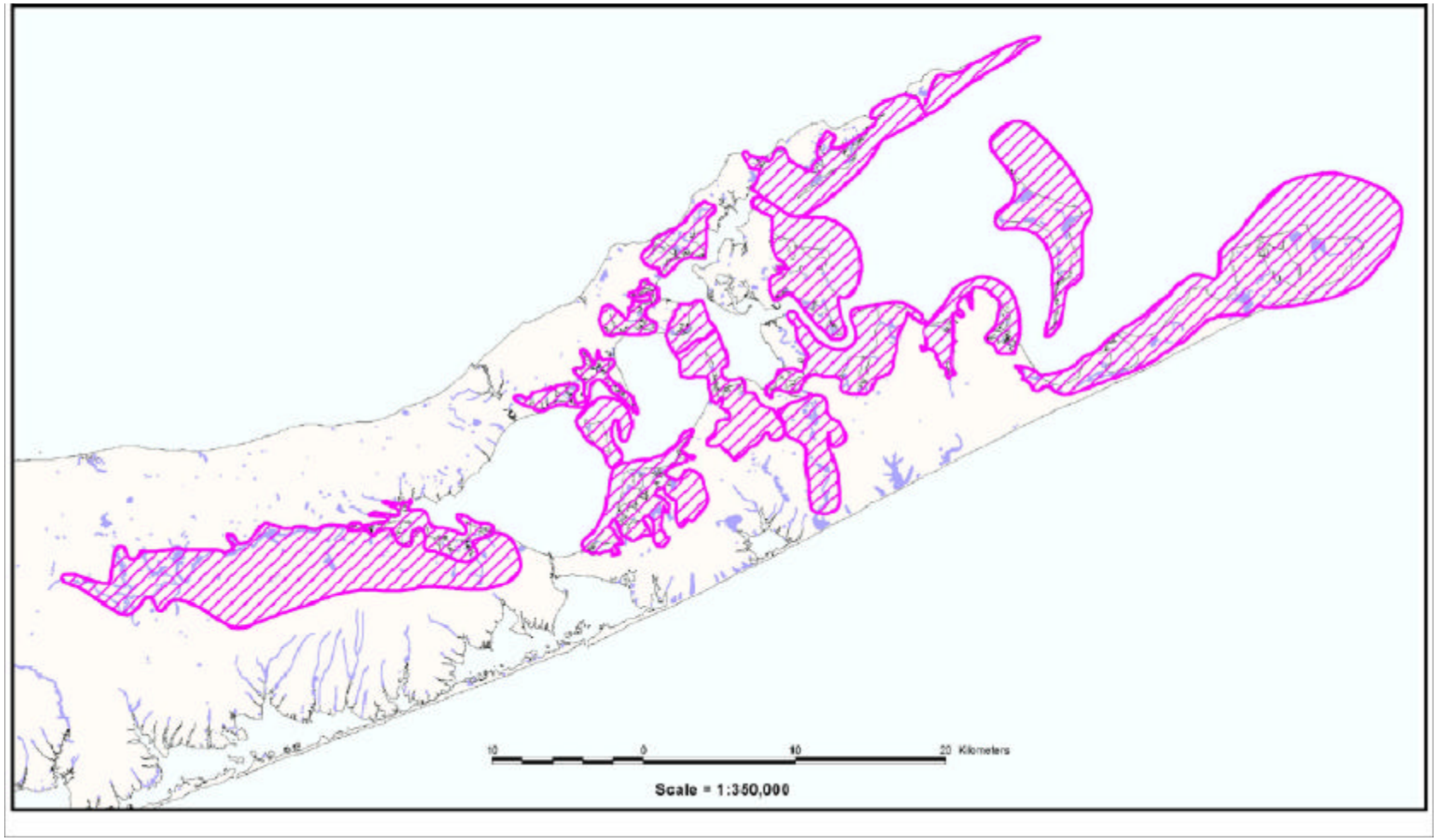
Harmful algal blooms (HABs) caused by phytoplankton can be problematic in several ways: they can be directly detrimental to shellfish, they can be instrumental in the development of hypoxia/anoxia, stressing and/or killing the shellfish, or they can render shellfish unmarketable because of public health reasons. While not all harmful phytoplankton may be considered exotic, there is

considerable evidence that at least some are. Most likely portals of entry are through ballast water (Simard and Hardy 2004), through bivalve transfers (Hegaret et al. 2006), or through dredge disposal operations, probably as cysts (Boesch et al. 1997). Public health related phytoplankton along the northeast coast that can be concentrated by bivalves include the dinoflagellates *Alexandrium tamarense* and *A. fundyense*, responsible for paralytic shellfish poisoning, and *Dinophysis acuminata, D. fortii* and *Prorocentrum lima*, responsible for diarrhetic shellfish poisoning. Diatoms (*Pseudo-nitzschia multiseries*, *P. pungens*, *P. australis*) have been associated with amnesic shellfish poisoning. None to date have caused problems in the Peconic Estuary. Phytoplankton that are directly detrimental to shellfish, and that have recently appeared in the Peconic Estuary, include the dinoflagellate *Cochlodinium polykrikoides*, first noted in 2002 (Nuzzi 2004) and which has resulted in shellfish mortalities (Gobler et al. 2008), and the pelagophyte *Aureococcus anophagefferens*, blooms of which resulted in the almost total destruction of the Peconic bay scallop, *Argopecten irradians* (Nuzzi and Waters 2004). There are species present that have either not bloomed (e.g., *Pfiesteria piscicida, P. shumwayii*) or, although they have been problematic elsewhere, have not proven to be so in the Peconic ecosystem (e.g., *Prorocentrum*, *Heterosigma*).

4.1.1.7. Critical Natural Resource Areas

In 1996, the Peconic Estuary Program delineated areas of particular ecological significance throughout the estuary and identified such areas as Critical Natural Resource Areas (CNRAs). Seventeen areas were identified as CNRAs (Figure 14). These areas are considered to be very high in ecological quality and provide important spawning, breeding, nursery, and feeding habitats for a diversity of rare, keystone, and commercially important species of fish, shellfish, birds, sea turtles, and sea mammals (PEP, 2001). Some of the CNRAs include portions of the estuary as well as upland freshwater and terrestrial zones.

Figure 14. Critical Natural Resource Areas throughout the Peconic Estuary



Source: Peconic Estuary Program, 2001

Areas of the Peconic Estuary that are considered to be rare ecological systems or areas that provide particularly significant benefits to populations of fish and wildlife have been designated by the NYS Department of State (NYSDOS) as Significant Coastal Fish and Wildlife Habitats (SCFWHs) These areas have been identified under the Waterfront Revitalization of Coastal Areas and Inland Waterways Act. Many of the SCFWHs overlap with or are contained within CNRAS. There are approximately thirty-seven SCFWHs located in the Peconic and Gardiners Bay system; however, only a small portion of those are found within the Shellfish Cultivation Zone. The SCFWHs situated within the study area are discussed below.

- Cutchogue Harbor and Wetlands – approximately 490 acres including 205 acres of shallow open waters within the harbor. This area is very productive for marine finfish and shellfish and is one of the top areas in Southold for the harvesting of scallops and clams. Historically, eelgrass beds were present in the southwestern portion of the harbor.

- Orient Harbor – approximately 1,900 acres consisting primarily of open water area in the harbor, along with an undeveloped tidal wetland area and Dam Pond on its north shore. The Harbor supports extensive, healthy eelgrass beds, and important habitats for a variety of fish and wildlife species.

- Shelter Island Eastern Shallows – approximately 59 acres, extending from Hay Beach Point southeastward to Reel Point on Ram Island. The area consists of marine shallows and eelgrass-dominated SAV beds on muddy and gravelly sand substrates that provide habitat for lobsters, crabs, whelk, Atlantic ridley (endangered) and loggerhead sea turtles (threatened), hard clams, juvenile finfish, and oyster toadfish.

- Mashomack Preserve, Shelter Island – approximately 2,200 acres, only a small portion of which extends into the Shellfish Cultivation Zone. Habitat includes eelgrass beds, coastal marshes, freshwater wetlands,

beaches, dunes, bluffs, and an extensive upland forest with ponds. The shallows to the east of Mashomack support important eelgrass beds. Species inhabiting this area include osprey, piping plover (endangered and federally-threatened), least tern (threatened), glossy ibis, herons and egrets.

- Sag Harbor and Northwest Harbor – approximately 3,000 acres consisting primarily of open water that is productive habitat for finfish and shellfish. This area was one of the most important bay scallop producing areas on Long Island. Fish inhabit the open waters year-round, which offer feeding areas for least tern, piping plover, and osprey. Wintering waterfowl average over 440 birds each year, and seals are known to rest and sun on the exposed rocks of the Sag Harbor Cove jetty.

- Cedar Point/Hedges Bank Shallows – approximately 44 acres, extends from the tip of Cedar Point eastward along Hedges Bank to Lafarges Landing. Consists of marine shallows and eelgrass-dominated SAV beds on gravelly sand substrates, which support an important population of bay scallops. Species documented in this area include crabs, whelk, green turtles (threatened), hard clams, juvenile finfish, and oyster toadfish.

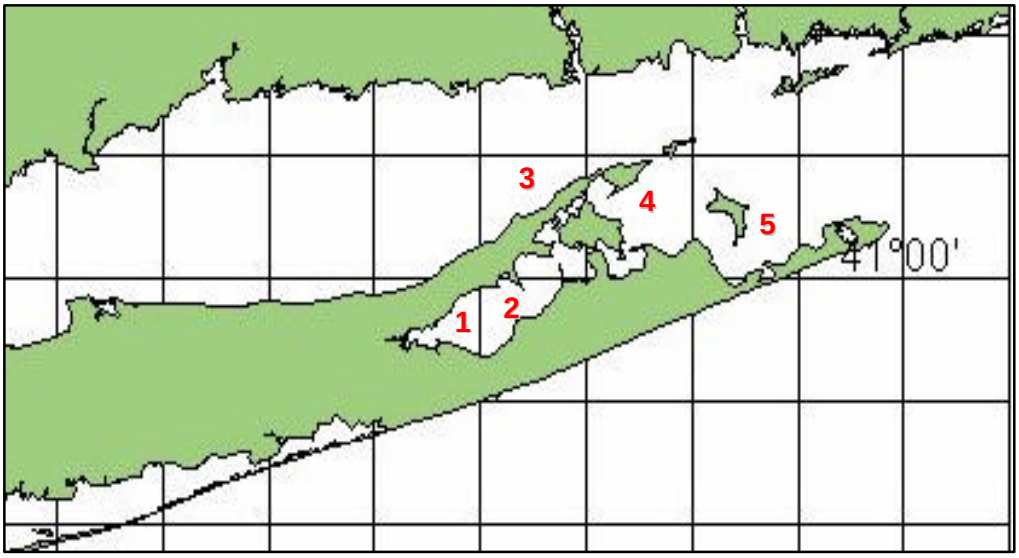
- Plum Gut – approximately 500 acres of open water between Orient Point and Plum Island, ranging in depths from less than 20 to over 60 feet. Significant concentrations of many fish species forage within this area, including striped bass, bluefish, tautog, summer flounder, and scup. This area is one of two major passage corridors for striped bass in the spring and fall, and one of the most popular areas for recreational fishing, including charter boats. This area is also of regional significance for the commercial trap net fishery and lobster fishery. Bottlenose dolphin, harbor porpoise, harbor seal, and sea turtles also use this area.

- Accabonac/Hog Creek Point Shallows – approximately 24 acres, extends southeastward from the eastern shore of Hog Creek inlet and Lionhead

Rock offshore, to below the southern end of Gerard Park. The area consists of marine shallows and eelgrass-dominated SAV beds. Crab and whelk have been documented within the area. Shellfish such as hard clam may also be present in the eelgrass meadows.

Many of the species that occur within the Peconic Estuary represent juvenile forms of some of the state's most valuable commercial and recreational finfish resources (C. Grahn, NYSDEC Bureau of Marine Resources, personal communication, June 2007). In 1996, essential fish habitat (EFH) designations were created under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) in an effort to maintain suitable fisheries. EFH are defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (Magnuson-Stevens Act, 16 U.S.C. 1801 et seq.). EFHs have been identified by regional fishery management councils and other Federal agencies and delineated into 10-minute square grids. Five essential fish habitats (EFH) lie within, or encompass a significant portion of the study area (Figure 15). These EFHs and the marine species documented for each are described below.

Figure 15. Essential Fish Habitats within the Shellfish Cultivation Zone



Source: National Marine Fisheries Service

EFH Grid #1: Waters within Flanders Bay and western Great Peconic Bay affecting the following: from just east of Deep Hole Creek southeast of Mattituck, past Jamesport, and South Jamesport, around Flanders Bay to the Shinnecock Canal north of Flanders, Red Creek, and Squiretown, and also east of Riverhead (Table 13). Waters within the southwest part of Shinnecock Bay are found in this square as well. Also, Atlantic Ocean waters within the square within Long Island Sound on the absolute northwest corner of the square, from Mattituck Hills to northeast of Centerville; and the waters within Great South Bay estuary at the very bottom of the square.

EFH Grid #2. Atlantic Ocean waters within the square, western Little Peconic Bay and eastern Great Peconic Bay affecting the following: southwest of New Suffolk, Cutchogue, southern Nassau Point, Robins Island, along with and north of North Sea, Sebonac Neck, Southampton, and Shinnecock Hills, from Shinnecock Canal to south of Jessup Neck (Table 14). This grid also includes a small portion of the Atlantic Ocean at the southern portion of the square.

EFH Grid #3. Atlantic Ocean waters within the square within Long Island Sound affecting the following: northeast Long Island from east of Duck Pond Point to just east of Rocky Point on the north, north of Greenport, and Southold, including waters affecting Horton Lane Beach, Goldsmith Inlet, Horton Point, Horton Neck, Shelter Island Sound, northern Little Peconic Bay, and Noyack Bay (Table 15). Also, these waters are within the Peconic Bays, and affect the following: northern Cutchogue Harbor, Hog Neck Bay, Great Hog Neck, Cedar Beach Point, Paradise Point, Southold Bay. In addition, these waters affect the western half of Shelter Island from Hay Beach Point to east of West Neck Harbor, around West Neck, Jennings Neck, Shelter Island Heights, Dering Harbor, and Shelter Island, and Jessup Neck from the north half of Nassau Point to just east of Cleaves Point, south of Greenport.

EFH Grid #4. Waters within the square within Gardiners Bay affecting the following: Orient, Ram Island, Coecles Harbor, Three Mile Harbor, and Northwest Harbor, along with around the eastern half of Shelter Island, North Haven Peninsula, Barcelona Neck, and the Northwest Creek, north of Sag Harbor, from Hay Beach to east of West Neck Harbor (Table 16).

EFH Grid #5. Atlantic Ocean waters within the square within Gardiners Bay affecting the following: Gardiners Island and part of the northern part of the split of Long Island from just west of Rocky Point and south of Hillers Hill State Park past Napeague Bay and Napeague Harbor, Lazy Point, Accabonac Harbor, to Hog Creek Point (Table 17). Also affected are Cartwright Island and Hicks Island.

Table 13. Marine Species Identified in the EFH Located in the Western Portion of the Peconic Estuary

Species	Eggs	Larvae	Juveniles	Adults
Atlantic salmon *(Salmo salar)*			X	X
Atlantic cod *(Gadus morhua)*				
haddock *(Melanogrammus aeglefinus)*				
pollock *(Pollachius virens)*			X	X
whiting *(Merluccius bilinearis)*				
offshore hake *(Merluccius albidus)*				
red hake *(Urophycis chuss)*	X	X	X	X
white hake *(Urophycis tenuis)*				
redfish *(Sebastes fasciatus)*	n/a			
witch flounder *(Glyptocephalus cynoglossus)*				
winter flounder *(Pleuronectes americanus)*	X	X	X	X
yellowtail flounder *(Pleuronectes ferruginea)*				
windowpane flounder *(Scopthalmus aquosus)*	X	X	X	X
American plaice *(Hippoglossoides platessoides)*				
ocean pout *(Macrozoarces americanus)*				
Atlantic halibut *(Hippoglossus hippoglossus)*				
Atlantic sea scallop *(Placopecten magellanicus)*				
Atlantic sea herring *(Clupea harengus)*			X	X
monkfish *(Lophius americanus)*				
bluefish *(Pomatomus saltatrix)*			X	X
long finned squid *(Loligo pealei)*	n/a	n/a		

short finned squid *(Illex illecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus triacanthus)*				
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
summer flounder *(Paralicthys dentatus)*			X	X
scup *(Stenotomus chrysops)*	X	X	X	X
black sea bass *(Centropristus striata)*	n/a		X	
surf clam *(Spisula solidissima)*	n/a	n/a		
ocean quahog *(Artica islandica)*	n/a	n/a		
spiny dogfish *(Squalus acanthias)*	n/a	n/a		
tilefish *(Lopholatilus chamaeleonticeps)*				
king mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
cobia *(Rachycentron canadum)*	X	X	X	X
blue shark (*Prionace glauca)*				X
dusky shark *(Charcharinus obscurus)*		X		
sandbar shark *(Charcharinus plumbeus)*		X	X	X
sand tiger shark *(Odontaspis taurus)*		X		

Source: National Marine Fisheries Service, 2007

Table 14. Marine Species Identified in the EFH Located in the Lower Mid Portion of the Peconic Estuary

Species	Eggs	Larvae	Juveniles	Adults
Atlantic salmon *(Salmo salar)*			X	X
Atlantic cod *(Gadus morhua)*				
haddock *(Melanogrammus aeglefinus)*				
pollock *(Pollachius virens)*			X	
whiting *(Merluccius bilinearis)*	X	X	X	X
red hake *(Urophycis chuss)*	X	X	X	
witch flounder *(Glyptocephalus cynoglossus)*				
winter flounder *(Pleuronectes americanus)*	X	X	X	X
yellowtail flounder *(Pleuronectes ferruginea)*				
windowpane flounder *(Scopthalmus aquosus)*	X	X	X	X
Atlantic sea scallop *(Placopecten magellanicus)*				
Atlantic sea herring *(Clupea harengus)*			X	X
monkfish *(Lophius americanus)*	X	X		
bluefish *(Pomatomus saltatrix)*			X	X
long finned squid *(Loligo pealei)*	n/a	n/a	X	
short finned squid *(Illex illecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus triacanthus)*				
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
summer flounder *(Paralicthys dentatus)*		X	X	X
scup *(Stenotomus chrysops)*	X	X	X	X
black sea bass *(Centropristus striata)*	n/a		X	
surf clam *(Spisula solidissima)*	n/a	n/a		

ocean quahog *(Artica islandica)*	n/a	n/a		
spiny dogfish *(Squalus acanthias)*	n/a	n/a		
tilefish *(Lopholatilus chamaeleonticeps)*				
king mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
cobia *(Rachycentron canadum)*	X	X	X	X
sand tiger shark *(Odontapis taurus)*		X		
blue shark (*Prionace glauca)*				X
White shark *(Charcharinus carcharias)*			X	
dusky shark *(Charcharinus obscurus)*		X		
sandbar shark *(Charcharinus plumbeus)*		X	X	X
Tiger shark *(Galeocerdo cuvieri)*			X	
Skipjack tuna *(Katsuwonus pelamis)*				X

Source: National Marine Fisheries Service, 2007

Table 15. Marine Species Identified in the EFH Located in the Upper Mid-Portion of the Peconic Estuary

Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
Atlantic salmon *(Salmo salar)*			X	X
Atlantic cod *(Gadus morhua)*				
Haddock *(Melanogrammus aeglefinus)*				
Pollock *(Pollachius virens)*			X	X
Whiting *(Merluccius bilinearis)*				
Offshore hake *(Merluccius albidus)*				
Red hake *(Urophycis chuss)*	X	X	X	X
White hake *(Urophycis tenuis)*				
Witch flounder *(Glyptocephalus cynoglossus)*				
Winter flounder *(Pleuronectes americanus)*	X	X	X	X
Yellowtail flounder *(Pleuronectes ferruginea)*				
Windowpane flounder *(Scopthalmus aquosus)*	X	X	X	X
American plaice *(Hippoglossoides platessoides)*				
Ocean pout *(Macrozoarces americanus)*				
Atlantic sea scallop *(Placopecten magellanicus)*				
Atlantic sea herring *(Clupea harengus)*			X	X
Monkfish *(Lophius americanus)*				
Bluefish *(Pomatomus saltatrix)*			X	X
Long finned squid *(Loligo pealei)*				
Short finned squid *(Illex illecebrosus)*				
Atlantic butterfish *(Peprilus triacanthus)*				
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
Summer flounder *(Paralicthys dentatus)*			X	X
Scup *(Stenotomus chrysops)*	X	X	X	
Black sea bass *(Centropristus striata)*	n/a		X	

Surf clam *(Spisula solidissima)*	n/a	n/a		
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a		
Tilefish *(Lopholatilus chamaeleonticeps)*				
King mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
Cobia *(Rachycentron canadum)*	X	X	X	X
Sand tiger shark *(Odontapis taurus)*		X		

Source: National Marine Fisheries Service, 2007

Table 16. Marine Species Identified in the EFH East of Shelter Island, West of Gardiners Is.

Species	Eggs	Larvae	Juveniles	Adults
Atlantic salmon *(Salmo salar)*			X	X
Atlantic cod *(Gadus morhua)*				
Haddock *(Melanogrammus aeglefinus)*				
Pollock *(Pollachius virens)*				
Whiting *(Merluccius bilinearis)*				
Offshore hake *(Merluccius albidus)*				
Red hake *(Urophycis chuss)*				
White hake *(Urophycis tenuis)*				
Witch flounder *(Glyptocephalus cynoglossus)*				
Winter flounder *(Pleuronectes americanus)*	X	X	X	X
Yellowtail flounder *(Pleuronectes ferruginea)*				
Windowpane flounder *(Scopthalmus aquosus)*	X	X	X	X
American plaice *(Hippoglossoides platessoides)*				
Ocean pout *(Macrozoarces americanus)*				
Atlantic halibut *(Hippoglossus hippoglossus)*				
Atlantic sea scallop *(Placopecten magellanicus)*				
Atlantic sea herring *(Clupea harengus)*			X	X
Monkfish *(Lophius americanus)*				
Bluefish *(Pomatomus saltatrix)*			X	X
Long finned squid *(Loligo pealei)*	n/a	n/a		
Short finned squid *(Illex illecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus triacanthus)*				
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
Summer flounder *(Paralicthys dentatus)*			X	
Scup *(Stenotomus chrysops)*	X	X	X	X
Black sea bass *(Centropristus striata)*	n/a		X	X
Surf clam *(Spisula solidissima)*	n/a	n/a		
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a		
Tilefish *(Lopholatilus chamaeleonticeps)*				
King mackerel *(Scomberomorus cavalla)*	X	X	X	X

Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
Cobia *(Rachycentron canadum)*	X	X	X	X
Sand tiger shark *(Odontapis taurus)*		X		
Blue shark *(Prionace glauca)*				X

Source: National Marine Fisheries Service, 2007

Table 17. Marine Species Identified in the EFH Surrounding Gardiners Island

Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
Atlantic salmon *(Salmo salar)*			X	X
Atlantic cod *(Gadus morhua)*				
Haddock *(Melanogrammus aeglefinus)*				
Pollock *(Pollachius virens)*				
Whiting *(Merluccius bilinearis)*				
Offshore hake *(Merluccius albidus)*				
Red hake *(Urophycis chuss)*				
White hake *(Urophycis tenuis)*				
Redfish *(Sebastes fasciatus)*	n/a			
Witch flounder *(Glyptocephalus cynoglossus)*				
Winter flounder *(Pleuronectes americanus)*	X	X	X	X
Yellowtail flounder *(Pleuronectes ferruginea)*				
Windowpane flounder *(Scopthalmus aquosus)*	X	X	X	X
American plaice *(Hippoglossoides platessoides)*			X	X
Ocean pout *(Macrozoarces americanus)*				
Atlantic halibut *(Hippoglossus hippoglossus)*				
Atlantic sea scallop *(Placopecten magellanicus)*				
Atlantic sea herring *(Clupea harengus)*			X	X
Monkfish *(Lophius americanus)*				
Bluefish *(Pomatomus saltatrix)*			X	X
Long finned squid *(Loligo pealei)*	n/a	n/a		
Short finned squid *(Illex illecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus triacanthus)*				
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
Summer flounder *(Paralicthys dentatus)*			X	
Scup *(Stenotomus chrysops)*	X	X	X	X
Black sea bass *(Centropristus striata)*	n/a		X	X
Surf clam *(Spisula solidissima)*	n/a	n/a		
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a		
Tilefish *(Lopholatilus chamaeleonticeps)*				
King mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
Cobia *(Rachycentron canadum)*	X	X	X	X
Sand tiger shark *(Odontapis taurus)*		X		

Blue shark *(Prionace glauca)*				X
Dusky shark *(Charcharinus obscurus)*		X		
Sandbar shark *(Charcharinus plumbeus)*		X	X	X

Source: National Marine Fisheries Service, 2007

4.1.1.8. Rare (R), Threatened (T) and Endangered (E) Species

The NYS Natural Heritage Program (ECL 9-1503) was contacted to determine if there is any record of rare species or ecological communities within the Shellfish Cultivation Zone. The Heritage Program indicated that there are rare or state-listed animals and plants, significant natural communities, and other significant habitats which occur or may occur within or in the immediate vicinity of the Shellfish Cultivation Zone. Specifically, the Heritage Program identified the occurrence of black skimmers, common terns, least terns, and roseate terns along the shores of the Peconic Estuary that often feed in the offshore waters.

The Heritage Program also identified eelgrass meadows off-shore of Shelter Island. This community is considered to be significant from a statewide perspective, with a high ecological and conservation value. Table 18 lists the species of special concern that have been tabulated by the Natural Heritage Program of NYSDEC.

Table 18. Species of Special Concern that Occur or May Occur within the Shellfish Cultivation Zone (Source: Natural Heritage Program, personal communication)

Common Name	Scientific Name	NY State Listing	NY State Rank*
Least Tern	*Sternula antillarum*	Threatened	S3B
Common Tern	*Sterna hirundo*	Threatened	S3B
Black Skimmer	*Rynchops niger*	Special Concern	S2
Roseate Tern	*Sterna dougallii*	Endangered (also federally listed as endangered)	S1B
Marine Eelgrass	*Zostera marina*	(unprotected)	S3

* Rarity in NYS as ranked by the NY Natural Heritage Program on a 1 to 5 scale:
S1 = Critically imperiled; S2 = Imperiled; S3 = Rare or uncommon; S4= Abundant and apparently secure; S5 = Demonstrably abundant and secure; B = Breeding population

Sea turtles that migrate to the Peconic Estuary each summer consist mainly of loggerhead turtles (T), Kemp's ridley turtles (E), and green turtles (T) (Morreale

et al., 2005). A sea turtle catch-and-release study conducted by Morreale et al. (2005) captured a total of 35 green turtles, 17 Kemp's ridley turtles, and 2 loggerhead turtles (all of which were juveniles) throughout the eastern portion of the Peconic Estuary. This study was conducted in fall 2002 and during the two subsequent summer and fall seasons. The amount of green turtles appears to have increased over the past decade, and this species is currently the most abundant sea turtle migrating into the estuary (Morreale and Standora, 1994, Morreale et al., 2005).

Atlantic ridley (E) and loggerhead sea turtles have been documented in the Shelter Island Eastern Shallows, Accabonac/Hog Creek Point Shallows, and Plum Gut SCFWH areas (NYSDOS, 2002). Northwest Harbor may be important feeding and resting habitat for juvenile Kemp's ridley sea turtles (E), especially during the late summer and fall; however, more documentation on the use of this area by this species as well as other sea turtles is needed. Green turtles have been documented in the Cedar Point/Hedges Bank Shallows and the Accabonac/Hog Creek Point Shallows SCFWH areas (NYSDOS, 2002). This species feeds directly on eelgrass, green fleece, and sea lettuce, present in the shallow water. Juvenile loggerhead turtles may also be attracted to this area due to the presence of Horseshoe crabs (NYSDOS, 2002). Loggerhead and Kemp's ridley turtles feed heavily on crabs and mollusks (Morreale et al., 2005).

Although not federally or state-listed, other important marine species are known to utilize the waters of the Peconic Estuary. Harbor seals and, to a lesser degree, harp seals and grey seals utilize a number of haul-out areas around the eastern portion of the estuary on a year-round basis (PEP, 2001). The bottle-nosed dolphin and the harbor porpoise have also been sighted within the estuary in recent history (PEP, 2001). Two bottle-nosed dolphins were found in Sag Harbor Marina in the fall of 2006, which were then rescued by the Riverhead Foundation for Marine Research and Preservation (M. Quinn, The Independent, October 4, 2007). More recently, a pod of dolphins required rescue from Northwest Creek in

East Hampton (Cotroneo 2007). Seals, porpoises and dolphins are protected under the Marine Mammal Protection Act of 1972.

4.1.1.9. Migratory Waterfowl and Other Bird Populations

The Peconic Estuary is a valuable resource for waterfowl including wading birds, sea ducks, dabbling ducks, shorebirds, and raptors. The open water areas of the estuary serve as important winter habitat for many species of waterfowl, including white-winged scoter (*Melanitta fusca*), long-tailed duck (*Clangula hyemalis*), scaup (*Aythya marila*, *Aythya affinis*), common goldeneye (*Bucephala clangula*), bufflehead (*Bucephala albeola*), American black duck (*Anus rubripes*), Canada goose (*Branta canadensis*), red-breasted merganser (*Mergus serrator*), canvasback (*Aythya valisineria*), and American widgeon (*Anas americana*) (PEP Habitat Restoration Workgroup, 2000).

Sea ducks, scoters and common eiders are common in the deeper waters (>10m) of the estuary (PEP, 2001). Sea ducks use the estuary for over-wintering primarily from November through April, and feed mainly on shellfish and benthic invertebrates (PEP, 2001). Diving ducks are found in water depths ranging from 2 to 18 feet deep and generally feed on SAV beds and bivalves (PEP, 2001).

The Peconic Estuary is situated along the Atlantic Flyway (Maine to Florida) and is a resting stop for many species of migrating waterfowl. The Audubon Society conducts mid-winter bird counts from December 14th through January 5th to track bird migration. Known as the Christmas Bird Count (CBC), over 2,000 volunteers participate in the count each year. The CBC is an all-day abundance and species tally of early-winter bird populations performed by local volunteers along specified routes. Each route, or count area, consists of a 15-mile diameter circle. Seven count areas have been designated by the Audubon Society throughout Suffolk County. Three of these count locations fall within the project study area, and are identified as: LI-Quogue-Watermill; LI-Orient; and LI-Montauk.

The Quogue-Watermill count area extends east to west from Quogue to Watermill, and north to south from the northern tip of Robins Island to the offshore waters of the Atlantic Ocean. This area includes the open waters of Flanders Bay-East, Great Peconic Bay, and the southwestern portion of Little Peconic Bay. The Orient count area encompasses the land and open water in a 15-mile radius from the northernmost tip of Shelter Island, which includes the eastern portion of Hog Neck Bay, Noyack Bay, Shelter Island Sound, the western portion of Gardiners Bay, and Northwest Harbor, as the southernmost portion of the area. The Montauk count area covers all of the land and water eastward from Amagansett to Montauk Point, including most of Gardiners Island; and extending to the northern portion of Gardiners Island, southward to the offshore waters of the Atlantic Ocean. Table 19 presents the bird species identified and recorded in the three east-end count areas during the most recent CBC (107th), performed from December 14, 2006 through January 5, 2007.

Table 19. Bird Species Identified During the 2006-2007 CBC at Count Areas Located within the Shellfish Cultivation Zone and/or Immediate Surrounding Area

Species	Quogue - Watermill	Orient	Montauk
Snow Goose (white form)		9	1
Brant	242	1	18
Canada Goose	1299	1557	1052
Mute Swan	306	104	41
Wood Duck		7	
Gadwall	14	8	52
American Wigeon	15	11	192
American Black Duck	1237	1226	525
Mallard	756	534	233
Northern Shoveler	27		
Northern Pintail	1	5	1
Green-winged Teal	15		2
Canvasback	27	18	75
Redhead	3		0
Ring-necked Duck	35	22	60
Greater Scaup	26	110	502
Lesser Scaup	97	3	40
scaup sp.	120	65	
King Eider			1

Common Eider	9	19	3537
Harlequin Duck			2
Surf Scoter	222	1572	731
White-winged Scoter	173	2523	9512
Black Scoter	128	365	97
scoter sp.			62
Long-tailed Duck	749	808	379
Bufflehead	1589	1320	213
Common Goldeneye	228	785	301
Barrow's Goldeneye		2	
Hooded Merganser	203	144	50
Common Merganser	4		2
Red-breasted Merganser	1237	874	653
Ruddy Duck	1387	28	205
Canada Goose X Greater White-fronted Goose (hybrid)		1	
Ring-necked Pheasant	20	2	1
Wild Turkey	1	4	44
Northern Bobwhite		10	
Red-throated Loon	33	74	586
Common Loon	179	276	608
Pied-billed Grebe	6	3	7
Horned Grebe	30	228	64
Red-necked Grebe			2
Northern Gannet	786	94	1640
Double-crested Cormorant	79	9	39
Great Cormorant	1	23	16
American Bittern	4		
Great Blue Heron (Blue form)	75	53	22
Great Egret	15	7	6
Green Heron		1	
Black-crowned Night-Heron		1	4
Bald Eagle			3
Northern Harrier	9	8	14
Sharp-shinned Hawk	4	10	15
Cooper's Hawk	4	5	6
Accipiter sp.			1
Red-tailed Hawk	14	25	42
Rough-legged Hawk	1	1	4
Golden Eagle			1
American Kestrel	3	2	1
Merlin	2	3	4
Peregrine Falcon	1	1	4

Clapper Rail	2		
Virginia Rail	2	1	7
American Coot	31	9	37
Black-bellied Plover	175	17	12
Killdeer	1		14
American Oystercatcher	3		
Greater Yellowlegs	6	2	2
Ruddy Turnstone	2	109	21
Sanderling	145	437	230
Purple Sandpiper		5	34
Dunlin	278	47	22
Wilson's Snipe	1	4	2
American Woodcock	1		14
Laughing Gull			1
Black-headed Gull			1
Bonaparte's Gull	26	27	76
Ring-billed Gull	437	550	465
Herring Gull	1994	1774	2440
Great Black-backed Gull	595	268	809
Black-legged Kittiwake			6
Razorbill		9	47
Rock Pigeon	99	196	143
Mourning Dove	151	410	403
Monk Parakeet	2		
Eastern Screech-Owl	13	22	13
Great Horned Owl		21	9
Snowy Owl			1
Northern Saw-whet Owl			1
Belted Kingfisher	18	40	4
Red-headed Woodpecker		1	
Red-bellied Woodpecker	10	122	38
Yellow-bellied Sapsucker		1	2
Downy Woodpecker	27	123	64
Hairy Woodpecker	2	23	5
Northern Flicker	13	70	60
Eastern Phoebe		1	2
Tyrannus sp.			1
Blue Jay	98	498	208
American Crow	648	971	502
Fish Crow	1		
Horned Lark	9	56	17
Tree Swallow	1		
Black-capped Chickadee	311	563	439

Tufted Titmouse	55	290	111
Red-breasted Nuthatch	1	3	2
White-breasted Nuthatch	15	127	39
Brown Creeper	2	11	1
Carolina Wren	61	149	173
House Wren	1		
Winter Wren	4	17	32
Marsh Wren			15
Golden-crowned Kinglet	66	35	31
Ruby-crowned Kinglet	2	14	6
Eastern Bluebird		14	4
Hermit Thrush	6	25	48
American Robin	247	1541	297
Gray Catbird	3	10	21
Northern Mockingbird	41	82	92
Brown Thrasher	3	4	2
European Starling	660	1708	1947
American Pipit			1
Cedar Waxwing		22	14
Orange-crowned Warbler		2	
Nashville Warbler		2	
American Pipit	3		
Yellow-rumped Warbler	45	40	116
Palm Warbler	1	1	6
Common Yellowthroat	2		1
Eastern Towhee	5	11	32
American Tree Sparrow	27	35	25
Chipping Sparrow	4	2	2
Field Sparrow	15	4	31
Savannah Sparrow	43	67	25
Savannah (Ipswich) Sparrow	1	2	6
Saltmarsh Sharp-tailed Sparrow			2
Sharp-tailed Sparrow sp.			2
Fox Sparrow	5	16	17
Song Sparrow	155	347	381
Swamp Sparrow	22	36	27
White-throated Sparrow	316	689	724
White-crowned Sparrow		2	1
Dark-eyed Junco	64	95	92
Lapland Longspur			4
Snow Bunting	80	3	201
Northern Cardinal	53	277	184
Red-winged Blackbird	143	290	373

Eastern Meadowlark	15		16
Rusty Blackbird		2	2
Common Grackle	5	121	8
Boat-tailed Grackle	40		
Brown-headed Cowbird	11		502
Purple Finch	2		
House Finch	173	280	307
American Goldfinch	51	138	108
House Sparrow	104	307	391

Source: National Audubon Society, 2007

The New York State Ornithological Association (NYSOA, formerly Federation of New York State Bird Clubs) has conducted annual mid-winter waterfowl counts almost every year since 1955. This program relies on volunteers and is conducted during a 9-day count period in January. The waterfowl species recorded throughout the Peconic Estuary are combined with waterfowl counts from Bronx, New York, Kings, Queens, Richmond, Nassau, and Suffolk counties to represent a regional waterfowl overview.

During the 2007 waterfowl count, a total of 114,729 ducks were recorded in the Long Island region; 18,331 of which were for dabbling ducks and 96,398 were diving ducks. Loons, grebes, corms, and coot totaled 2,379, and the total number of geese was 40,574 (Bryan Swift, NYSOA, personal communication, 2007). A total list of waterfowl species for the Long Island region in 2007 is presented in Table 20.

Table 20. Waterfowl Species Recorded on Long Island during NYSOA Waterfowl Count

Species	Count
Goose, White-fronted	25
Snow	516
Canada	22,798
Brant	17,235
Swan, Mute	1,415
Wood Duck	7
Gadwall	1,332
Wigeon, Eurasian	5
American	1,558

Am. Black Duck	6,034
Mallard	8,200
Mallard X Black	26
Northern Shoveler	686
Northern Pintail	34
Green-winged Teal	449
Canvasback	409
Redhead	50
Ring-necked Duck	559
Scaup, Greater	36,243
Lesser	5,083
not to species	829
Eider, Common	2,680
Scoter, Surf	6,966
White-winged	1,865
Black	4,586
not to species	12,448
Long-tailed Duck	9,164
Bufflehead	4,065
Goldeneye, Common	1,320
Barrow's	1
Merganser, Hooded	1,414
Common	32
Red-breasted	4,058
Ruddy Duck	4,626
Loon, Red-throated	910
Common	290
Grebe, Pied-billed	43
Horned	177
Red-necked	5
Eared	1
Cormorant, D.-crested	155
Great	46
American Coot	752
unidentified	63
Total	**159,160**

Source: B. Swift, NYSOA, personal communication, 2007

In addition to the mid-winter waterfowl count, NYSOA has completed a Breeding Bird Atlas project, which mapped the distribution of the more than 250 species of birds that breed in the state. This project first commenced in the early 1980s and

was performed a second time from 2000-2005 to determine how breeding distributions have changed over the past twenty years. Table 21 identifies the waterfowl species that breed throughout the Peconic Estuary.

Table 21. Waterfowl Species that Breed within the Peconic Estuary

Species	NY Legal Status
Canada Goose	Game species
Mute Swan	Protected
Mallard	Game species
Gadwall	Game species
American black duck	Game species
Green-winged teal	Game species
Wood duck	Game species
Double-crested cormorant	Protected
Red-breasted merganser	Game species
Blue-winged teal	Game species

Source: NYSDEC Breeding Bird Atlas, 2005

The North Fork Audubon Society developed the New York's Important Bird Area Program in an effort to identify and conserve the most important places for bird species vulnerable to habitat loss or disturbances. Examples include species that are rare or threatened, congregate in large numbers in one place at one time, or are restricted in distribution or to a particular habitat or region. Important Bird Areas (IBAs) are designated by a technical committee if the area meets standard criteria established by BirdLife International. Three of the four IBAs located on Eastern Long Island lie within the project study area: Orient Point and Plum Island IBA; Northwest Harbor/Shelter Island Complex IBA; and Peconic Bays and Flanders Bay IBA.

The Peconic Bays and Flanders Bay IBA encompasses the bay system extending from the mouth of the Peconic River to Little Peconic Bay, including the adjacent shoreline and Robins Island. This IBA is an important breeding area for colonial waterbirds, including piping plovers, American oystercatchers, common terns, least terns, and black skimmers (North Fork Audubon Society website, www.northforkaudubon.org, accessed December 2007). It is also an important

wintering and staging area for ospreys, waterfowl, loons, and grebes, particularly Canada geese, American black ducks, scaup, long-tailed ducks, redbreasted mergansers, and common loons (North Fork Audubon Society website, www.northforkaudubon.org, accessed December 2007).

The Northwest Harbor/Shelter Island Complex IBA includes the diverse habitats on and around Shelter Island, including Cedar Beach Point on Great Hog Neck, The Nature Conservancy's Mashomack Preserve, Morton National Wildlife Refuge, Grace Estate, and adjoining shoreline and offshore waters. At-risk species that breed here include ospreys (estimated 25 pairs), piping plovers (16 pairs in 1999), common terns (two pairs in 1996, 14 pairs in 1995), and least terns (87 pairs in 1996; 3% of state population) (North Fork Audubon Society, 2007). The Mashomack Preserve and Sag Harbor portion of this IBA is thought to sometimes hold as many as 20,000 to 40,000 waterfowl at peak times (North Fork Audubon Society, 2007).

The Orient Point and Plum Island IBA encompasses the land and water extending from Orient Harbor to Plum Island and including Orient Beach State Park. This IBA is a breeding site for great egrets, snowy egrets, black-crowned night-herons, piping plovers, American oystercatchers, herring gulls, great black-backed gulls, least terns, and double-crested cormorants; and an important wintering area for Canada goose, American black duck, mallard, canvasback, scaup, long-tailed duck, scoters, bufflehead, common goldeneye, and red-breasted merganser (North Fork Audubon Society, 2007).

4.1.2 Impacts

4.1.2.1. Amplification of Native and Exotic Shellfish Diseases

Shellfish diseases are naturally occurring in the marine environment and are not caused by aquaculture operations. A number of existing shellfish diseases are known to affect both natural and cultured populations of shellfish, as discussed above in Section 4.1.1.6. When introduced or amplified through aquaculture,

diseases and parasites pose a significant threat to wild populations of shellfish (SeaWeb Aquaculture Resources website, www.seaweb.org, access on February 20, 2008). While the proposed Lease Program will not cause or create new shellfish diseases, the potential for disease introduction through seed importation, and for outbreaks of diseases that may occur at low levels in limited density natural populations, can not be dismissed.

The effects of exotic species introduced by aquaculture operations have been recently reviewed by McKindsey et al. (2007). The authors cite numerous references describing the importance of aquaculture as a vector for the introduction and spread of exotic species, defined as "species that have been introduced to an area outside of their natural range." Exotic species may be "target" species, i.e., those bivalves that have been intentionally introduced, or species associated with the introduced bivalve (Carlton 1989, 1999) or facilitated by aquaculture activities. Associated species include "hitchhikers" – those that grow in association with the bivalve, and disease causing organisms that may be indiscriminate in their impacts, affecting both the target and other species.

Not only can the importation of shellfish species themselves promote the spread of disease, but the movement of contaminated water, containers, and other equipment may also introduce or transport disease organisms (SeaWeb Aquaculture Resources website, www.seaweb.org, access on February 20, 2008).

4.1.2.2. Harvest of Shellfish

Shellfish grown loose (not contained within aquaculture cages) on the bay bottom are harvested using non-mechanical devices (hand-operated) and mechanical devices, such as dredges. Non-mechanical means may include the use of hand-operated rakes or tongs, as well as direct hand harvest. Mechanical devices include various types of towed dredges, patent tongs, escalator dredges, hydraulic dredges, dry dredges (non-hydraulic dredges), and suction dredges (Barnes et al., 1991).

Hand-operated rakes and tongs are manually pushed or pulled into the sediments in shallow waters. Hand rakes consist of a metal basket with a rectangular opening connected to a long metal rod. Metal teeth along the bottom lip of the basket harvest the shellfish and contain them in the basket. Hand tongs consist of two long wooden handles each of which contains a wire frame with a row of teeth along the bottom. The wooden handles are connected to each other in a scissor-like fashion that enables the wire frames to form a basket when the tongs are closed, trapping the shellfish within the wire frames. Hand rakes physically disrupt the bay bottom and remove seagrasses if present, but are less intense than mechanical dredges.

Non-hydraulic dredges consist generally of a metal frame with spring-loaded teeth attached to a chain-mesh bag (e.g. scallop dredge, box dredge). The teeth scrape the bay bottom to capture shellfish and guide them into the metal bag. This dredge type is typical for harvesting sea scallops and oysters in waters too deep for tongs.

Escalator dredgers consist of a dredge head with an attached conveyor belt that carry the shellfish to the surface. This type of dredge is generally limited to shallow water (up to about 15 m) due to the length of the escalator (National Research Council, 2002).

Hydraulic dredges inject highly pressurized water into bottom sediments to create a slurry from which burrowing clams can be easily extracted (National Research Council, 2002). When compared to conventional shellfish harvesting techniques, hydraulic dredges are more efficient, allow for continuous harvesting with a lower mortality rate, and increase the area and bottom type that can be dredged (MacPhail, 1961: Parker, 1981). Hydraulic dredges can capture as much as 90 percent of the clams in the dredge path (National Research Council, 2002). Types of hydraulic dredges include: towed hydraulic dredges, suction dredges, and hydraulic escalator dredges. Some hydraulic dredges also use suction to capture

shellfish (e.g. Venturi system) and guide them into the collection bag or to a conveyor belt (hydraulic escalator dredge) (Mattice and Bosworth, 1979).

The towed hydraulic dredge consists of a scraper blade, a hydraulic manifold from which water is pumped, and a shellfish collection bag (e.g. chain mesh bag) (Barnes et al., 1991). The dredge is towed from the vessel generally in deeper water (Coen, 1995: Barnes et al., 1991). The hydraulic escalator dredge uses pressurized water jets in combination with a conveyor belt. Water jets extract burrowed shellfish from the sediment and transport them onto a conveyor belt which brings them to the surface.

Suction dredges essentially capture shellfish along with the other surface material that may be present beneath the dredge. Once captured by the suction hose, shellfish and the other material is washed over a fine-mesh sorter to remove mud and sand, and then deposited on the vessel deck (Powell and Ashton-Alcox, 2004). Suction dredges are efficient in gravel or rocky substrates and are not limited by depth (Mattice and Bosworth, 1979). The cutterhead dredge combines a mechanical rotating cutter with hydraulic suction (Barnes et al., 1991). The cutterhead rotates to loosen the sediment while hydraulic suction pulls the sediment material past the cutterhead into a pipeline (O'Neill, 2001). A modified version of the hydraulic escalator dredge uses a Venturi suction system to pull shellfish (as well as other materials caught in the suction) to the conveyor belt (Barnes et al., 1991).

Suction dredges are more likely to capture smaller shellfish than larger shellfish when compared to non-suction dredgers, which risks the potential for a long term decline in shellfish abundance, shell coverage, and bottom complexity (Powell and Ashton-Alcox, 2004). Larger shellfish are more likely to escape capture from a suction dredge due to their greater weight and sinking velocity, or because they are more firmly affixed to the bed (Powell and Ashton-Alcox, 2004).

Mechanical shellfish harvesting either through non-hydraulic or hydraulic means, results in a direct impact to the harvest site, and often to the immediate surrounding area. Impacts may include: the resuspension/turbidity effects on the water column; direct burial/smothering of shellfish; release of sediment contaminants; release of nutrients and subsequent decrease in water quality due to elevated BOD; direct destruction of SAV beds; direct disturbance or removal of infauna; effects on economically important finfish and crustacean resources, smoothing of bedforms, and dispersal of shell aggregate (Caddy, 1973: Auster et al., 1996: Moore and Orth, 1997: Coen, 1995).

Mr. David Relyea of Frank M. Flower & Sons believes the hydraulic dredging conducted by Flowers is not seriously detrimental to the environment and makes the sediment more suitable for successful clam sets (D. Relyea, Frank M. Flower & Sons, personal communication, June 2007). He also stated that the dredging does not cause an extensive cloud of suspended sediment except in the immediate vicinity of the dredge when it is raised to the surface and flushed to remove sediment carried up in the dredge. The Flowers & Sons company operates what is regarded as a successful and productive oyster and clam aquaculture business in the relatively confined waters of Oyster Bay Harbor on leased lands, and the company relies on hydraulic dredging as an important tool in its operations. Extensive use of dredging on the former Blue Point's Company land in Great South Bay, however, is generally believed to have resulted in long-term damage to the bay bottom, including destruction of eelgrass beds, scouring, and over-harvesting of natural clam stocks.

A study regarding impacts associated with scallop dredging found damage to flora and megafauna to a depth of 10 cm, and that 70% of living maerl beds (2 or more species of coralline algae) were killed in the dredge path (Hall-Spencer and Moore, 2000). Dredge tracks in maerl habitats from a scallop dredge may remain visible for approximately 2.5 years (Hall-Spencer and Moore, 2000).

Hydraulic and suction dredges have a more significant impact to the bay bottom than dry-dredges. Suction dredges are less selective than non-suction dredges, removing small particles often enriched in juvenile shellfish and cultch, risking the potential for a long-term decline in shellfish abundance, shell coverage, and bottom complexity (Powell and Ashton-Alcox, 2004).

The recovery of a dredge site may take weeks to years, depending on the type of environment and the biology of the animals and plants affected (Hirsh et al., 1978). Currie and Parry (1996) monitored the effects of a 3-meter wide scallop dredge on soft bottom sediments and found that the dredge flattened callianassid (shrimp) mounds, filled adjacent pits and depressions, and left dredge tracks up to 25 mm deep. One month after dredging, the dredge tracks were still visible and the sea bed remained flat. Six months later, the tracks were not evident and callianassid mounds were abundant. Eleven months post dredging activities, the topography of the dredged site appeared similar to that of the adjacent control site. Their statistical analysis suggested that "changes to community structure caused by dredging were smaller than those that occur between seasons and years."

Hydraulic dredges use high pressurized water that is injected into bottom sediments to harvest burrowing clams. The hydraulic water jets cut into the bottom sediments creating shallow trenches along the dredge line, approximately 4-8 inches deep depending on the type of equipment used. This cutting action restructures the bottom sediments and directly disturbs sediment biota. Trenches created by hydraulic dredges generally persist for one to two months, and upwards of three years when cut through SAV beds (Tarnowski, 2001). Trenches cut through gravelly substrates in low current environments may also persist for an extended period of time (Caddy, 1973). Trenches created in sandy substrates or in areas of high energy recover the fastest (Tarnowski, 2001), although the recovery time is dependant on site wave action and tidal conditions (Eleftheriou and Robertson, 1992).

Hauton et al. (2003) reported that after a hydraulic dredge penetrated bottom sediments to a depth of 0.34 meters, the gravel component was significantly reduced, the degree of sediment sorting increased, and the complex benthos-sediment structural features recorded prior to dredging were physically removed. Observations of the dredge track directly following dredging operations showed that the trench created was approximately 10.3 cm deep, with parallel embankments on either side (Hauton et al., 2003). One month following dredging activities, measurements of the trench showed only about a 37% recovery in overall depth.

The following from the Ocean Studies Board (OSB), established by the National Research Council to advise the federal government on issues of ocean science, engineering, and policy, is perhaps the most concise statement available on the effects of dredging and trawling:

> For the most part, existing information about the direct responses of benthic communities to trawling and dredging is consistent with the general principles that govern how ecologists expect communities and ecosystems to respond to acute and chronic physical disturbance. Trawling and dredging change the physical habitat and biologic structure of ecosystems and therefore can have potentially wide-ranging consequences. Mobile gear reduces benthic habitat complexity by removing or damaging the actual physical structure of the seafloor, and it causes changes in species composition. The reduction of physical structure in repeatedly trawled areas results in lower overall biodiversity. Of direct concern to commercial and recreational fisheries is the possibility that losses of benthic structural complexity and shifts in community composition will compromise the survival of economically important demersal fishes. Mobile gear also can change surficial sediments and sediment organic matter, thereby

affecting the availability of organic matter for microbial food webs (National Research Council, 2002).

Effects are generally related to the intensity of, and time scale within which the operations are undertaken, as well as the type of area being worked. Structured and vegetated bottoms are more likely to be adversely affected than are bare, unvegetated bottoms. Overall, less of the bay bottom is likely to be disturbed during the harvest of cultivated shellfish, since the shellfish are planted on the bottom in high densities (K. Rivara, East End Marine Farmers Association, personal communication, February 2008). Hydraulic dredging in Oyster Bay Harbor has been undertaken by the Frank M. Flowers & Sons Company for many years without evidence of undue environmental degradation (D. Relyea, Frank M. Flower & Sons, personal communication, June 2007).

4.1.2.3. Placement of On-bottom Structures on Sediment Characteristics, Benthic Fauna

The following was gleaned from McKindsey et al. (2006a) who have summarized studies and reviews (Simenstad and Fresh 1995, Deslous-Paoli et al. 1998; Kaiser et al. 1998; Jamieson et al. 2001; Kaiser 2001; Cranford et al. 2003; Newell 2004; Pillay 2004) and updated findings concerning the physical disruptions caused by the bottom culture of bivalves. The addition of culture structures, which can include lines, bags, racks, trestles, tables and predator exclusion netting, can lower current velocities (Nugues et al. 1996), or alter current patterns in shellfish growing areas that are already typically located in areas of limited velocity. The resulting increased sedimentation rates are exacerbated by biodeposition from bivalve filter feeding (Ottman and Sornin 1985; Castel et al. 1989; Martin et al. 1991; Kirby 1994; Nugues et al. 1996; Forrest and Creese 2006; Mallet et al. 2006). Increased sedimentation was found to be further exacerbated by the presence of predator-exclusion netting, with resultant infaunal community dominance by deposit-feeding worms, an increase in the primary productivity represented by *Enteromorpha* spp., and the attraction of the common periwinkle,

Littorina littorea, to the cultivated plots. (Spencer et al. 1996; 1997). Increased numbers of capetellid species were noted under racks (Forrest and Creese 2006).

Increased sedimentation rate did not always result in sediment accretion because of enhanced erosion under off-bottom culture structures (Forrest and Creese 2006; Ottman and Sornin 1985; Everett et al. 1995) and it is suggested that the effects of sedimentation are variable and site specific.

4.1.2.4. Sedimentation and Scouring

Suspended and transient gear within the water column may present constraints on local tidal flow with flow increasing around and underneath the structures. Tidal flow restrictions from a large grouping of submerged gear may result in strong tidal flow underneath the structures possibly resulting in localized scouring and a coarsening of the bottom sediments (Felsing and Petch, 2007). Cage mooring structures also have the potential to scour the seafloor as the anchor moves according to the transmitted action from the attached float or structure. The degree to which scouring impacts the seafloor is dependant upon the length and type of chain on the seafloor; prevailing sea conditions; and, the nature and presence of flora and fauna communities (PIRSA, 2005).

4.1.2.5. Changes in the Phytoplankton Composition and Nutrient Cycling

Shellfish, as suspension feeders, filter particulate matter from the water column, including phyto- and zooplankton, assimilate a portion of it, and dispose of the rest as feces (digested) or pseudofeces (undigested) material that settles to the bottom. This activity is essential in the recycling of nutrients found in suspended organic matter (benthic-pelagic coupling), and in moderating phytoplankton levels through “top-down” control. When harvested, they are also effective in “bottom-up” control as only about 40% of ingested nitrogen is returned to the system via excretion and elimination (Ferreira et al., 2007a).

Because filtration is essentially indiscriminate, planktonic prey are limited only by size or, possibly, by the production of extracellular metabolites that might conceivably result in siphon closure or loss of feeding efficiency. The latter has been suggested by Bricelj and Kuenstner (1989) and supported by investigations of Draper et al. (1990), and Gainey and Shumway (1991), as a mechanism by which the brown tide organism *Aureococcus anophagefferens* acts on shellfish. Thus, the likelihood of changes in phytoplankton population composition, as opposed to population size, is slight, and is more likely to be related to complex, nutrient related trophic cascades rather than feeding.

4.1.2.6. Displacement and Attraction of Species

Benthic communities can be altered by both bottom and off-bottom aquaculture infrastructure that provides both substrate for attachment, and forage and refuge areas (Spencer 2002) with the potential to increase secondary productivity (Dealteris et al. 2004). Dealteris et al. found significantly higher numbers of fish, crustaceans, mollusks, sponges, hydroids, bryozoans, and ascidians in areas of submerged aquaculture gear as compared to *Zostera* beds and non-vegetated seabed, with a 0.94 correlation between organism abundance and available emergent surface area. Although not significant, higher diversity was also noted in the areas of submerged gear.

While seagrasses, such as *Zostera marina*, can be adversely affected through shading by overlying aquaculture infrastructure, sedimentation and erosion, and by disturbances associated with set-up and harvesting (Everett et al. 1995), Powers et al. (2007) suggest that macroalgal growth on aquaculture netting improves nursery habitat for mobile invertebrates and juvenile fish.

University of Connecticut Estuarine Ecosystems Ecologist Jamie Vaudrey (as quoted in Getchis, 2007) states of oyster aquaculture and its associated gear that "There may be positive and/or negative impacts of this type of aquaculture but at the current level of activity in Long Island Sound, we have been unable to measure any impact to the eelgrass resource, or to water or sediment quality," In

the same document Mark Johnson, a marine biologist with the Connecticut Department of Environmental Protection Marine Fisheries Division, notes that "in the big picture, the amount of damage is probably small and we have the management tools for addressing those problems when we become aware of them."

McKindsey et al. (2007) citing Bruno and Bertness (2001) note that, as foundation species, bivalves can influence benthic communities by "creating general habitat, providing refuge from predation, reducing physical and physiological stress, enhancing settlement and recruitment, and increasing food supply." The three-dimensional structure provided by the bivalves themselves or by aquacultural infrastructure "can be particularly pronounced in areas previously devoid of any relief or hard substrate (e.g., flat sand or mud dominated)" (McKindsey et al. 2007), and would be expected to attract other species, likely increasing local diversity. Kelaher et al. (2007) suggest that the loss of specific bioengineering species (i.e., "species that "modify habitats via their own physical structures"), including loss via over-harvesting, can reduce biodiversity in coastal ecosystems. It seems then that, while redundancy of bioengineering species may be desirable as a natural condition, areas stripped of native fauna, naturally or anthropogenically, may benefit from bivalve monoculture. The importance of habitat created by molluscan shellfish along the U.S. Atlantic coast has been discussed by Coen and Grizzle (2007).

4.1.2.7. Suspended Sediment/Turbidity

Resuspension of sediments is a naturally occurring process that takes place from the activities of benthic organisms within the sediments and by tidal currents, increased wind velocity, and storm waves (Barnes et al., 1991). Mechanical dredging techniques used for shellfish harvesting also increase the amount of suspended sediments, which may result in turbidity plumes. Turbidity plumes consist predominantly of fine particles that remain in suspension after dredging activities cease. The size and suspended duration of a turbidity plume is

dependant on the substrate affected, depth of the dredge cut, and the scale of the operation (Barnes et al., 1991). The distance and direction of the plume is subject to wave currents. Substrates consisting predominately of silt/clay sediments remain in suspension the longest when altered by dredging activities (Tarnowski, 2001).

Mechanical dredges (e.g., scallop dredge and oyster dredge) harvest shellfish by scraping the surface of the bay bottom. On soft bottoms, these dredge types flatten the microrelief and resuspend fine sediments, whereas on hard rocky bottoms, the dredges scrape off epibenthic organisms and disturb the substrate (National Research Council, 2002). Observations of a turbidity plume created by a scallop dredge showed that particle concentrations decreased to levels comparable to a large storm nine minutes after dredging activities ceased; and that 98 percent of the sediment loadings decreased to background levels after 30 minutes of dredge activities (Black and Parry, 1999).

Of all the mechanical shellfish harvesting techniques, hydraulic dredges create the largest turbidity plumes (Richardson, 1984). The high-pressurized water injected directly into the bay bottom by hydraulic dredges physically disturbs and suspends sediment biota and, more often than not, results in a plume of suspended sediments, commonly referred to as a turbidity plume. Suspended sediments and turbidity plumes cause short-term impacts to aquatic life which include shading, decrease in primary production, effects on the filter feeding of shellfish (Barnes et al., 1991), and fish gill clogging and irritation (Simenstad, 1991).

A study conducted by Kyte and Chew (1975) focusing on the effects of the hydraulic escalator, recorded suspended sediments as high as 584 mg/L during dredging activities on a silt/clay substrate where background silt loading ranged from 4 to 441 mg/L. The sediment concentrations within the plume dropped significantly to 89 mg/L and remained visible 61 meters from the dredge (Kyte and Chew, 1975). Ruffin (1995) found that a turbidity plume created by a

hydraulic dredge returned to background levels approximately three hours after operations ceased. Light attenuation took 4.8 hours to return to background levels in deep waters and up to 22 hours in shallow waters (Ruffin, 1995).

Tolerance of marine organisms to turbid waters decreases with increasing temperature or decreasing dissolved oxygen, and may become adverse during warmer summer months (Hirsh et al., 1978). Turbidity plumes with high silt content may lower pH levels and/or directly smother shellfish larvae once resettled (Barnes et al., 1991). Finfish are likely to move away from or avoid highly turbid areas; however, this may not be the case for young fish or if food supplies are increased as a result of increases in organic material (ABP Research, 1997). Turbid waters affect finfish by clogging gills, reducing disease resistance and growth rate, altering egg and larval development, and limiting vision affecting the ability to catch prey.

When turbidity interferes with light penetration, plant growth, particularly the growth of rooted vegetation that can't alter its position in the water column, is hindered. The consequent decrease in photosynthesis, and the potential for death and decomposition, can result in lowered levels of dissolved oxygen. Turbidity levels resulting from shellfish harvesting are believed to only have short-term impacts on primary production and plant growth since suspended sediments are temporary and localized (Flemer, 1970 in Barnes et al., 1991). As noted previously, hydraulic dredging in Oyster Bay Harbor by the Frank M. Flowers Company has not resulted in noticeable ecosystem damage.

Impacts of turbidity plumes created by hydraulic shellfish dredges in subtidal or intertidal waters are believed to be negligible on biological resources when compared to natural environmental variation (e.g. currents, winds and waves) (Coen 1995, Godwin 1973), since nearly all of the suspended sediments remain within approximately one meter of the bay bottom and settle within approximately four hours of disturbance (Barnes et al., 1991).

Toxins (e.g., pesticides, heavy metals, hydrocarbons) entering the estuary are likely to adhere to suspended sediments and eventually settle to the bay bottom (USEPA, 2006a). Physical disturbances of these sediments could potentially release toxins to the water column, where they may become concentrated by filter-feeding organisms. This potential release increases with the amount of physical disturbance to the sediments. Resuspension of sediments into the water column may occur naturally due to tidal currents and storm-generated waves; bioturbation (disturbance of sediments by benthic organisms); or, by man-made disturbances such as dredging activities (Barnes et al., 1991). Bioaccumulation of heavy metals, pesticides, and polychlorinated biphenyls (PCBs) was shown to occur in several marine species exposed to varying amounts of different sediments under laboratory conditions; however, none of the species had accumulations that would influence their survival (Hirsh et al. 1978).

Bioaccumulation of contaminants resulting from mechanical shellfish harvest equipment is less likely to occur since biological activity of filter feeders is lowest during winter months when much of the shellfish harvesting takes place (Tarnowski, 2001). Barnes et al. (1991) concluded that the release of metals from shellfish dredging activities is insignificant as no significant releases of metals have ever been observed. A study conducted by Richardson (1984) reported that a hopper dredge, which uses agitation to dredge channels (a far more aggressive process than hydraulic shellfish dredges) significantly increased heavy metals in the water column; however, concentrations only remained present for a brief amount of time after dredging activities ceased. Potential impacts associated with the release of suspended toxins are minimized in an estuarine environment, where currents and the continuous mixing of the water column would dilute toxin concentrations (Barnes, et al., 1991) (Drobeck and Johnston, 1982), although the likelihood of impacts would increase as in areas where water movement decreased, as in the more enclosed areas which are typically uncertified for shellfish harvesting.

Another concern regarding sediment resuspension from dredging activities is the release of nutrients into the water column. An excessive amount of nutrients released to the water column could result in algal stimulation/eutrophication, ammonia toxicity, and chemical oxygen demand (Barnes et al., 1991). Nutrient releases from shellfish harvesting techniques are believed to be negligible (Kyte et al., 1975; Barnes et al., 1991). Barnes et al. (1991) concluded that the quantity of nutrients released is low and the associated impacts will be less than those resulting from a more widespread, high energy event such as a storm or from the daily nutrient loadings from point and non-point sources. Impacts should be limited in time (from minutes to a maximum of one week) and space (generally confined to the active harvest area) (Barnes et al., 1991).

Resettling of suspended sediments can smother sessile and non-motile species and, while most of the impacts are localized to the dredge site, increased wave or current action may transport the sediments several meters away to nearby habitats. Settling sediments are less likely to cause significant impacts to bottom habitats in areas where wave or current action regularly shifts substrates, since the dredged material would be moved rather quickly through natural dispersion (Hirsh et al., 1978).

Hauton et al. (2003) reported that sediment suspended by a hydraulic dredge smothered the surrounding maerl habitat by 20-fold with 1 mm of silt, which extended a distance of at least 8 meters either side of the dredge track. The distance in which suspended sediments settle from the dredge site is dependant on wave currents. In some cases, suspended sediments may travel and settle over adjacent subtidal or intertidal habitats some distance from the dredged area. Black and Parry (1999) reported a plume created by a scallop dredge traveled a distance of 350 meters from the dredged site in one hour and suspended sediments, consisting entirely of silts and clays, persisted for several hours 50 meters beyond the site. Oysters tend to suffer the highest impacts from settling sediments as a direct result of burial (Lunz 1938, Oliver and Slattery 1973, Rose

1973). Suspended sediments may also interfere with the ability of oysters to attach to a hard surface, a critical step in their survival, once the sediments settle. Settling sediments may also bury the demersal eggs of winter flounder, which are known to spawn in late winter (Barnes, et al., 1991). Despite the potential problems noted, impacts to benthic communities, in most instances, are perceived to be insignificant since most benthic organisms are capable of tolerating burial effects up to 30 cm (Coen, 1995; Barnes et al., 1991).

4.1.2.8. Carrying Capacity/Phytoplankton Depletion/Nutrients

Carrying capacity can be interpreted on a wide scale of values which include physical, biological, and social variables. Since there is no definitive way to determine the carrying capacity of the estuary for bivalve culture, the effects of cultured species on the surrounding environment is presented as more theoretical than practicable.

Inglis et al. (2000) from which much of the following is derived, define four generic types of carrying capacity associated with bivalve culture: physical, production, ecological, and social (Table 22). Physical carrying capacity is "the total area of marine farms that can be accommodated in the available physical space"; production carrying capacity is "the stocking density of bivalves at which harvests are maximized"; ecological carrying capacity is "the stocking or farm density which causes unacceptable ecological impacts"; and social carrying capacity is "the level of farm development that causes unacceptable social impacts."

Table 22. Four Types of Carrying Capacity that may be Applied to Aquaculture Development and the Spatial Scales at which they are Most Relevant (from Inglis et al. 2000).

	Definition	**Likely Scale of Effect**
Physical Carrying Capacity	Limits set by the physical space and conditions required for marine farms (size, situation, water depth, etc.)	Subembayment →Planning area
Production Carrying Capacity	The sustainable stocking density at which production levels are maximized	Farm → embayment → adjacent embayments → region
Ecological Carrying Capacity	Levels at which farm development causes significant changes in the ecosystem	Farm → embayment → region
Social Carrying Capacity	Levels at which farm development impairs or conflicts with other human use	Embayment → region

Because of the size of the Peconic Estuary, perhaps the largest physical constraint involves planning restrictions associated with shore based facilities, including hatchery operations and staging areas. The social carrying capacity is less easily dealt with and, insofar as zoning regulations may be affected, can influence the physical carrying capacity. Social carrying capacity involves a fairly large number of often competing interest groups including wild-stock bivalve and other benthic species fishers, commercial finfishers, recreational fishers and boaters, and coastal residents. Unfortunately, there are scant data available on which to estimate socio-economic benefits accrued from artisanal and/or recreational fisheries, and data that are available are often anecdotal, lacking empirical value.

The remaining carrying capacities, “ecological” and “production” are interrelated and, undoubtedly, the most complex and least understood. The production carrying capacity is limited by the availability of suitable food for the shellfish, which in turn is limited by the nutrients available for primary production. Based on data collected by the SCDHS (unpublished) it appears that, perhaps with the exception of its western portion (Flanders Bay), nitrogen is the nutrient that limits production in the Peconic Estuary. Flanders Bay and its associated tributaries are subject to greater nitrogen input, and the bay has the longest residence time within

the system (Nuzzi and Waters 2004, Hardy 1976). Both productivity as measured by chlorophyll-*a*, and total nitrogen decrease from west to east.

4.1.2.9. Physical Carrying Capacity

Because bivalves require specific conditions for growth, physical constraints include the size of the areas within which those conditions can be met. Additional constraints include zoning ordinances, local waterfront plans, navigational issues, habitat protection, and protection of wild fisheries. Once information is gathered it can be incorporated into a GIS-based model for selection of appropriate sites (Arnold et al. 2000). The geographic areas are probably best selected initially on the basis of water quality conditions that are optimum for growth of the species concerned, after which other constraints can be assimilated into the final decision. Variations in water quality throughout the Peconic Estuary (salinity, temperature, nutrients, productivity, residence time, etc.) are important in initial site selection.

4.1.2.10. Production Carrying Capacity

Once an area has been determined suitable, maximum sustained production, which is the aim of any shellfish aquaculture operation, depends on population dynamics (growth rate and mortality levels and, if there is a dependence on natural spawn, reproductive rates), trophic dynamics (nutrient availability, phytoplankton production, predation, competition, etc.), and the hydrodynamic characteristics of the growing area.

4.1.2.11. Ecological Carrying Capacity

Ecological carrying capacity refers to the influence exerted by the cultured species on the surrounding environment. Inglis et al. (2000) list the following as potential adverse impacts of mussel culture:

- organic enrichment of sediments below the farmed areas by faeces and pseudofaeces;
- shifts in benthic food webs from predominantly suspension-feeding to deposit-feeding faunas;
- shading of submerged plants and animals by surface infrastructure;

- drop of shells and other waste materials, localized depletion of phytoplankton from surface and sub-surface waters; and
- attraction of predators, such as starfish and fish (Cole and Grange 1996, Kaiser et al. 1998, Stenton-Dozey et al. 1999, Cole et al. in press[sic]).

Mussel farms have been noted to increase sedimentation 2 to 3 times over ambient, varying "seasonally with phytoplankton abundance and seston quality, but also related to farm size, stocking density and the hydrodynamic environment of the farm," but sedimentation is lower by at least an order of magnitude of that experienced with salmonid culture (Ingles et al. 2000). Sedimentation of organic material, mostly feces and pseudofeces, can result in oxygen depletion, especially in poorly flushed areas, although in well oxygenated areas with good water movement this is not likely to occur (Grenz et al. 1990). It has been suggested that, in shallow, well mixed coastal areas, primary production may be enhanced by nutrients regenerated in the sediments (Bartoli et al. 2001), as opposed to areas where nutrients become available only during spring and fall overturns.

Inglis et al. (2000) note that there are insufficient data on, and lack of adequate monitoring of sediment dwelling infauna to determine the long-term effects of mussel farms on benthic macrofauna. However, it's noted that there is often a decline in large burrowing suspension-feeding bivalves, echinoderms, crustaceans, and polychaetes, and an increase in the numbers of surface feeding gastropods and small opportunistic polychaetes, nemerteans and crustaceans (Tenore et al. 1982, Mattsson and Lindén 1983, Grant et al. 1995, Stenton-Dozey et al. 1999). Lowered species diversity and a decline in overall faunal abundance sometimes occur (Tenore at al. 1982, Mattsson and Linden, 1983), although these effects are usually restricted to the immediate area of the farm (Grange and Cole 1997, Kaiser et al. 1998, Stenton-Dozey et al. 1999).

The accumulation of mussels, mussel shells and other debris in sub-farm sediments provides reef-like habitat for small fish and mobile fauna (Inglis, et al.

2000) and attracts predatory fish, starfish, crabs, sea urchins and other echinoderms (Tenore et al. 1982, Mattsson and Linden 1983, Cole and Grange 1996). Tallman and Forrester (2007) note that "oyster grow-out cages provide good quality habitat for fishes typically associated with hard-bottom habitats," and that "habitat restoration programs for these fishes should thus consider grow-out cages alongside other types of artificial reef." Dealteris et al. (2004) reached similar conclusions regarding the habitat value of aquaculture gear.

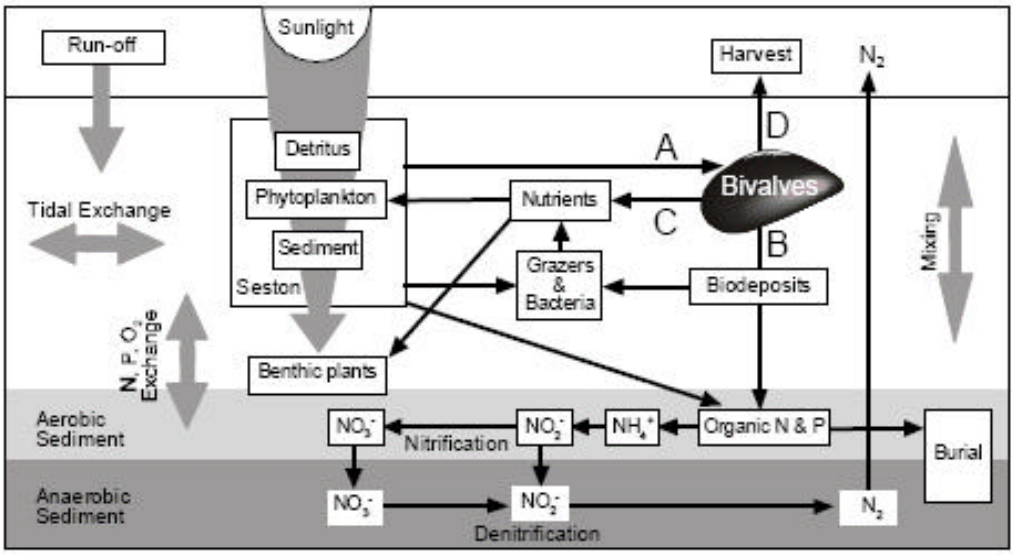
The production of numerous larvae by farmed bivalves has the potential to add to the natural population (see Section 9, Enhanced Recruitment), as well as to influence trophic characteristics. Ingles et al. cite the work of Underwood and Fairweather (1989), and Menge et al. (1999) on the potential for increased numbers of mussel larvae to result in changes in rocky intertidal communities. Cultured bivalve larvae can compete with larval planktonic stages of other benthic species with, as yet, unknown consequences. Adult bivalves can affect planktonic communities through predation, and competition with other species, including zooplankton, for food (Horsted et al. 1988). They can filter out typical zooplankton species, including those of commercially important species (Gibbs 2004). Inglis et al. (2000), however, suggest that the possible long-term effects of mussel farming on the abundance and range of benthic fauna are not likely to be detectable at low levels of farm development.

Heck and Valentine (2007) argue that top-down effects, which have been impacted greatly by the removal of apex predators and mid and lower order consumers, are most important in controlling benthic ecosystem and structure. Cerrato et al. (2004) note the potential of the hard clam *Mercenaria mercenaria* to prevent blooms of the harmful brown tide alga *Aureococcus anophagefferens* by preying on the species prior to it becoming problematic. It has been suggested that the replacement of historic predator communities in the form of cultured bivalves can improve the quality of eutrophied waters (Haamer 1996) and mitigate negative impacts associated with land use (Landry 2002). Golen (undated)

suggests the possibility of "nutrient trading," utilizing shellfish aquaculture as a mechanism for reaching TMDL goals. Rodhouse and Roden (1987), however, predict decreased production when more than half of an embayment's productivity is required for bivalve farming. Newell (2004) notes that in some situations bivalves can exert bottom-up control by modifying sedimentary nutrient regeneration processes. This can be beneficial when aerobic sediments overlie anaerobic sediments and nitrification-denitrification processes are coupled, as N can be permanently removed from the sediments as nitrogen gas. However, overly intense bivalve culture and biodeposition can be detrimental, resulting in hypoxia and decoupling of the reactions, the release of phosphorus to the water column, and a buildup of toxic hydrogen sulfide. Fulwieler et al. (2007) suggest that the warming climate has reduced the ability of estuarine sediments to replenish inorganic nitrogen to the water column, thus reducing productivity in Narragansett Bay, Rhode Island. A similar reduction in productivity, as measured by chlorophyll-*a*, has been noted for the Peconic Estuary (Nuzzi 2005), the effect of which on the estuary's ability to support aquaculture is as yet unknown.

The following conceptual model (Figure 16) from Fisheries and Oceans Canada (DFO 2006) illustrates the complexity of ecosystem interactions resulting from bivalve aquaculture.

Figure 16. Conceptual Diagram of Bivalve Aquaculture Interactions in Coastal Ecosystems Related to: (A) the removal of suspended particulate matter (seston) during filter feeding; (B) the bio-deposition of undigested organic matter in feces and pseudofeces; (C) the excretion of ammonia nitrogen; and (D) the removal of materials (nutrients) in the bivalve harvest.



(Reproduced with permission from DFO, 2006)

Cranford et al. (2003), in their review of ecosystem level effects of marine bivalve aquaculture, note that dense bivalve populations can: control suspended particle (including phytoplankton) dynamics; divert suspended matter to benthic food webs by packaging it as feces and pseudofeces that settle to the bottom; alter coastal nutrient dynamics by consuming dissolved nutrients, and excreting both particulate and dissolved nutrients.

They also note that aquaculture must be considered in light of all other activities, both natural and human, in estuarine and coastal systems, and that an understanding of the net impact of bivalve interactions with ecosystems can be approached through simulation modeling. The following research needs are listed by Cranford et al. (2003):

- Ecological role of bivalve filter feeders: *accurately quantify the density-dependent role of bivalves in controlling phytoplankton and seston*

concentrations, including studies of hydrodynamics, bivalve ecophysiology, and phytoplankton community and productivity responses to grazing pressure.

- Organic loading: *identify important processes controlling the severity of seabed organic enrichment impacts caused by bivalve biodeposits and determine the capacity of different coastal ecosystems to assimilate or recover from the effects of aquaculture-related organic loading.*
- Nutrient dynamics: *develop a predictive understanding of the potential effects of bivalve aquaculture on nutrient concentrations, elemental ratios and rate of cycling in coastal systems and study the consequences of altered nutrient dynamics to phytoplankton communities and blooms, including harmful algal blooms.*
- Ecosystem structure: *investigate the effects of bivalve culture on ecosystem structure resulting from direct competition between bivalves, zooplankton and epibionts for trophic resources, and the transfer of energy and nutrients to benthic food webs.*
- Numerical modeling: *integrate knowledge obtained on the consequences of bivalve culture on ecosystem structure and function through the use of ecosystem modeling to assess the net impact of aquaculture activities on major system components and to address issues of aquaculture productive capacity and sustainability.*
- Ecosystem status: *develop a scheme for classifying and assessing the state of ecosystem functioning for regions supporting bivalve aquaculture. Integrate multiple ecosystem stressors from anthropogenic, land- and marine-use in ecosystem studies of culture systems.*

This is not meant to suggest immediate action prior to program initiation, but rather to provide ideas for research topics to be undertaken, as possible, in an effort to fully understand the consequences, good and bad, of shellfish aquaculture.

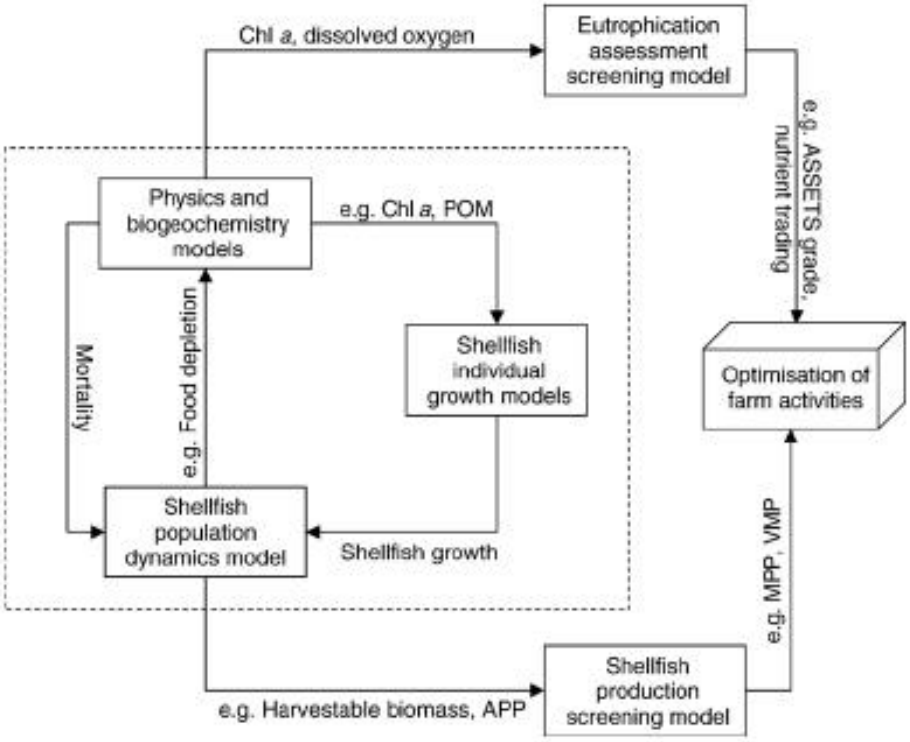
The Farm Aquaculture Resource Management (FARM) model developed by Ferreira et al. (2007a) addresses questions of optimum conditions for aquaculture. A conceptual scheme of the various FARM model components is shown in Figure 17. The authors also suggest "emissions trading" as a mechanism for controlling eutrophication noting that only 40% of ingested nitrogen was returned to the system via shellfish excretion and elimination. From an analysis of revenue sources they estimate that income could be doubled by emissions trading. Chamberlain et al. (2006) present "three different approaches to modeling specific aspects of shellfish aquaculture-environment interactions." A carrying capacity assessment model for oyster (*C. gigas*) culture in an Irish embayment suggested that the carrying capacity was determined more by particulate matter than by phytoplankton, and that the harvest could be optimized by a five-fold increase in seeding (Ferreira et al. 1998). Ferreira refers to the document, Recruitment over-fishing in a bivalve mollusc fishery: hard clams **(***Mercenaria mercenaria***)** in North Carolina, in which Broekhuizen et al (2004) used models to assess the influence of mussel farms in New Zealand's Firth of Thames on an important finfish (snapper eggs and larvae), phytoplankton and zooplankton. Products designed to address physical, production and ecological carrying capacity in five Irish loughs where mussels and oysters are cultured are described by Ferreira et al. (2007b). The objectives of the SMILE (**S**ustainable **M**ariculture in Northern **I**rish **L**ough **E**cosystems) project were:

- *To establish functional models at the lough scale, describing key environmental variables and processes, aquaculture activities and their interactions*
- *To evaluate the sustainable carrying capacity for aquaculture in the different loughs, considering interactions between cultivated species, targeting marketable cohorts, and fully integrating cultivation practices*
- *To examine the effects of overexploitation on key ecological variables*

- *To examine bay-scale environmental affects of different culture strategies*.

The use of models such as these may prove valuable for optimizing aquaculture activities while preserving and protecting other aspects of the ecosystem. It should be noted, however, that "modeling of ecological carrying capacity is still in its infancy" and production carrying capacity models require further refinement (McKindsey et al. 2006b).

Figure 17. Conceptual Scheme of the Various Components of the FARM Model. The model core is within the dotted rectangle, the two screening models are external



(Source: Ferreira et al., 2007a)

4.1.2.12. Enhanced Recruitment

The potential for aquaculture to supplement wild stock has been shown by Kennedy and Roberts (2006) who present evidence that commercial stocks of *Ostrea edulis* were assisting in the redevelopment of native oyster beds in Northern Ireland. Wilbur and Swartzenberg (2003), using genetic markers, found that Louisiana oyster (*C. virginica*) aquaculture lease stock spawns prior to

harvest, and contributes to the wild population. Similarly, *Mercenaria* reaches reproductive maturity prior to harvest, and aquaculture could enhance recruitment "thereby sustaining otherwise unsustainable high levels of harvest of wild stocks" (Peterson 2002).

Thirty percent of seed clams (*Mercenaria mercenaria*) in Oyster Bay Harbor are estimated to have been derived from hatchery clams. Widespread oyster sets observed in creeks and along the shoreline of the Peconic Estuary in the Town of Riverhead are believed to be attributed to oyster spawning from oyster aquaculture stocks in the area (D. Lessard, Town of Riverhead, personal communication, October 2007). Oysters seeded by the Town of East Hampton Shellfish Hatchery have also acted as a substrate for new oyster sets after the plantings were left undisturbed for several years (J. Aldred, Town of East Hampton, personal communication, February 2008). Natural oyster sets in Cold Spring Pond (Southampton) have been attributed to the use of aquaculture of osyters in the embayment (S. Tollefsen, private oyster grant holder, personal communication, July, 2007, and William Pell, personal communication, February 2008).

4.1.2.13. Site Impacts, Down-drift Impacts

On-site species diversity is likely to be increased by structure provided by the bivalve and by farm infrastructure (see Section 4.1.2.6, Displacement and Attraction of Species). Broekhuizen et al (2002) distinguish between three types of organisms in the area of the farm: primary organisms are the shellfish's prey; secondary organisms are cultured shellfish competitors, *i.e.*, "those which suffer as a result of depletion of the primary organisms;" tertiary organisms are those affected for other reasons such as habitat change or predator immigration.

As practices involved in hard clam aquaculture (grow-out trays and anti-predator netting) make it incompatible with the protection of submerged aquatic vegetation (SAV), such culture is generally prohibited in SAV habitat. Hershner and Woods (1999) developed GIS habitat suitability models to estimate the distributions of

suitable clam (*Mercenaria mercenaria*) aquaculture areas and suitable SAV (*Zostera marina* and *Ruppia maritime*) habitat in Virginia waters of Chesapeake Bay in an effort to assess actual and potential conflicts between the two, and to assist in management.

In his discussion of the effects of oyster culture on eelgrass, Vandermeulen (2006) notes that, "in general, seagrass appears to suffer when oyster aquaculture is present, but site-specific differences in current regime, gear use and harvest method may go a long way to ameliorating these effects." He is in agreement with Pregnall's (1993) conclusion (as cited by Simenstad and Fresh 1995) that oyster culture shouldn't be allowed in areas of eelgrass meadows. However, as oyster reefs themselves have significant habitat value, and eelgrass beds offer valuable habitat to bivalves as a settlement site and protective area, "a mix of eelgrass beds and natural oyster reef would offer a high quality marine habitat" that should be preserved. In the case of the Peconic Estuary in which there are presently no natural oyster reefs, it might be of value to investigate the potential for their development adjacent to areas of eelgrass beds. Vandermeulen notes that:

> "The addition of an oyster aquaculture operation to such a site [mix of eelgrass beds and natural oyster reef] would need to preserve the existing habitat (due to its sensitive and important status as habitat). The preservation of the existing habitat could be achieved by developing oyster aquaculture on site as follows:
>
> 1. Density of added oyster biomass should be low.
> a. direct bottom culture: <10 to 50% cover of oyster (Simenstad and Fresh 1995), <300 seed bags/acre (Dumbauld 2005 unpublished report).
> b. long-line culture: >10 feet spacing between lines (Rumrill and Poulton 2004).
> c. stake, rack and float culture: unknown at present, but an industry estimate of the meaning of 'low density' for each of these culture methods could be used.
>
> 2. Configuration of aquaculture gear (stakes, racks, etc.) should be such that excessive erosional or depositional 'patches' are not created.

3. Harvest method should avoid bottom disturbance as much as possible.
   a. driving heavy machinery onto the intertidal should be prohibited.
   b. dredge harvest should be prohibited, and use of tongs avoided, SCUBA harvest is preferred.

Once oyster aquaculture has been established on site, monitoring of sediment, eelgrass and native oyster health should occur for at least two years prior to the expansion of aquaculture operations. Expansion should be iterative, based upon proof of no harm with each iteration."

Again, this is not meant to suggest that these culture practices be utilized, or these activities undertaken, but rather to note potential methodology and items for investigation if and as the aquaculture program is actualized.

A discussion of the complex inter-specific interactions that might be expected on site is found in Section 8, Carrying Capacity. On-site impacts suggested by Broekhuisen et al (2002) are listed in Table 23.

Table 23. Postulated and Documented Local-scale Effects Associated with Shellfish Aquaculture (Broekhuisen et al 2002)

Nature of Direct Impact	Possible consequences	References
Nutrient enhancement through shellfish excretion	Enhanced algal growth rates	Gibbs et al. 1992
Nutrient release from degrading faeces and pseudofaeces	Buffering of pelagic nutrient depletion Enhanced algal growth rates	Tenore et al. 1982
Oxygen depletion within water-column or sediments	Physiological stress amongst planktonic organisms, emigration of larger (motile) organisms Pulsed release of nutrients and sulfides etc. from sediments	Considered unlikely in shellfish aquaculture operations (Morrisey & Swales 1996), but see [sic]
Change in particle size-spectra and particulate content in water-column	Changed sedimentation & sedimentation characteristics Changed light scattering	Impacts upon light field considered unlikely (Ross, A.H. 2002)
Removal of phytoplankton	Reduced food supplies for other phyto-herbivores Community composition biased towards fast-growing species	Gibbs et al. 1992; Ogilvie et al. 2000 Dahlback & Gunnerson 1981
Release of larval shellfish into water- column	Enhanced food supply for some planktivores Other plankton may suffer greater competition for resources	Postulated
Depletion of zooplankton and eggs/larvae of fish and benthic invertebrates etc.	Other organisms may suffer greater competition for resources	Tenore et al. 1985 Horsted et al. 1988
Accumulation of organic detritus and shell hash on sea-floor	Oxygen depletion Nutrient release Change in benthic species assemblage	Dahlback & Gunnersson 1981 Grenz et al. 1990 Kaspar et al. 1985
Complexity contributed by the physical structure of the aquaculture facility and its biota	Changes species assemblage within the water-column and on the sea-floor (invasive species) Changed hydrodynamics Changed erosion/sedimentation characteristics	New Zealand experience with the ascidian *Ciona intestinalis*, seaweed *Undaria pinnatfida* and other mussels *Mytilus galloprovincialis*

Chamberlain et al. (2006) discuss the use of a finfish sedimentation model (DECAMOD) to predict near-field benthic effects of suspended mussel farms, and the model is said to have promise in "understanding the near-field effects of shellfish aquaculture" (DFO 2006).

Down-drift impacts can include the attraction of predators to farmed and adjacent sites, possibly affecting farm production (Pryor et al. 1999) as well as natural populations. More complex far-field interactions are less easily determined, but Broekhuizen et al. (2002) discuss those that are listed in Table 24 taken from their work.

Table 24. Postulated and Documented Down-drift Effects Associated with Shellfish Aquaculture (Broekhuisen et al 2002)

Nature of Impact	Possible Consequences	References
Changed current speeds	Enhanced local deposition leading to sediment starvation elsewhere	Postulated
Nutrient release by mussels and from organic debris	Enhanced phytoplankton growth, possibly with blooms	(Cembella et al. 1997)
Phytoplankton depletion	Selection for fast-growing species even where total far-field biomass is little changed	(Riemann et al. 1988) for changes in size structure within enclosures
Zooplankton depletion	Reduced zooplankton biomass, selection for fast growing species, adverse impacts on higher trophic levels	(Horsted et al. 1988) for documented depletion of microzooplankton by Mytilus edulis. Higher order effects are speculative.
Depletion of eggs and larvae of fish and benthic invertebrates	Reduced species abundance, changed community structure and function	Postulated but see (Cummings et al. 2001)
Selection for species lacking an egg/larval dispersive stage		
Displacement of rocky shoreline/reef invertebrates by mussels through pre-emptive settlement and consumption of the dispersive egg/larval stages	Reduces species abundance and community diversity	Postulated

4.1.2.14. Accidental Release of Shellfish

The potential for accidental introduction of non-native or "exotic" shellfish can be avoided by culturing only native organisms. The use of endemic species for culture is "likely to have little effect on background populations of the wild population and thus may have limited far-field effects" (McKindsey et al. 2007).

4.1.2.15. Genetic Changes

The current unquantifiable risk of "compromising the genetic variability of wild stocks" (ICES 2003), must be considered by any aquaculture operation.

Because of the potential for the commingling of genes between selected and wild stock (EOBRT 2007), many aquaculture researchers suggest the use of only local varieties, and this is required by a number of regulatory agencies. On the other hand, selective breeding of native stock may prove valuable. Informal breeding for fast growth and JOD resistance by the Frank M. Flowers and Sons Co. in Oyster Bay resulted in stock used as a starting point by the University of Maine for selective breeding to successfully produce a disease resistant cultured *C. virginica* (Rawson and Feindel 2006).

4.1.2.16. Impacts to Protected and Important Species

The placement of aquaculture gear within the water column is not expected to cause significant adverse impacts to the protected shorebird species that occur within or in the immediate vicinity of the Shellfish Cultivation Zone. Protected shorebirds such as black skimmers, common terns, least terns, and roseate terns could be impacted from an increase of human disturbance in preferred foraging areas. Shorebirds generally exhibit high site fidelity and may fledge from foraging areas where they overlap with aquaculture sites (Jamieson et al., 2001); however, the placement of sites beyond 1,000 feet from shore, and the avoidance of currently productive areas, will likely result in minimal disturbance.

On the contrary, hundreds of common and roseate terns have been observed utilizing floating aquaculture raft systems during summer months in the Town of East Hampton. The rafts provide staging platforms for food foraging, feeding

their young, and flocking up for fall migration (J. Aldred, Town of East Hampton, personal communication, February 2008).

Some species of sea turtles feed on bottom-dwelling invertebrates (e.g. mollusks, crabs), and some aquaculture gear associated with on-bottom culture (i.e. exclusion netting) placed directly on the foreshore surface could limit access to foraging sea turtles. However, the 1,000 foot shoreline buffer for shellfish aquaculture leases under the proposed program would limit lease areas capable of using foreshore netting. Aquaculture in deeper water may involve the physical removal and killing of undesirable species, such as macroinvertebrate predators, on leased lands, which could impact the food supply for certain species of sea turtles. Species that rely on SAV as their main food source would not be restricted in terms of foraging areas, since no leases would be permitted in known seagrass areas.

Much important finfish spawning and nursery grounds occur in eelgrass beds, which will be excluded from the underwater lands available for leases under the proposed program. Structures associated with aquaculture systems provide local habitat for juvenile fish. Some species of fish, however, lay their eggs on the bay bottom and could be impacted by shellfish harvesting activities. Fish eggs resting on the bay bottom of a lease site could be destroyed or smothered by the use of mechanical dredges to harvest on-bottom planted shellfish.

4.1.3 Mitigation

Every attempt must be made to prevent or mitigate potential adverse impacts of aquaculture while maintaining the economic viability of aquaculture operations. Regulations need to be developed considering both environmental and cost/benefit concerns. All the literature reviewed suggests that ecosystem effects related to aquaculture are scale-dependent (number and size of farms, and intensity of culture), thus the first mitigating circumstance will be the extent of farming allowed.

4.1.3.1 Limit Lease Number

Under the proposed program, a one-percent growth rate for new leases will be implemented so that no more than five-percent of the total area currently used for aquaculture (approximately 5,982 acres) will be leased over the first five years. The 5% growth limit was based on a growth rate estimate that would be considered conservative, but allow for moderate growth with minimal conflicts with other bay users. The conservative growth rate will also provide for an opportunity to learn from experience what the impact of aquaculture is at selected sites. A limit on the total amount of underwater lands committed to aquaculture will limit the extent of potential adverse impacts to ecological and socio-economic conditions in the Peconic Bay/Gardiners Bay system.

4.1.3.2. Limit Lease Size

The program will provide for the placement of leases in areas where conflicts with existing users of the estuary will be minimized and where environmental impacts to sensitive marine and coastal environments will be avoided. A complete description of the process for identifying areas suitable for shellfish aquaculture leases within the study area is described in Section 2.

Under the proposed program, new aquaculture leases within the Shellfish Cultivation Zone will be limited to 5- or 10-acre size plots, with the exception of private oyster grants where the lease would overlay the grant parcel. The 5 to 10-acre lease sizes for new aquaculture sites are considered large enough to support a profitable operation, but small enough to avoid becoming burdensome to other users, or to result in adverse ecosystem changes. The limited acreage permitted for leases will reduce the loss of foraging areas and habitats used by protected and sensitive marine life (sea turtles, dolphins, seals, etc.). In addition, impacts to juvenile fish populations would be reduced, as the amount of disturbance to fish spawning grounds would be minimal.

4.1.3.3. Type of Lease

The most likely bivalves for aquaculture are the oyster (*Crassostrea virginica*), the hard clam (*Mercenaria mercenaria*), the bay scallop (*Argopecten irradians*), and the blue mussel (*Mytilus edulis*). Culture techniques include on-bottom, off-bottom, and suspended. Under the proposed program, culture techniques will be limited to off-bottom gear for existing aquaculture operations that wish to remain at their current site without any change to culture and type of operations. This will limit the potential impacts of leases that are established at existing aquaculture sites by preventing substantial lease acreage expansion and limiting the type of cultivation. Experimental/educational leases and municipal leases for shellfish resource restoration also available under the proposed program are anticipated to result in positive environmental impacts, including improvement in water quality and estuarine habitat. All new leases must undergo review as part of the NYSDEC permit acquisition process, and permits will have conditions that limit the type of aquaculture activities deemed appropriate for the lease site.

In the past, the shellfishing industry on Long Island has been subject to devestating impacts that were the result of a reduction in habitat through a change in the environmental conditions (i.e., brown tide, QPX, Dermo, MSX). A possible mitigation to these outbreaks having a devastating effect on a shellfish population is the ability for a grower to be able to relocate their stock to another location if the environmental conditions surrounding the lease area deteriate. For example, if an outbreak of brown tide were to occur in the inner bays it could benefit the natural and cultivated oyster resources in Peconic Bay and Gardiners Bay, by allowing the farmers the ability to be re-locate their stock to areas in the eastern portions of the bays that are eligible for leasing until the outbreak subsides and their stock can be returned to the inner bay areas. This flexibility would help to mitigate adverse effects of such environmental changes on the aquaculture industry in the bays.

Overall, the proposed action will encourage the placement of leases in areas deemed acceptable for aquaculture based on the program development process discussed in Section 2.

4.1.3.4. Ongoing Municipal Input

Under the proposed program, all lease applications will be subject to review by the five Towns in the Peconic Bay/Gardiners Bay system. Input and comments provided by the Towns within a specific time period will be taken into consideration by the County in the approval process. This input will ensure that local concerns are considered.

4.1.3.5. Limit Biomass of Shellfish

The biomass of shellfish farmed cannot exceed the production carrying capacity (see Section 8) of the farm locale. To do so would result in diminishing returns for the farm as well as for native populations. The production carrying capacity may be measured in terms of wet or dry weight, by energy or organic carbon, but greatly depends on the physical carrying capacity and the functions of the ecosystem (McKindsey et al., 2006). The cumulative effects of several farms in localized areas, as well as throughout the estuary must be considered. Most effects of bivalve aquaculture seem to be related to the scale (intensity and extent) of aquaculture rather than the type of infrastructure (DFO 2006), and the lease program as it is currently proposed does not seem problematic relative to carrying capacity. The ability to determine effects requires site specific input including nutrient loading and dynamics, light and/or temperature limitations, phytoplankton growth rates, shellfish filtration characteristics (rates and size limitations), hydrodynamics, flushing, etc. Broekhuizen et al. (2004) suggest that, based on their model, phytoplankton in the Firth of Thames are dependent upon ambient DIN concentrations, and it's conceivable that, depending on the magnitude of mussel farming (*i.e.*, if large scale aquaculture occurs), the potential exists for increasing the "nitrogen deficit within the firth in the long term." The model also suggests that "phytoplankton populations are likely to become depleted during times when temperature and/or light levels limit cell-growth

rates" but that ammonium released by mussels will enhance growth rates during other times. They note that phytoplankton depletion "will not exceed the area of the farm itself by a large margin." As only a very small percentage of the Peconic Estuary is likely to be utilized for aquaculture, and the area utilized will be at least 1,000 feet offshore, any effect on the overall phytoplankton population will probably be negligible.

4.1.3.6. Restrict Harvest Methods

The type of cultivation in terms of species and method of harvest will not be specified under the lease, but will be subject to NYSDEC permit requirements. NYSDEC does not issue permits for shellfish harvesting techniques. On/Off-Bottom Culture Permits issued by NYSDEC must comply with the regulations set forth within provisions of the ECL, which permits the use of mechanical and hydraulic dredging equipment on privately-owned or state-leased underwater lands. Currently, the use of hydraulic dredges on temporary assignments is prohibited under a special condition stated in the culture permits. Currently, private oyster grant holders must obtain a NYSDEC on-bottom culture permit to cultivate species other than oysters, which also allows for the use of mechanical harvesting techniques (e.g. hydraulic dredges) on the site. Dredging would only be permitted to harvest aquaculture stock, and not natural stock.

If the use of mechanical and hydraulic operations is permitted by NYSDEC for a lease under the County Lease Program, impacts to environmentally-sensitive areas (i.e. eelgrass beds, natural and historic shellfish beds) would be minimized, as new leases would not be issued in such areas. Additionally, the limited percentage of estuary bottom affected would not likely be problematic. Should it become so, it would likely contravene the intentions of the farmer, and result in a reevaluation of methodology to improve yield and, ultimately, profit.

4.1.3.7. Establish Buffers Around Leases and Environmental Resources

A concentration of leases within an area of the estuary could create significant impacts to boat navigation, as well as to recreational and commercial uses of the

bays. A method of mitigation will be to establish buffers between leases to reduce areas the intensity of leases in an area. This will allow for navigation between lease sites and ensure the availability for recreational and commercial uses within the area. In addition, establishing a buffer zone between lease sites will help to mitigate conflicts that may occur from inadvertent overlapping of aquaculture activities, as well as conflicts with other users.

Establishing a buffer zone between lease sites will help to mitigate conflicts that could occur from accidental overlapping of cultivation areas. A buffer zone may also help the mitigate the need for an acuate survey of each lease area.

Extensive research on the environmental characteristics and features of Peconic Bay and Gardiners Bay has been conducted to assess areas of environmentally-sensitive resources (i.e. significant coastal fish and wildlife habitats; eelgrass beds; present and historic natural shellfish beds; and conditional and closed shellfish harvest beds) within the study area. In addition to a review of existing reports and studies of the Peconic Estuary, interviews were conducted with regulatory agencies and knowledgeable individuals. Results of the search identified environmentally-sensitive, and other important natural resource areas. These locations were mapped as environmental resource conditions (refer to Figure 3) and have been excluded as areas for potential leases in the Shellfish Cultivation Zone.

This provision will prevent significant adverse impacts to the protected sea turtle species that commonly migrate to the eastern portion of the estuary, particularly the significant coastal fish and wildlife habitats described earlier under Section 4.1.1. It will also protect sensitive fish spawning areas located in eelgrass beds and elsewhere. The 1,000-foot shoreline buffer required for aquaculture leases will minimize significant adverse impacts to protected shorebird species, as well as other important species such as harbor seals and grey seals commonly found at haul-out areas in the eastern portion of the estuary. Further, the exclusion of

leases in most of the waters of Gardiners Bay will limit the potential impacts of habitat displacement of marine mammals in the area, such as seals and dolphins that sometimes frequent these waters.

4.1.3.8 Require Environmental Monitoring Plans

Environmental monitoring plans must be as comprehensive as possible while remaining economically realistic. See section 4.1.3.14 Monitoring Environmental Conditions, below for a discussion.

4.1.3.9. Require Disease Testing of Shellfish

Local sources of shellfish should be used for cultivation, preferably from the same estuary where cultivation will be undertaken. If this is not possible, seed may be obtained from reputable dealers elsewhere, as close as possible to the culture site. Any testing required should be determined by shellfish biologists familiar with local conditions and the potential for stock to be contaminated. Information on disease history for each lot and site of origin should be provided from past hatchery production experience, and a certificate certifying each lot to be disease free should be provided. In no case should non-native species be used. Details on permissible stock origin, and diseases to be screened, should be developed by shellfish experts.

NYSDEC is currently working on adopting a "Policy of Acceptable Origin of Shell and Shellstock for Introduction in New York". Criteria identified includes: the use of native species only; restriction on the source of shellfish (north of New York) with no known disease presence (specific exceptions apply); health certification would be required prior to the issuance of a permit; Shellfish Importation Permit required prior to importing shellfish from locations outside of New York; genetically altered strains are not permitted to be introduced into State waters with the exception of disease resistant stocks. These requirements will serve to avoid adverse impacts associated with uses of non-native species.

Marine animal diseases that could affect New York's cultured and wild marine resources are currently research by the Marine Disease and Pathology Research Consortium at Stony Brook University's School of Marine and Atmospheric Sciences (SoMAS). The Consortium also provides disease analytical and certification services for the interstate shipment of shellfish by private aquaculture companies. The work of the Consortium is presently contributing to a more effective understanding and management of local marine diseases, particularly high priority diseases, such as QPX. The Consortium represents an international resource that can help serve aquaculture interests in the study area.

4.1.3.10. Transient Gear Aquaculture System

Transient gear used for off-bottom culture provides habitat for many organisms throughout the year, and is especially beneficial to ecosystems that support native species of recreationally and commercially important fish and invertebrates in their early life history stages (Dealteris, et al. 2004). Transient gear minimizes the predation of cultured shellfish and contains mobile cultured species (i.e. scallops) until harvest (Massachusetts Office of Coastal Zone Management, 1995). Gear suspended in the water column allows for the use of a three-dimensional space for cultivation, as opposed to the lease limits on the seafloor.

Gear such as cages, racks, or long-lines are generally manually hauled to the surface through the use of a specially designed reel at the bow of the boat. This eliminates the use of mechanical and hydraulic dredges, therefore minimizing direct impacts to the benthic community. An increase in the benthic community biodiversity below transient culture sites was reported by McKindsey et al. (2006a).

The proposed program, however, does not include mandates on particular methods of grow-outs or harvest techniques, and any regulations to particular grow-out methods would be regulated by NYSDEC.

4.1.3.11. Plot Rotation

Dredging operations have a direct impact on the benthic community at a culture site. Transient gear decreases direct impacts by eliminating the need to dredge the bay bottom; however, benthos may still be impacted by the accumulation of feces and pseudofeces from the cultured shellfish and associated biofouling, and shell aggregate. Plot rotation may minimize any potential significant adverse impacts to the benthic community by allowing time for the benthos to recover. Periodically rotating the location of transient gear within a lease area may also reduce user conflicts with recreational boaters and fishermen. Although not a requirement under the proposed program, plot rotation could be performed by lessees if it proves beneficial.

4.1.3.12. Use of Local Seed Stock

Non-native bivalve species have the potential to introduce exotic and/or pathogenic species, and competing, non-beneficial genetic strains. Exotic species can adversely affect the cultured bivalves (i.e. biofouling) and, in more extreme cases the surrounding ecosystem (McKindsey et al., 2007). Exotic species may inadvertently be transferred within the bivalves themselves, in the water or sediment associated with them, or on equipment (i.e. ropes, stocking material, etc.) transferred with them (McKindsey et al., 2007). Mitigation measures for exotic species that have been released into the marine environment are generally not very successful (McKindsey et al., 2007). To reduce the potential for aquaculturally-introduced exotic species to impact the estuary it is recommended that shellfish seed stock be purchased through local hatcheries whenever possible. The NYSDEC policies discussed under Section 4.1.3.9 would also help to precent introduction of exotic species.

4.1.3.13. Phasing of Program

In order to assess and address any unforeseen impacts associated with the shellfish aquaculture lease program, the program will be implemented in such a way that will allow for program adjustments to mitigate those impacts. The proposed Lease Program will be subject to five-year planning periods during the

initial ten years of the program. The first five-year planning period will allow for a one-percent increase in the amount of underwater land available for shellfish aquaculture, as outlined earlier in Section 2. The Lease Program will be subject to review during the second five-year period to establish program components after ten years. This review will be based on an environmental assessment, which will include, but is not necessarily limited to: data on environmental conditions of the bays collected within the County's ongoing water quality monitoring program; results of the Lease Program to date; need/demand for additional lease space; and town, public and industry input.

4.1.3.14. Monitoring Environmental Conditions

The following provides information on suggested monitoring developed by environmental researchers, and is not meant to imply that monitoring operations be undertaken by leaseholders. While it is not always possible to determine the cause(s) of water quality changes, those resulting from aquaculture operations are likely to be quite localized, especially at the proposed scale, and should be detectable if significant. Aquaculture, at least initially, is not likely to cause widespread changes. The planned phased increase in aquaculture activities will provide the opportunity to discern cumulative impact, if any.

Broekhuizen et al. (2002) have suggested candidate characteristics for determining pelagic ecosystem changes that might result from aquaculture operations (Table 25).

Table 25. Candidate Characteristics by which Deviations from the Pelagial-phase Ecological Carrying Capacity of the Firth of Thames Might be Assessed (Broekhuizen et al. 2002)

Characteristic	Core or site-specific	Sampling frequency	Rationale	Data which might be used to define trigger levels
Nutrient concentrations	Core	Weekly to monthly	Nutrients (esp. nitrogen) frequently limit primary production in the Firth of Thames	(a) Departures from "control" site concentrations (b) excursions beyond historical (pre-farming) ranges characteristic of prevailing ENSO conditions. (c) changes in phases of seasonal nutrient cycle
Size fractionated phytoplankton concentrations	Core	Weekly to monthly	Indicator of food availability to other organisms feeding upon phytoplankton	(a) Chlorophyll concentrations in "control" areas. (b)half-saturation coefficients for feeding/ growth in key grazer taxa
In-situ chlorophyll fluorescence	Core	Weekly to monthly	Large areas can be surveyed quickly thereby compensating for the high spatial Variability which is common in phytoplankton distributions	
Abundance of key zooplankton taxa (microzooplankton, copepoda, eggs and larvae of benthic organisms	Core	Monthly	Indicator of changes in abundance/community composition of phytoplankton & microzooplankton. Indicator of food availability to higher trophic levels (fish etc.)	(a) Abundance in "control areas" (b) Half-saturation coefficients for feeding/growth in key planktivore taxa
Survival of larval fish	Site-specific	Several times during spawning season	Variations in larval survival in fish usually determine adult stock-size	Survival relative to expected survival based upon historical data (e.g. SST-relationship for snapper (Francis 1993))
Abundance of selected post-pelagial stages of benthic organisms (incl. tidal zone organisms)	Site-specific	Monthly to annually	Indicator that farming is reducing survival/recruitment success of the egg/larval stages of these organisms, or reducing productivity of adult stages (reduced phytoplankton availability etc.)	(a) Departures from control site abundances (b) Departures from historical norms
Population size and distributions of charismatic megafauna*	Site-specific	Annual	Indicator that farms are having adverse trophic or disturbance effects	(a) Departures from control site abundances (b) Departures from historical norms

*Broekhuizen et al. suggest “that public concern is concentrated upon the so-called ‘charismatic megafauna’ (birds, mammals, some fish *etc*.).”

The following table (Table 26) of recommended indicators of bivalve aquaculture habitat effects from the Division of Fisheries and Oceans Canada (DFO 2006) includes benthic characteristics in addition to pelagic.

Table 26. Recommended Indicators of Bivalve Aquaculture Habitat Effects with the Associated Spatial Scale of Impact That Each Can Address

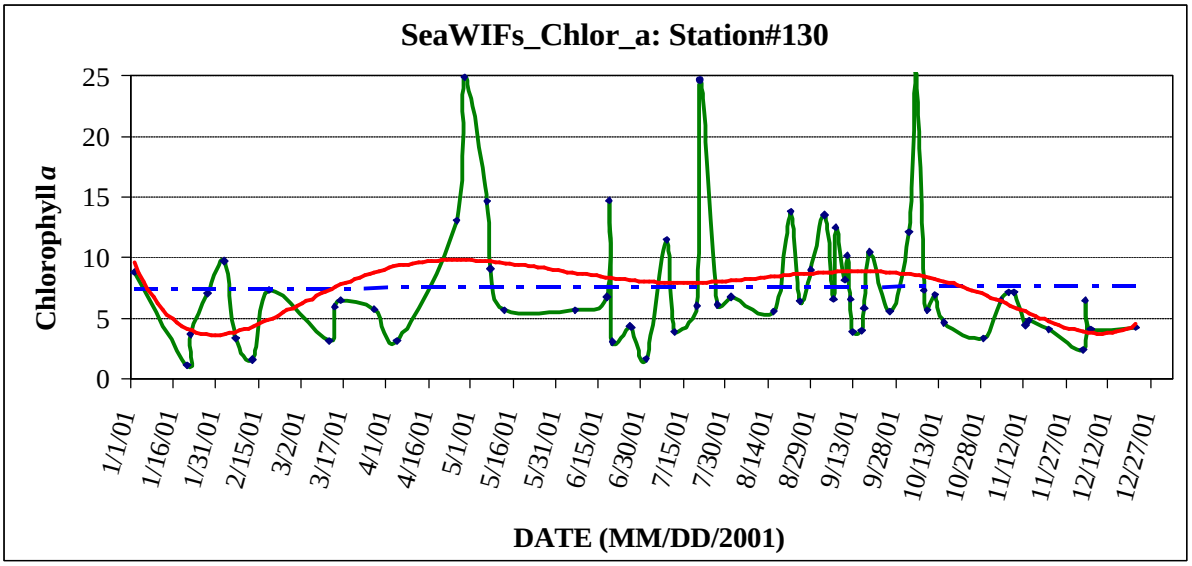
Indicators	Spatial Scale
1) Benthic Habitat	
• Geochemical (total free sulfides, redox potential, organic content, porosity)	Lease
• Imaging (sediment profiling, video)	Lease
• Benthic community biotic indices (indicator species, trophic indices, indices of biological integrity)	Lease
2) Pelagic Habitat	
• Secchi depth	Lease
• Chlorophyll depletion	Lease-bay
• Bacteria/Chlorophyll ratio	Bay
• Picoplankton/Chlorophyll ratio	Bay
• Performance of caged and cultured bivalves (condition indices, shell/meat weight and growth, biochemical indicators)	Lease-bay
• Farm inventory (production, stocking density/biomass, mean yield per cultured unit)	Lease-bay

This information provides a starting point for discussion on monitoring activities that can be considered for the Peconic Estuary.

Costs for the above described monitoring would be prohibitive for fledgling aquaculture operations, especially if required on an individual basis, but they may be approachable if an industry consortium could be developed, to work in conjunction with already-operating agency monitoring programs (*e.g.*, those undertaken by the SCDHS, NYSDEC, USGS, etc.). The addition of remote sensing, especially for *in-situ* chlorophyll fluorescence, might prove valuable as it synoptically integrates large areas. Several problems still exist, however, in the use of satellite imagery, including the time scale of fly-over, cloud cover, and the resolution required to discern small scale variations that occur in small estuaries. Investigations currently supported by Suffolk County suggest that SeaWiF

satellite observations have sufficient resolution to recognize elevated chlorophyll levels that are not recognizable with low temporal resolution ship operations (Szekielda 2006, Nuzzi 2007) (Figure 18)

Figure 18. SeaWiFS Observations (green; spiking highest) for Suffolk County Station 130 in Peconic Bay for the Year 2001 (linear trend line blue dashed) and polynomial fit (red) (from Szekielda 2006)



4.2 Socio-economic and Cultural Impacts

4.2.1 Existing Conditions/Setting

4.2.1.1. Commercial Fishing

The Environmental Conservation Law (ECL) NYSDEC divides commercial finfishing activity into a net fishery (ECL §40.5 NYSDEC 2007) and a pot or trap fishery (ECL §40.6NYSDEC 2007b), and sets restrictions on gear type and number for each fishery.

Commercial fisheries facilities exist at Greenport and in East Hampton. Greenport supports several draggers, trawlers, and scallopers (USEPA, 2002). Greenport is also home to the Greenport Seafood Dock and Market and the Greenport Fish factory, both of which provide facilities for the unloading and

distribution of fish; and a commercial fishing dock owned by Suffolk County and leased to the Village of Greenport that provides layover for commercial craft. East Hampton contains a commercial fishing facility within Three Mile Harbor, as well as Lake Montauk (located east of the study area). The Three Mile Harbor facility serves trawlers, lobster boats, and trap fishermen (USEPA, 2002). Several commercial markets are located in Montauk where fish are packaged and shipped to the central seafood market in New York City and elsewhere.

According to the New York State Department of Agriculture and Markets (2004) 41.3 million pounds of fish and shellfish with a dockside value of $59.6 million were landed in New York State in 2000, during which the state's commercial fishing industry employed about 10,500 people and contributed $149 million to the state's economy. The total economic value to New York State is estimated at $8 billion annually. Although shellfish, including clams, oysters and lobsters, accounted for only 28% of the harvest (11.6 million pounds), they made up 60% ($36 million) of the total dockside value in 2000. Finfish accounted for $16 million and squid for $7.7 million.

4.2.1.1.1. Types of Activities

Net Fishery

- Dragging and Trawling – Trawls are nets towed behind a boat, the mesh sizes of which are defined for specific fisheries (e.g., summer flounder, winter flounder, weakfish, scup, black sea bass, tautog) and by regulatory requirements. In some areas trawlers are also termed "draggers." Trawling within the Peconic Estuary is restricted to the open waters east of Shelter Island (ECL §13-0341) (refer to Figure 2).

- Gill Nets – The gill net fishery is one of importance in Gardiners Bay. Gill nets are predominantly used to capture bluefish, weakfish, bunker and striped bass. The use of gill nets for commercial fishing has increased dramatically since the mid-1970s, which alone accounted for 25 percent of the total catch within the Peconic/Gardiners Bay area during the mid-

1990s (Weber and Grahn, 1995). The use of gill nets within the Peconic Estuary is restricted to the open waters east of Shelter Island, and is prohibited in the Peconic Bays and adjacent bays and harbors west of Shelter Island (ECL §13-0343). Gill nets are also limited to specific mesh sizes for each fishery.

Annual landings by gill nets in the estuary, including sink gill nets, runaround gill nets, and other types of gill nets, averaged approximately 268,467 pounds from 1980-1992 (Weber and Grahn, 1995). Recent landing data pertaining specifically to the Peconic Bay/Gardiners Bay system is not available.

- Pound Nets – Pound or trap nets are generally found within 1,000 ft. from shore and are not likely to be affected by aquaculture leases (refer to Figure 2). When permitted by the Commissioner of NYSDEC, they may be used east of Shelter Island and, if they do not interfere with navigation or shellfish aquaculture, in waters to the west (ECL §13-0343).

- Fish Pots or Traps – Fish pots or traps are cages, usually made from metal or wood, are baited to attract, and entrap, finfish or crustaceans. They are generally designed for a specific target, and to "fish fast." In some trap fisheries, pots are hauled multiple times per day. Selectivity, in terms of the fishery and the size of the catch, is one of the benefits of trap fishing, as is low bycatch mortality in properly designed and fished traps. Additionally, the gear is passive, that is, it is not towed or dragged along the bottom, thus avoiding damage to the bottom environment. There are areas, however, that should probably be avoided (e.g., oyster reefs) to prevent damage from repeated setting and hauling of pots. "Ghost fishing" by pots that have been lost, and pots that are not checked as frequently as they should be, can result in fish mortality. New York State code prevents fishing pots or traps within 500 feet of any artificial reef (§13-0343-a).

- Pin-hooking

  Commercial fishing for finfish is also performed by hook and line fishing, commonly referred to as pin-hooking. Pin-hookers refer to hook and line fishermen who sell their catch. Party and charter boats sometimes fish commercially with hook and line when they are not booked for hire. Party and charter boats will also sell fish left behind by customers for the crew. The magnitude of the commercial pin-hooking catch is difficult to estimate and will vary according to regulatory catch and size limits, market demands, and availability of fish. In the Peconic Bay/Gardiner Bay area, pin-hooking has been done in the past for striped bass, bluefish, scup, porgy and other finfish species.

Shellfisheries

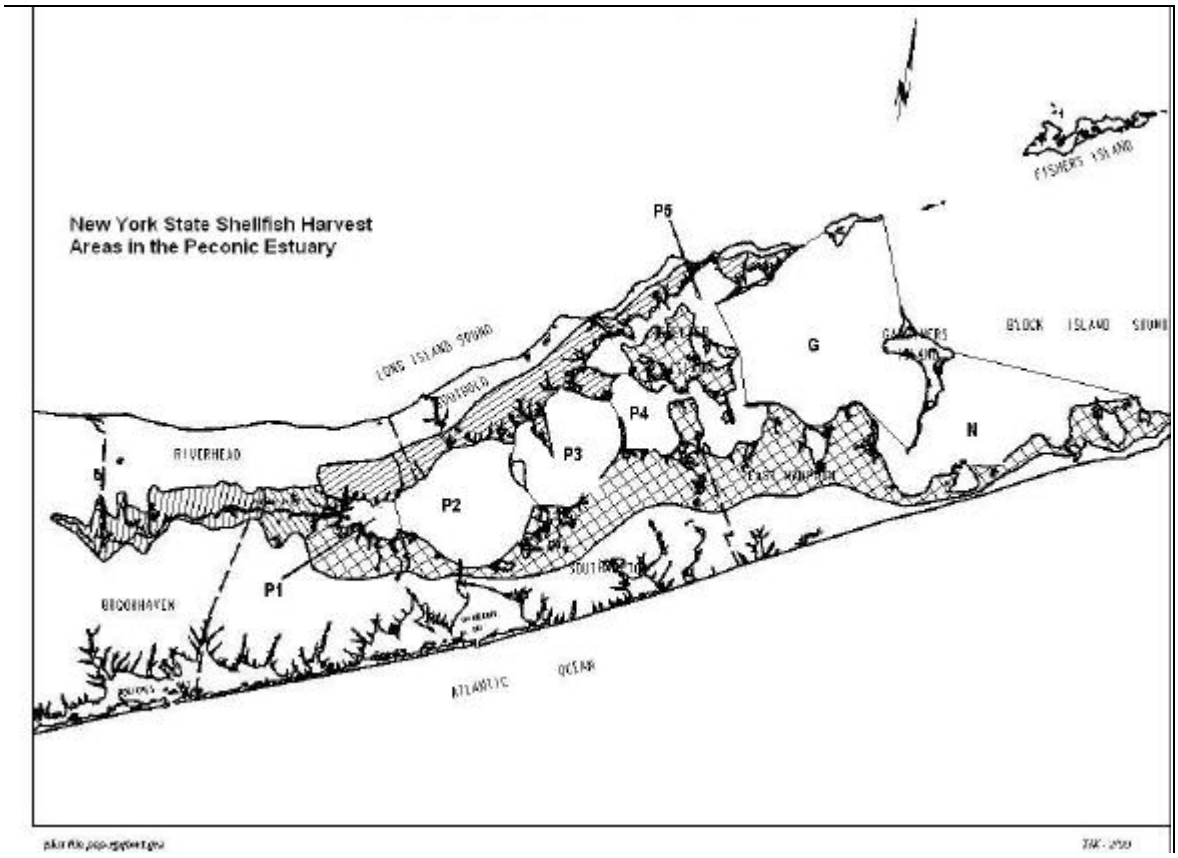
Except for bay scallops and whelks (regionally called "conch"), the shellfishery in the Peconic Estuary has consisted primarily of harvesting transplanted oysters and hard clams. The US Food and Drug Administration requires that commercially sold shellfish be identified with the location where it was harvested. Seven shellfish growing areas have been designated throughout the Peconic Bay/Gardiners Bay system: P1 through P5, G and N. Table 27 provides catch statistics, obtained from the NYSDEC, by town and harvest area (Figure 19) for the years 2003 – 2006.

Table 27. Shellfish Harvest (bushels, except for bay scallop which is in lbs) for the Peconic Estuary 2003 – 2006 (NYSDEC)

Town & Area	Year	HC	SC	O	M	C	BS (lbs)	RC
Southampton P1 - P4	2003	29,343	991	1,217	0	684	375	45
	2004	15856	1764	663	0	141	73	59
	2005	18,563	2,296	322	0	174	1,469	62
	2006	13,721	1,872	513	0	11	179	80
East Hampton P4, N & G	2003	1,170	10	488	0	1,127	15	40
	2004	662	58	509	0	736	0	0
	2005	1,095	1,057	700	0	425	0	0
	2006	979	103	608	0	1,160	714	0
Riverhead P1 & P2	2003	55	2	0	0	0	0	0
	2004	3	0	3	0	0	0	0
	2005	15	0	0	0	0	45	0
	2006	0	0	0	0	0	0	0
Shelter Island P4 & P5	2003	56	38	1	0	0	58	0
	2004	174	128	3	0	41	0	55
	2005	149	171	0	0	0	114	0
	2006	333	22	0	0	0	1,205	0
Southold P2, P3 & P5	2003	6,358	119	39	0	461	1,201	68
	2004	3,317	810	171	0	369	1,993	0
	2005	2,785	228	107	0	3,399	3,854	11
	2006	3,325	84	492	0	1,421	1,876	0

HC=hard clam, SC=soft clam, O=oyster, M=mussel, C=conch, BS=bay scallop, RC=razor clam

Figure 19. New York State Shellfish Harvest Areas in the Peconic Estuary



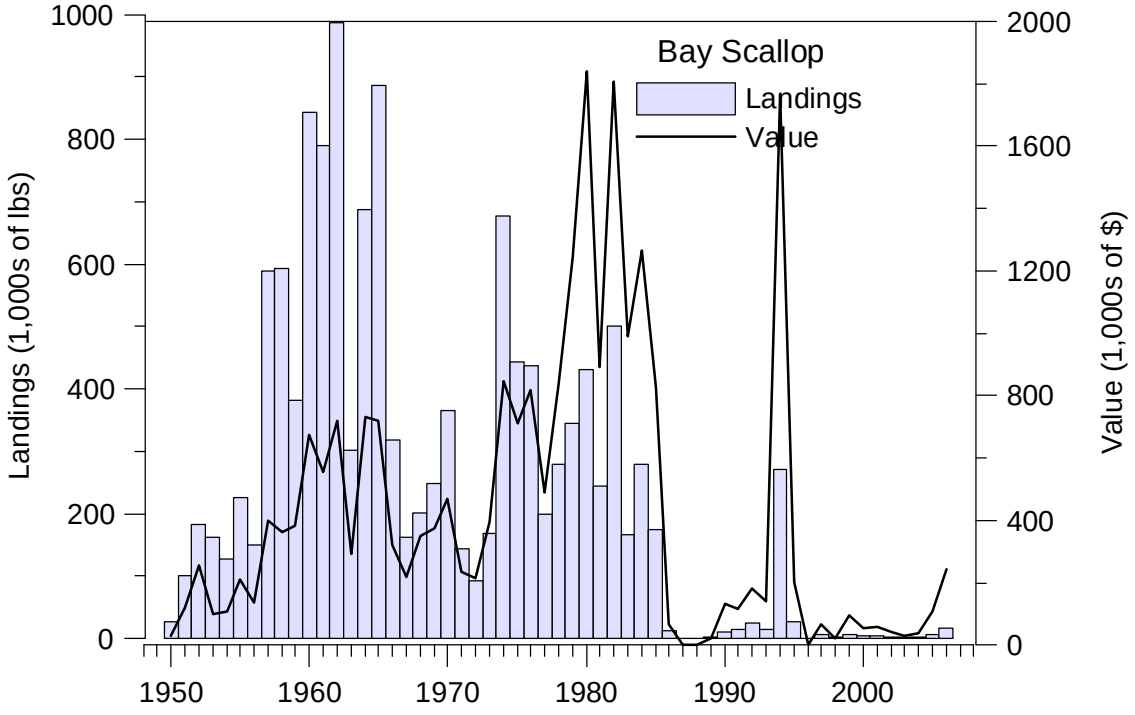
- Hard clamming – nearly 90% of the annual hard clam production comes from aquaculture activities in the Peconics (Suffolk County Department of Planning, 2002). Hard clam culture occurs on private oyster grants and temporary assignments throughout the estuary. The locations of the sites that culture hard clams have been previously identified in Tables 2 and 3, respectively, in Section 3. Hard clams are generally harvested using rakes or tongs from a small boat with an outboard engine, or larger vessel equipped with a mechanical dredge (refer to Section 4.1.2.2 for shellfish harvest methods).

- Oystering - nearly 90% of the annual oyster production comes from aquaculture activities in the Peconics (Suffolk County Department of Planning, 2002). Oyster culture occurs on private oyster grants and temporary assignments. The private oyster grants that are actively

culturing oysters are identified on the Shellfish Cultivation Zone (Figure 2). The temporary assignments that cultivate oysters are identified on Table 3 in Section 3. Oysters are generally harvested using non-mechanical and mechanical dredges (see Section 4.1.2.2 for specific harvest methods).

- Scalloping – Scalloping in the Peconic Estuary has suffered serious declines since the appearance of the brown tide organism *Aureococcus anophagefferens* in 1985. Except for a brief resurgence in 1994, which was followed in 1995 by another brown tide, the harvest has been extremely poor, despite attempts to rejuvenate the population through hatchery production and seeding. It is suspected that part of the problem is the loss of eelgrass, an important habitat for scallop setting and protection against predators. Figure 20 illustrates the decline of the scallop fishery in New York State, almost all of which was represented by the harvest in the Peconics.

Figure 20. Bay Scallop Landings in NYS 1950 – 2006 (NMFS Statistics)



Bay scallops are also a species cultured on several private oyster grants and temporary assignments throughout the estuary. Location of bay scallop culture sites are depicted in Tables 2 and 3 in Section 3. Harvesting scallops generally involves the use of small non-mechanical dredges from small boats, although dip nets have been traditionally used both from shore or on a boat.

Whelks (conch) - Whelks can be harvested with baited pots, trawls or dredges, but knobbed whelks (*Busycon carica*), because of their weight, are less likely to be taken in pots than the channeled whelk (*Busycon canaliculatum*). Pots are generally attached to a line and float, and horseshoe crab is the usual bait Pots are typically set in line 150 feet apart during prime season (May through mid-July, and mid-September through November) and are usually checked every other day.

Although data are limited, it appears that the conch fishery has assumed some importance in recent years, especially in the Towns of East Hampton and Southold (Table 28). Typical catches in the prime season are 10 to 12 bushels per day; yielding about $66 to $70 per bushel, based on discussions with commercial bayman. Whelk potting has become extensive in the Peconic and Gardiners Bays. Presently, there are approximately 30 whelk fishermen operating in the Peconic Bay/Gardiners Bay system, each of which may have up to 350 pots in use during the prime of a season (P. Wenczel, commercial bayman, personal communication, August 2007). Whelk pots are constantly moved to maintain catches as the area around a pot becomes depleted of market size whelks, or as the whelks move in search of food (D. Yaxa, private oyster grant holder, personal communication, September 2007). Table 28 indicates that, except for the Town of Southold, the number of whelk taken each year has diminished. As the whelk fishery data is limited, it's

currently possible only to speculate on the effect of fishing pressure on the population, especially as there does not appear to be any information on recruitment, spawning stock biomass or mortality.

Table 28. NYSDEC Whelk Landings in Peconic and Gardiners Bays (bushels)

Year	Southampton	East Hampton	Riverhead	Shelter Island	Southold
2005	174	425	-	-	3399
2004	141	736	-	41	369
2003	684	1127	-	-	461
2002	3027	3027	-	-	184
2001	-	58	-	-	506
2000	-	-	-	-	104

Fishing effort for whelk in the Mid-Atlantic states increased during the 1990s due to reduced populations of the marketable Caribbean Queen conch (*Strombus gigas*) and burdensome regulations on other regional fisheries (University of Delaware 2007). As illustrated in Table 29, most of the whelk harvested is exported, primarily to Southeast Asia.

Table 29. 1999 US Exports of Whelk

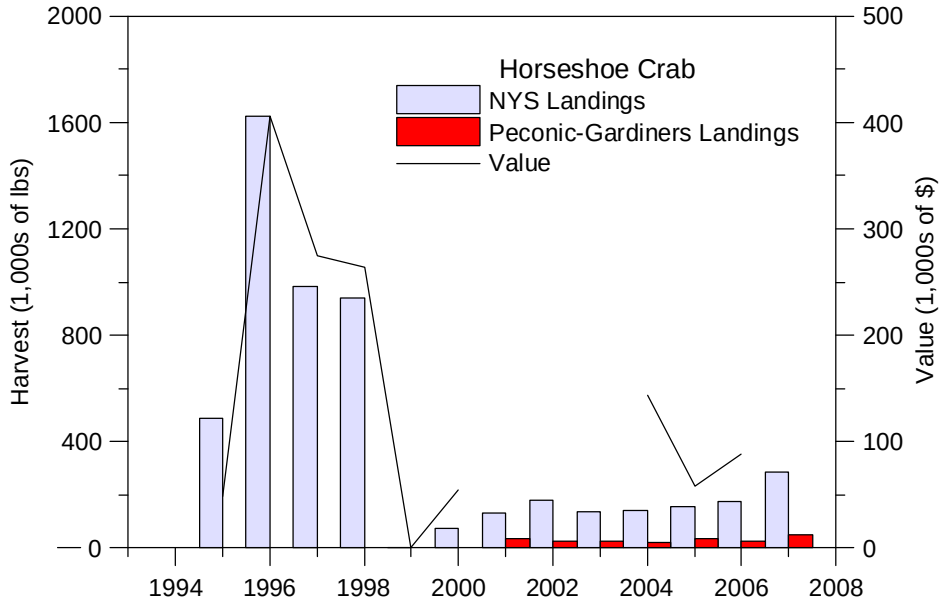
Destination	Kilos of Whelk
Australia	9,558
France	13,963
Caribbean Isles	110,054
Southeast Asia	674,488
Data from NOAA NMFS Fisheries Statistics and Economics Division (From University of Delaware, 2007)	

- Horseshoe Crabs

Because horseshoe crabs (*Limulus polyphemus*) are used as bait for whelks, the burgeoning whelk fishery has had a severe effect on mid-

Atlantic horseshoe crab populations. Harvest quotas set for each state by the Atlantic States Marine Fisheries Commission (ASMFC 1998, 2000, 2001, 2004, 2006) were exceeded in New York State in 1999 and 2000, after which there was a precipitous decline in numbers of crabs harvested, and in pounds harvested and dollar value (Figure 21). A declining trend is also evident in the total Atlantic coast harvest. New York voluntarily reduced its quota in 2004 to 150,000 crabs "due to concerns about interactions with shorebirds" (Mckown et al. 2006), although the harvest was below that limit beginning in 2000, suggesting that the decrease in horseshoe crab harvest did not likely result from a decrease in fishing pressure.

Figure 21. New York State Horseshoe Crab Harvest in Pounds and Dollar Value, 1990 – 2006 (NMFS statistics, 2001 – 2003 statistics from NYSDEC).



Hand harvesting during the spawning season when the crabs are on the beach accounts for most of the catch, currently followed by pound/trap nets. The numbers in 2004 were 62% and 16% respectively. Prior to 2004, dredging accounted for 15% to 24% of the harvest, declining to 3.4% in 2004 and 1.9% in 2009. The decrease has been attributed to a ban

on the use of dredges greater than 6 feet in length (McKown et al. 2006). From 2002 – 2007, the harvest from Peconic/Gardiners accounted for 13.9% (2006) to 23.8% (2005) of the total New York State catch (Table 30).

Table 30. Horseshoe Crab Harvest by Area (from McKown et al. 2006)

	2004		2004		2005		2006		2007**	
	lbs	**%**	**lbs**	**%**	**lbs**	**%**	**lbs**	**%**	**lbs**	**%**
Western LIS	7,418	5.5	9,956	7.0	4,659	3.0	11,231	6.5	16,348	6
Eastern LIS	2,214	1.6	7,299	5.1	9,842	6.3	9,813	5.7	9,263	3
Atl Ocean Offshore	3,210	2.4	2,376	1.7	1,170	0.8	1,846	1.1	5,380	2
Atl Ocean Inshore	11,827	8.8	25,283	17.8	6,486	4.2	6,243	3.6	4,334	2
South Shore Bays	67,666	50.4	60,722	42.7	82,482	53.0	98,431	57.1	173,726	61
Block Island Sound	7,468	5.6	11	0.0	0	0.0	115	0.1	0	0
Peconic/Gardiners	24,740	18.4	20,875	14.7	37,017	23.8	23,933	13.9	48,048	17
New York Harbor	111	0.1	40	0.0	0	0.0	605	0.4	2,446	1
other	80	0.1	221	0.2	25	0.5	9,572	85.2	130	0
not reported	9,489	7.1	15,467	10.9	13,865	8.9	10,579	6.1	24,445	9
TOTAL	134,223		142,249		155,544		172,368		284,120	

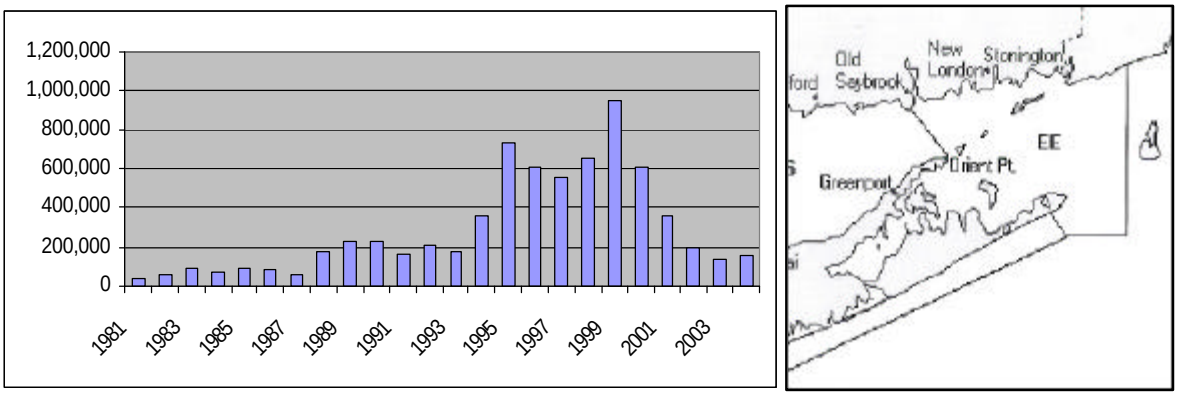
****2007 data is preliminary as of 1/4/2008**

- Lobstering

  Lobstering is performed with the use of baited traps set in lines or individually along the bay bottom, marked with small buoys and.or flags. Lobstering is performed in the eastern portion of the study area, particularly in Gardiners Bay. All lobster pots are required by NYSDEC to be clearly marked with owner identification. Because the population of the American lobster (*Homarus americanus*) in the Southern New England (SNE) zone has been found by the Atlantic States Marine

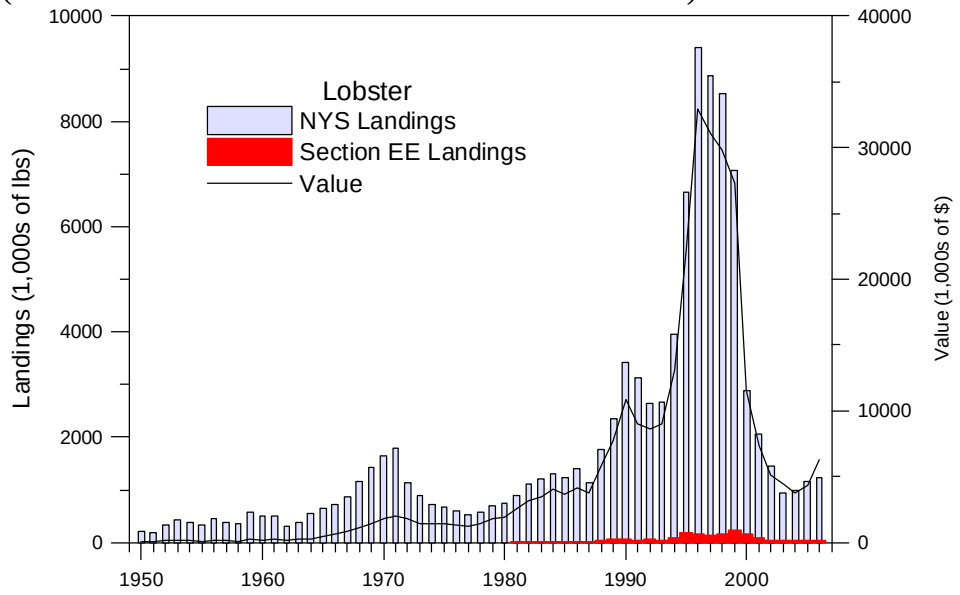
Fisheries Commission to be depleted and over-fished (Figure 22), strict regulations on the fishery have been instituted (ASMFC 2007).

Figure 22. New York Resident Commercial Lobster Landings (lbs) from Section EE 1981 – 2004 (McKown et al. 2006)



The vagaries of the lobster fishery in New York State are better illustrated by Figure 23, which presents landing and dollar value since 1950. Clearly, the years 1995-1999 reflect an unusually high catch. Landings from Section EE, which includes the Peconic Estuary, are also placed in perspective.

Figure 23. New York State Lobster Landings, 1950 – 2006
(NMFS statistics and Section EE NYSDEC statistics)

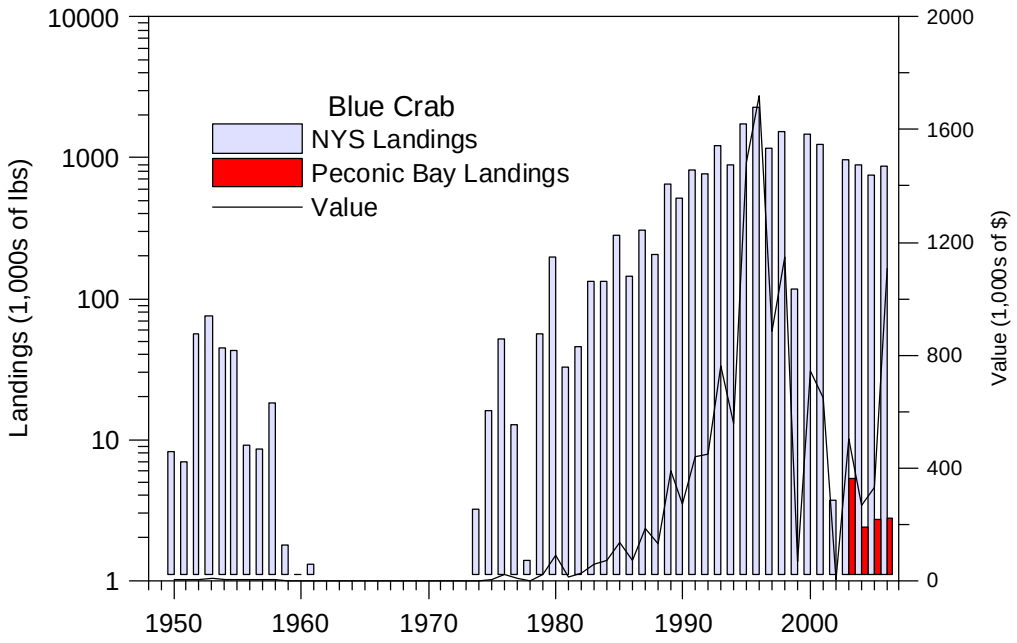


- Crabbing

  Blue crabs, the only marketable crab species, are typically found in intertidal marshes, sub-tidal SAV beds, and unvegetated, soft sediment shoreline habitats. Commercial crabbing is generally conducted through the use of baited wire crab pots set at a particular location for several days. All commercial crab pots are required by NYSDEC to be clearly marked with owner identification and buoys that are visible during the day and night, and must have a sinking line to decrease conflicts with, and increase safety of other users of the estuary (NYSDEC website, http://www.dec.ny.gov/environmentdec/18897.html, accessed December 5, 2007). Crab pots are required to contain an escape panel on the side of the pot to ensure that lost pots will not continue to kill marine organisms (NYSDEC website, http://www.dec.ny.gov/press/12372.html, accessed January 10, 2008). The minimum carapace size limit for blue crabs in New York State is 3.5 inches for peeler or shedder blue crabs, and 4.5 inches for hard-shell blue crabs.

  The blue crab industry in New York harvested more than 870,000 pounds of blue crabs in 2006, worth more than $1,100,000 (NMFS). As evidenced in Figure 24, the blue crab fishery in New York did not become significant until the early 1980s, peaking at about 2.3 million pounds in 1996. While there have been two poor harvest years since then (1999 and especially 2002), the fishery has remained relatively stable in recent years between about 0.75 to almost 1 million pounds annually.

Figure 24. Blue Crab Harvest in New York State 1950 – 2006 (NMFS statistics) and Peconic Bay 2003 - 2006 (NYSDEC statistics). Note the log scale

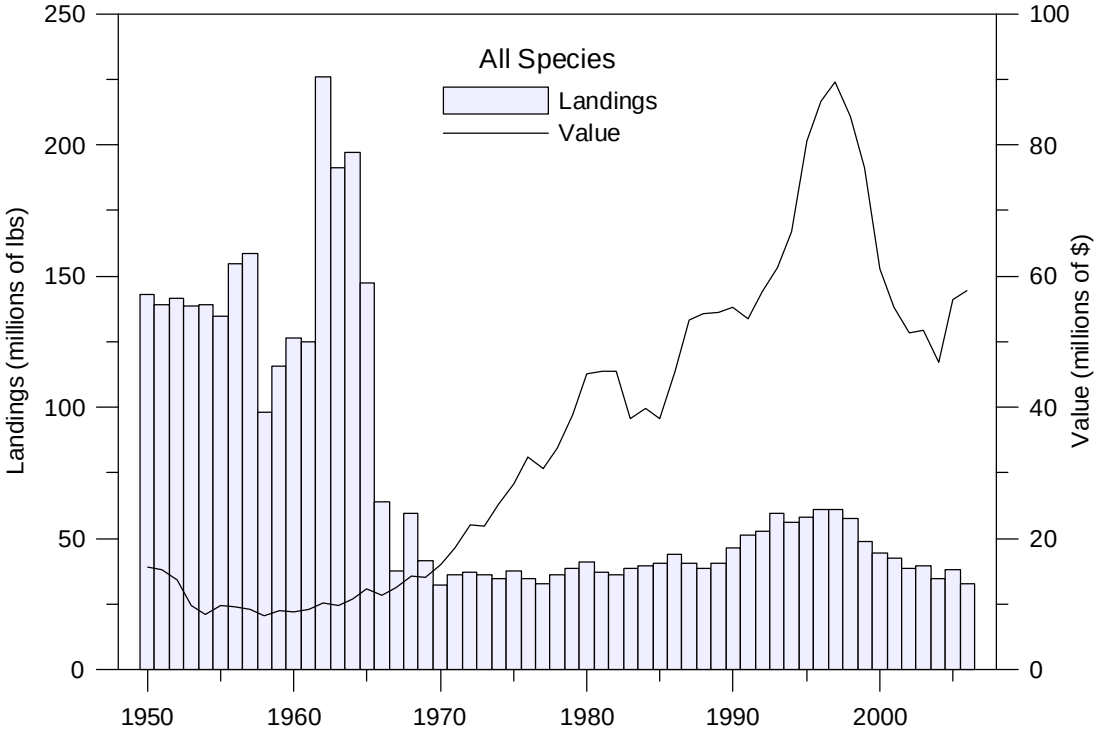


Party/Charter Boat Fishery – Gardiners Bay is a popular fishing area for party/charter boats. Party/charter vessels operate out of Greenport (four vessels), Orient Point (eleven vessels), and Southold (one vessel). Most finfish species sought during charter/party boat outings include fluke, bluefish, blackfish, and striped bass.

4.2.1.1.2. Landings and Values

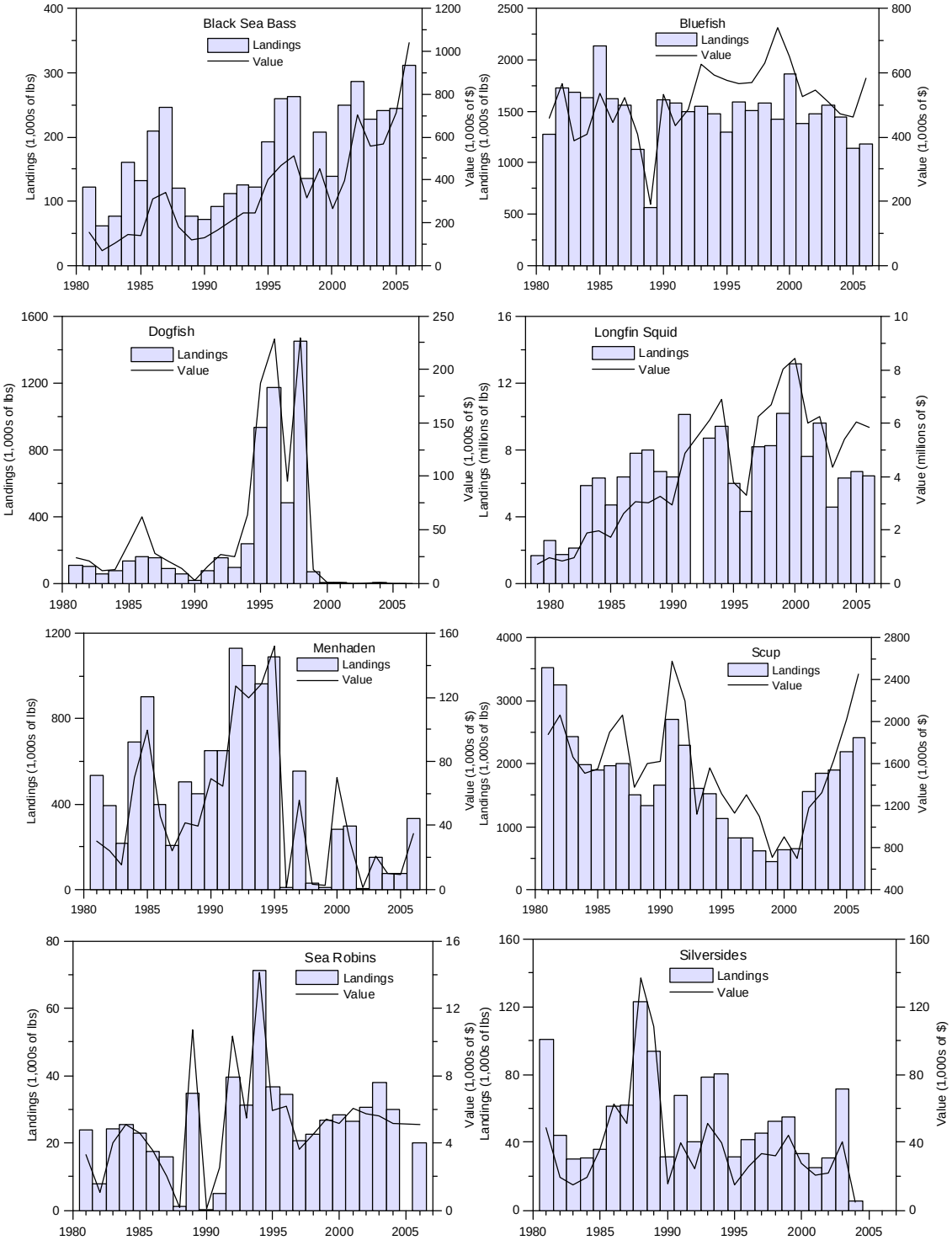
Commercial fisheries landings in New York State have averaged 43.4 million lbs annually since 1966 as opposed to 148.5 lbs annually for the sixteen previous years (NMFS 2007, Figure 25).

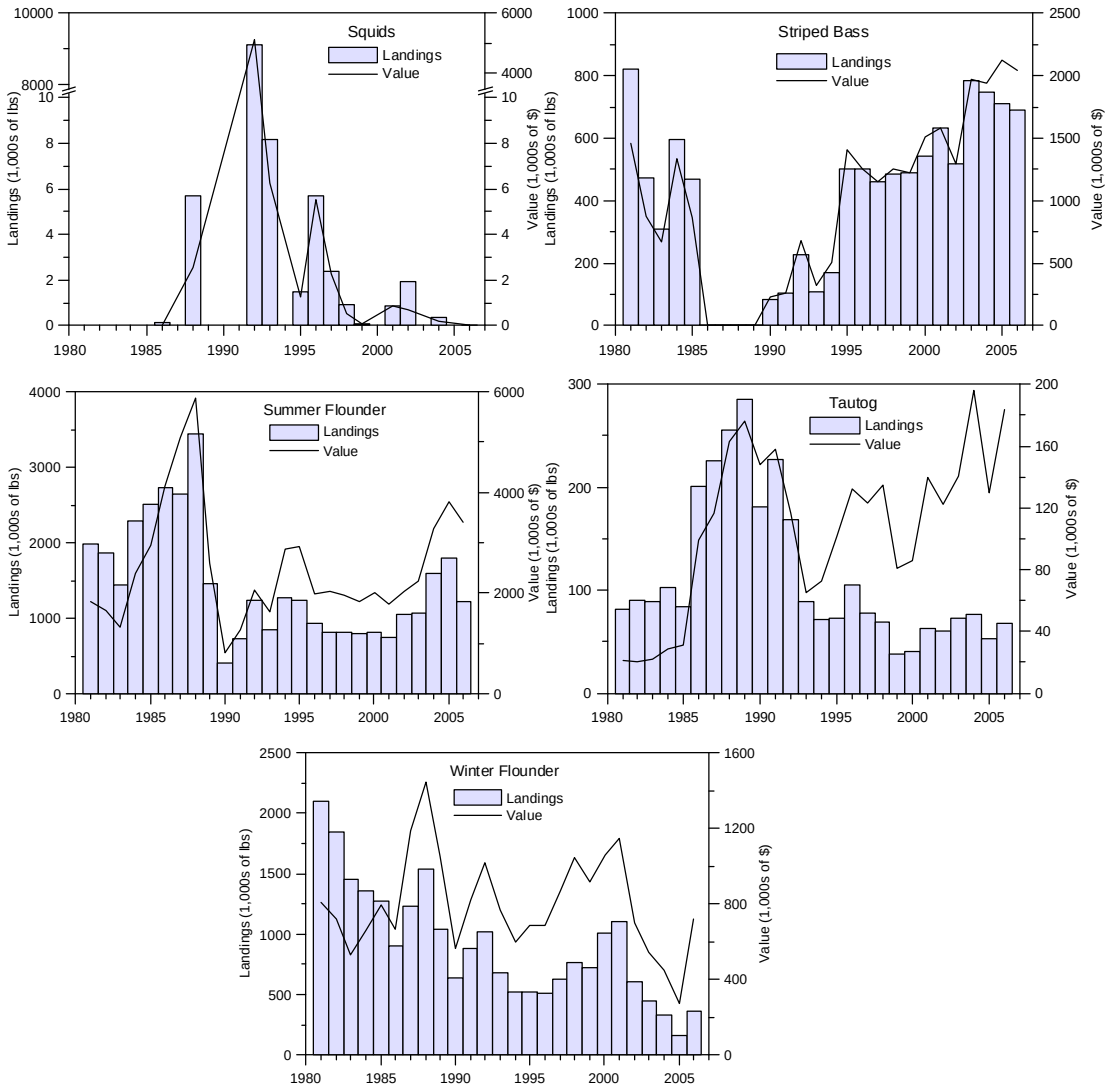
Figure 25. Commercial Fisheries Landings in New York State
(NMFS statistics)



Landings for the last three years have been: 34.5 million; 38.2 million; and, unofficially, 32.6 million lbs in 2006 (Figure 26). The top commercial marine species landed in New York in 2004 were Atlantic surf clam (6,824,576 lbs), long fin squid (5,708,886 lbs), and silver hake (5,068,459 lbs) (NYSDEC website, http://www.dec.ny.gov/outdoor/7903.html, accessed on December 6, 2007). The most commercially landed finfish species in 2004 include: silver hake at 5,068,459 lbs; scup at 1,899,566 lbs; and summer flounder at 1,587,033 lbs.

Figure 26. New York State Landings and Dollar Value of Selected Species, 1981 - 2006 (NMFS data)



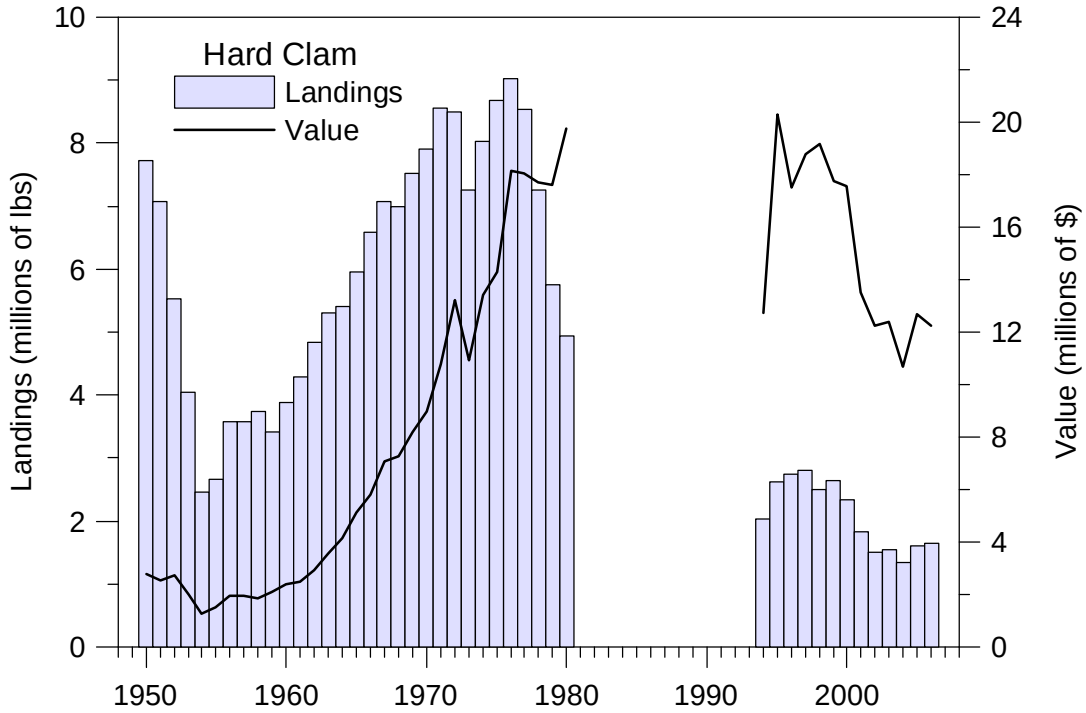


The 885,000 pounds of blue crab harvested in 2004 accounted for approximately $270,000 of the NY commercial fishing industry (NYSDEC website, http://www.dec.ny.gov/outdoor/7903.html, accessed on December 6, 2007). Bay scallops are highly valuable in dollars per pound due to the low numbers harvested. The most recent retail price range for scallops is from $25 to $29.95 per pound.

Total hard clam production in New York State is currently at less than 20% of its peak landings (Figure 27). The steady decline in population of hard clams in the Peconic Estuary, as throughout other areas of the state, can be attributed to over-

harvesting, recruitment failure, changes in water quality, poaching of seed clams, loss of suitable habitat and pollution (Timmons et al., 2004). Although hard clam landings are at very low numbers relative to historical abundance, it is still the most valuable marine species landed in New York, valued at over 12 million dollars in 2006.

Figure 27. New York State Hard Clam Landings and Dollar Value, 1950 – 2006 (NMFS statistics)



Wild shellfish harvests throughout the New York State have declined over the past two decades as a result of intensive harvesting, the occurrence of brown tides, changes in food supply via changes in phytoplankton species composition, increased predation by blue crabs (*Callinectes sapidus*), and environmental change such as increased winter water temperatures (Hoffman et al., undated). The Peconic Estuary wild scallop industry was once estimated to be worth more than $2 million dollars annually, and has been virtually eradicated by Brown Tide (SCDHS website, www.co.suffolk.ny.us, accessed on February 20, 2008). The

bay scallop industry has still not recovered to levels that existed prior to the initial outbreak of Brown Tide in 1985.

The decline of wild shellfish populations is also apparent in other local waters. Hard clam landings in the south shore bays of Long Island, particularly Great South Bay, have shown a downward trend in numbers since the 1970s when peak abundance was recorded. What was once the most productive shellfishing area in the country, accounting for more than 700,000 bushels of clams in 1976 (more than half the national total that year), now produces a wild harvest of approximately 17,000 bushels per year (less than 2.5 percent of the 1976 peak) (J. Rather, NY Times, November 23, 2003).

4.2.1.1.3. Characteristics of Commercial Fishermen

Numbers

The Peconic Estuary has a long history of commercial fishing and has become an important element in the local, as well as the state's economy. The estuary is home to two of the major marine commercial fishing ports in New York State: Greenport and Montauk (TechLaw, Inc., 2001).

In an effort to estimate the amount of commercial fisherman that operate within the study area, NYSDEC commercial fishing permits/licenses were reviewed (Table 31). Commercial fishing licenses/permits are required for the commercial harvest of all marine species in New York State (ECL § 11-1501 & 11-1521, 6 NYCRR Part 175). NYSDEC permits/licenses are not specific to individual waterbodies, but are issued on a regional basis. The commercial fishing licenses issued for Peconic and Gardiners Bays also allow for the harvest of marine life in other waters in Suffolk County as well as Nassau County. The number of commercial fishing permits/licenses issued for the Long Island region marine waters in 2006 was 4,352.

Table 31. NYSDEC Commercial Fishing Licenses Issued in 2006, Region 1: Nassau and Suffolk Counties

License/Permit Type	Number Issued in 2006
Resident Food Fish License	1,064
Non-resident Food Fish License	48
Marine Bait License	63
Striped Bass License	508
Summer Flounder Permit	338
Resident Horseshoe Crab Permit	337
Non-resident Horseshoe Crab Permit	10
Lobster Bait Gillnet	58
Menhaden Purse Seine License	22
Resident Whelk License	266
Non-resident Whelk License	12
Resident Crab License	603
Non-resident Crab License	29
Resident Lobster License	428
Non-resident Lobster License	30
Food Fish Landing License	33
Party/Charter Boat License	503

Source: NYSDEC Bureau of Marine Resources, personal communication, October 2007

Commercial shellfish harvesting requires a NYSDEC Shellfish Digger's Permit, pursuant to Section 13-0311 of the ECL. Currently, there are 1,770 Digger's Permits issued by NYSDEC. Table 32 shows the amount of Digger's Permits issued within Suffolk County.

Table 32. NYSDEC Shellfish Digger Permits Issued in 2006

Town	Number of Permits
East Hampton	239
Riverhead	35
Shelter Island	32
Southampton	185
Southold	211
Brookhaven	277
Babylon, Huntington, Islip, Smithtown (combined)	399

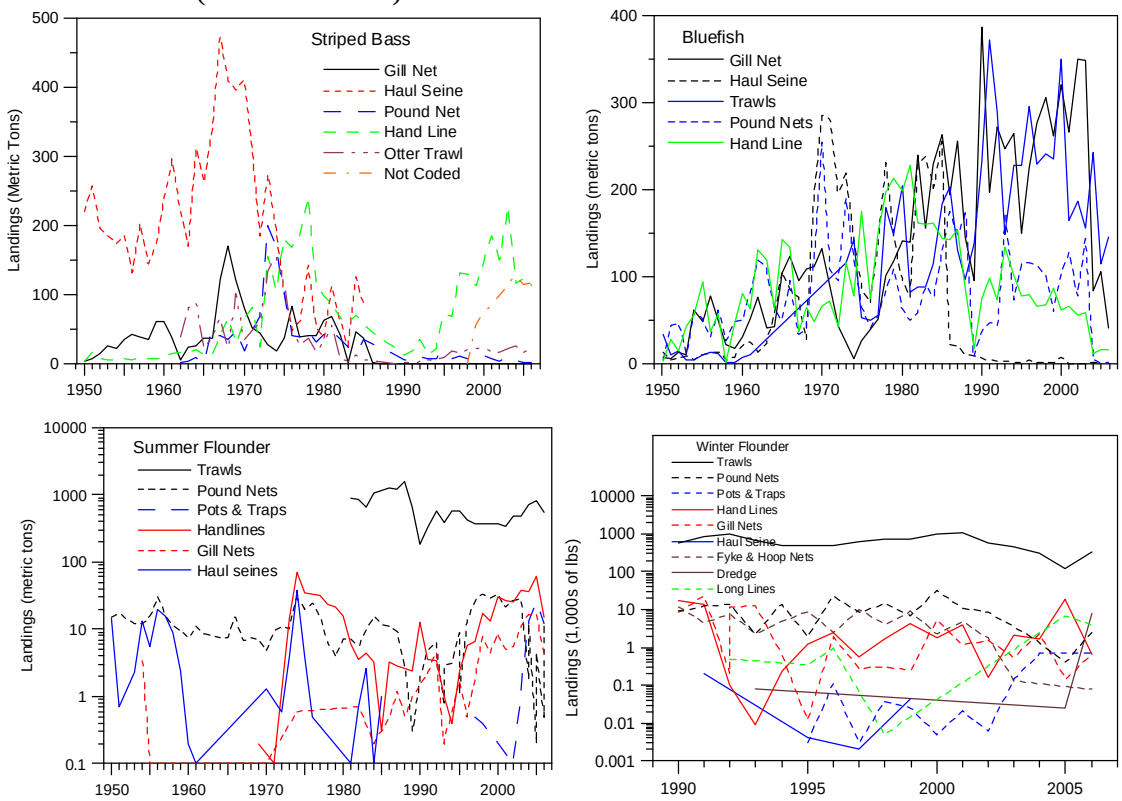
Source: NYSDEC Bureau of Marine Resources, personal communication, October 2007

Nature of Activities (seasons and location)

The Peconic Estuary supports a commercial fishery for more than thirty species of finfish and crustacea. The most commercially-harvested finfish species within the Peconics and Gardiners Bay are scup, Atlantic menhaden, weakfish, bluefish and squid (Weber and Grahn, 1995).

Commercial finfishing gear used in the Peconic Estuary predominantly consists of pound nets, haul seines and gill nets, and to a lesser extent, otter trawls and hand lines (pin-hooking) (Weber and Grahn, 1995). Figure 28, which presents the data for landings within the entire state, suggests that trawls are important in the bluefish and flounder fisheries, gill nets in the bluefish fishery, and, after haulseining was banned, hand lines in the striped bass fishery.

Figure 28. Landings per Gear Type for Select Finfish Species Caught in NYS, 1950 – 2006 (NMFS statistics)



Commercial shellfishing gear ranges from hand rakes to mechanical gear. Bay scallops may be commercially harvested from early November through late March, and are restricted to 10 bushels/person or 20 bushels/boat per day (NYSDEC website). All clams, oysters, mussels and other types of scallops may be taken throughout the year, as long as they are harvested in NYSDEC certified (open) areas (Table 33).

Many commercial baymen sell their catch immediately after harvesting, either dockside, at shoreline facilities, or within a few miles of the harvest area (Town of Southold, 2004). Shellfish are often sold directly to restaurants or retail food establishments, but may also be sold to distributors or wholesalers (Town of Southold, 2004).

Table 33. NYSDEC Seasonally-Regulated Commercial Marine Species

Species	**Open Season**
Finfish	
Striped Bass	Jul 1 - Dec 15*
Tautog	April 8 to last day of February
Atlantic sturgeon	No possession allowed
Weakfish	Hook & Line: April 1 - June 24; August 28 -Nov.15 All other gears: April 1 - June 24 and August 28 - Nov. 15 June 25 - Aug 27 and Nov 16 - Mar 31
Bluefish	Jan 1 - Dec 31
Winter flounder	Pound and Trap nets: July 26 - June 14 Fyke nets: October 1 - March 22 All other gear: December 1 - June 13
Oyster toadfish	January 1 - May 14 and July 16 - Dec 31
Large & Small Coastal Sharks	As per Title 50 CFR, Part 635+++
Pelagic Sharks	As per Title 50 CFR, Part 635+++
Prohibited Sharks	No possession allowed
Shellfish	
Bay scallop	First Monday in November through March 31

* The commercial striped bass fishery may be closed before December 31st if the allowable harvest cap is projected to be met prior to such date.

+++ Applicable provisions of the following are incorporated by reference: 50 CFR Part 635-Atlantic Highly Migratory Species, final rule as adopted by U.S. Department of Commerce as published in the *Federal Register*, Volume 64, Number 103, pages 29135-29160, May 28, 1999, and as amended in volume 68, Number 247, pages 74746-74789, December 24, 2003.

Source: 6NYCRR §40.1

Employment (full/part time employment and average income)

Baymen are independently employed and regard their livelihood as a way of life. Often, baymen will continue to work in a fishery even when it provides them reduced economic return (Lang, undated). Many commercial fishermen harvest various species, depending on the season. Clams and other shellfish have been a traditional supplemental source of income during closed finfish seasons.

Increasing NYSDEC catch/quota regulations for most of the commercial fisheries directly impact baymens' income (Minutes of July 19, 2007 Meeting between Cashin Associates and Peconic/Gardiners Bay Whelk Fishermen). Stricter regulations on horseshoe crabs are causing whelk fishermen to use other less desirable bait (i.e. fish scraps) for their whelk pots (P. Wenczel, commercial bayman, personal communication, August 2007). Table 34 shows the current restrictions on commercial shellfish catch limits, as regulated by NYSDEC.

Baymen are increasingly finding themselves facing many difficulties harvesting commercial species. Natural shellfish stocks, once heavily relied upon by baymen as a significant source of income, have become nearly depleted (e.g. scallops). Competitive pricing from other states has driven down the price of shellfish harvested from the Peconic Estuary.

Table 34. Restrictions on Commercial Shellfish Catch Limits in New York State

Species	Size Limits	Commercial Catch Limits	Gear Restrictions
Hard clam	1 inch thickness across the hinge	Any Number	No mechanical means. Rakes and tongs allowed. Teeth - 1 in spacing Basket - 15/16 in spacing
Soft clam	1-1/2 in length	Any Number	No mechanical means except churning by propeller allowed below low tide
Oyster	3" longest diameter	Any Number	No mechanical means. Dredge with sail allowed on state land and in some towns. Size limit exempted for oysters cultured or transplanted under permit from DEC.

Blue mussel	None	Any number. *	No mechanical means, except that dredges may be used in some areas.
Bank mussel	None	Any number	No mechanical means
Bay scallop	2-1/4 inch length from mid hinge to mid bill and an annual growth ring	10 bu/person 20 bu/boat per day	Dredges allowed; 36 inch max. width. Use of mechanical means to retrieve dredge prohibited. Use of dredge prohibited on Sunday.
Sea scallop	None	Any number	None
Surf clam	3 inches 4 inches in Atlantic Ocean for use as food	**	Special permit required for mechanical harvest
Ocean quahog	None	**	Special permit required for mechanical harvest

***** 15 bushels/person of blue mussels by dredge allowed in certain areas.
****** There are restrictions on mechanical harvesting for surf clams and ocean quahogs.

Source: NYSDEC website, http://www.dec.ny.gov/outdoor/29870.html, accessed on November 7, 2007

4.2.1.2. Oyster Grants and Temporary Marine Area Use Assignments

Shellfish aquaculture presently undertaken within the study area focuses primarily on oysters and hard clams. Bay scallops, blue mussels, soft clams, razor clams, are also cultivated, but to a lesser degree. Brown tide outbreaks have significantly reduced the economic feasibility of bay scallop production since the mid-1980s (Anderson and Spatz, 1997).

Seventy-five (75) privately held oyster grants are situated on the 65 underwater parcels in the Peconic Estuary, totaling 5,822 acres (Suffolk County Department of Planning, 2008). Numerous oyster grants had delinquent taxes extending back approximately 20 years with interest and penalties mounting, and have since reverted back to the County (Suffolk County, 2002). Six oyster grant parcel holders currently have On/Off-Bottom Culture Permits issued by NYSDEC, which allows for the cultivation of shellfish on their grant. All six of these grant holders also have NYSDEC permits to cultivate hard clams and/or bay scallops in addition to oysters. Cultivation of shellfish species other than oysters (i.e., bay scallops, hard clams) on an oyster grant is permitted by NYSDEC as long as the grant holder can provide documentation that proves the specific shellfish species had been cultivated on the site in the past (J. Thiel, NYSDEC Bureau of Marine

Resources, personal communication, October 2007). The on-bottom planting of shellfish is permitted on oyster grants, and harvest methods may include hydraulic dredging, as regulated by NYSDEC.

Seed stock for aquaculture activities is generally purchased through local hatcheries. Spat can be raised at the hatchery to a specific size that a grower prefers, as larger seed tends to have a higher survival rate (Chinabut et al., 2006). Shellfish cultivation conducted on temporary marine area use assignments is restricted to the use of off-bottom culture gear (i.e., rack-and-bag, cages, rafts, and longlines). As of February 2008, 24 temporary assignments are actively culturing shellfish; three temporary assignments are not actively culturing shellfish; two temporary assignment applications are in "pending" status, to be approved by NYSDEC; and, the status of three temporary assignments have yet to be determined. NYSDEC is currently conducting a survey to determine which existing temporary assignments are actively cultivating shellfish (D. Barnes, NYSDEC Bureau of Marine Resources, personal communication, December 2007).

The estimated time-frame for a shellfish aquaculture site in the Peconic Estuary to become productive can be upwards of five years from initial start-up (East End Growers Association, personal communication, April 2007). Clams can typically be harvested to a marketable size after three to five years of planting; and oysters generally after three years.

In 2002, Suffolk County estimated that approximately 200-300 individuals directly derived an income from aquaculture products from the Peconic Bays, including individuals participating in the hard clam transplant program (Suffolk County, 2002). In 2001, the clam relay program in the Peconics employed 250 people (Suffolk County Aquaculture Committee, 2001). In 2002, nearly 90% of the annual hard clam production and over 90% of the annual oyster production in the Peconic Estuary were produced via aquaculture. The Peconic Estuary

received approximately 80% of the hard clams relayed within the entire State, accounting for about 37% of the statewide hard clam landings (Suffolk County, 2002). Bay scallop production from the Peconic Estuary accounted for approximately 33% of the value of U.S. bay scallop landings in 1995 (Anderson and Spatz, 1997). In 1997, aquaculture production in the Peconic Estuary was valued at about $4.2 million, including hard clam transplant/relay programs (Anderson and Spatz, 1997). The value of aquaculture production in 1997 without the transplant/relay programs was approximately $15,000-25,000 (Anderson and Spatz, 1997). By 2004, shellfish aquaculture accounted for $11 million of New York State's economy (Timmons et al., 2004).

4.2.1.3. Shellfish Aquaculture in Other States

Virginia

Virginia currently leads the nation in the culture of hard clams producing approximately 194.4 million marketable hard clams through aquaculture in 2006 (Murray and Oesterling, 2007). Approximately 6,569 acres of bottom lands are leased for hard clam aquaculture; 282 of which are also used to culture oysters (Murray and Oesterling, 2006). In 2004, the state's hard clam aquaculture industry was valued at approximately $23.9 million (Murray, 2005). The state's commercial oyster aquaculture industry continues to grow at a rapid rate and was valued at approximately $212,700 in 2003 (Virginia Department of Environmental Quality, 2006). Non-commercial oyster cultivation has also significantly grown, with an estimated 2,000 individuals growing between 1,000 to 5,000 oysters for environmental purposes and personal consumption (Virginia Department of Environmental Quality, 2006).

Connecticut

Connecticut ranks second in New England in aquaculture production generating over $12 million in revenue on 67,000 acres of bottom lands (Getchis, T.S. 2005). Over the past decade, the industry has slowly

evolved from on-bottom culture operations to off-bottom culture involving surface and submerged culture gear (Getchis, T.S. 2005).

Maine

Maine's shellfish industry accounts for approximately $75 million of the state's annual economy (Snowe, 2005). Mussels and oysters are the main shellfish species cultured in the state. The mussel industry is a $7 million industry, and the oyster industry is valued at $1-2 million (Colgan, et al. 2002).

Shellfish grow-out periods are longer in Maine than in much of the nation, placing Maine growers at a disadvantage (Maine Sea Grant, accessed from http://www.fishresearch.org/RP_SeaGrant.asp on January 15, 2008). Standard shellfish aquaculture leases in Maine are approximately 100 acres, but may be up to 500 acres if the lessee meets certain requirements regarding fallowed acreage (Maine Department of Resources, accessed from www.maine.gov/dmr/aquaculture_lease_types.htm on January 15, 2008).

Massachusetts

Shellfish aquaculture within the state of Massachusetts is divided into public and private categories. Public aquaculture is conducted by municipalities for restocking and/or restoration efforts. Private aquaculture, valued at $4.5 million in 1996 (Crago, T. 2000) involves shellfish cultivation for commercial purposes. As of 2000, over 1,100 acres were cultivated by approximately 300 license holders practicing, almost exclusively, bottom culture (NEMAC 2001). The principal species grown are hard clams (*M. mercenaria*) and eastern oysters (*C. virginica*) with cultivation of other species, including soft shell clams (*Mya arenaria*), bay scallops (*Argopecten irradians*), surf clams (*Spisula solidissima*) and European oysters (*Ostrea edulis*) undertaken at a smaller scale (SEMAC 2004). Culture is predominantly on intertidal flats and to a lesser extent in shallow waters (Kraus, 1995).

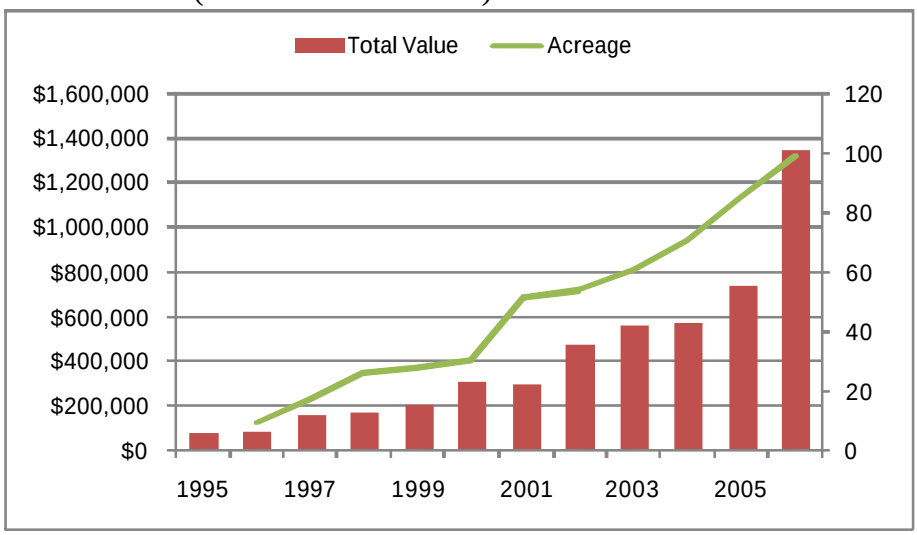
The Massachusetts shellfish growers in collaboration with the SouthEastern Massachusetts Aquaculture Center (SEMAC) have compiled an extensive "Best Management Practices" manual (SEMAC 2004) which, although largely concerned with intertidal areas, is nevertheless a valuable reference for the proposed Suffolk County program

Rhode Island

The following, from Alves (2007), describes the growth of the Rhode Island shellfish aquaculture industry, the total size of which is smaller than that of the proposed Suffolk County Lease Program. A steady increase in both acreage under cultivation, and dollar value is illustrated in Figure 29.

From 1995 through 2006 the shellfish aquaculture industry in Rhode Island grew from a total value (at the farm) of about $83,000 per year to over $1.3 million per year, increasing by 81% from 2005 ($744,319) to 2006 ($1,348,525) (Figure 29). The gross revenue was over $3.5 million. Except for the years 1997 and 1998 when a retail ornamental finfish operation was in business, all aquaculture in the state was in shellfish. In 2006, 28 farms cultivated a total of 99 acres, with the American oyster accounting for 97% of the harvest, and the hard clam accounting for the remaining 3%

Figure 29. Total Value of the Rhode Island Shellfish Industry and Acres Leased (data from Alves 2007)



Shellfish farming employed 17 full-time, year-round, 17 part-time, year-round, 8 full-time, seasonal and 15 part-time seasonal, employees in 2006. Total capital invested industry wide by the growers was $886,288, an average of $31,699 [sic] per lease holder, and returns averaged $13,621 per acre.

North Carolina

Shellfish species predominantly cultured in North Carolina include hard clams, oysters, and soft shell crabs. Approximately 1,906 acres of underwater lands in North Carolina are leased for shellfish aquaculture (Losordo, et al. 2006). In 2005, the state's clam and oyster aquaculture industry was valued at approximately $1 million (NC Department of Agriculture and Consumer Services website, accessed from http://www.agr.state.nc.us/markets/ aquaculture/statistics.htm# on January 15, 2008).

The East Coast Shellfish Growers Association (ECSGA) is currently in the process of developing a shellfish aquaculture Best Management Practices (BMP) manual for all shellfish growers along the east coast. As part of the development

process, ECSGA has been meeting with shellfish growers and other stakeholders throughout the east coast to gather input regarding local concerns and opinions. ECSGA feels that a shellfish aquaculture BMP can lead to greater industry environmental accountability, improve production efficiency, instill customer confidence in products, and result in a higher a degree of self regulation that can provide economic benefits to the industry and a better product for the consumer (ECSGA website, accessed from http://www.ecsga.org/pages/Newsletters/NewsletterV3-07.htm on January 15, 2008). Most states may already have in place their own set of BMPs for shellfish aquaculture; however, the ECSGA BMP can be used to enhance these documents to ensure a safe product and contribute positively to the environment.

Although the ECSGA BMP is currently in the development stage, once it has been completed the County will review the document and consider the feasibility of implementing some of the recommended practices into the proposed Lease Program.

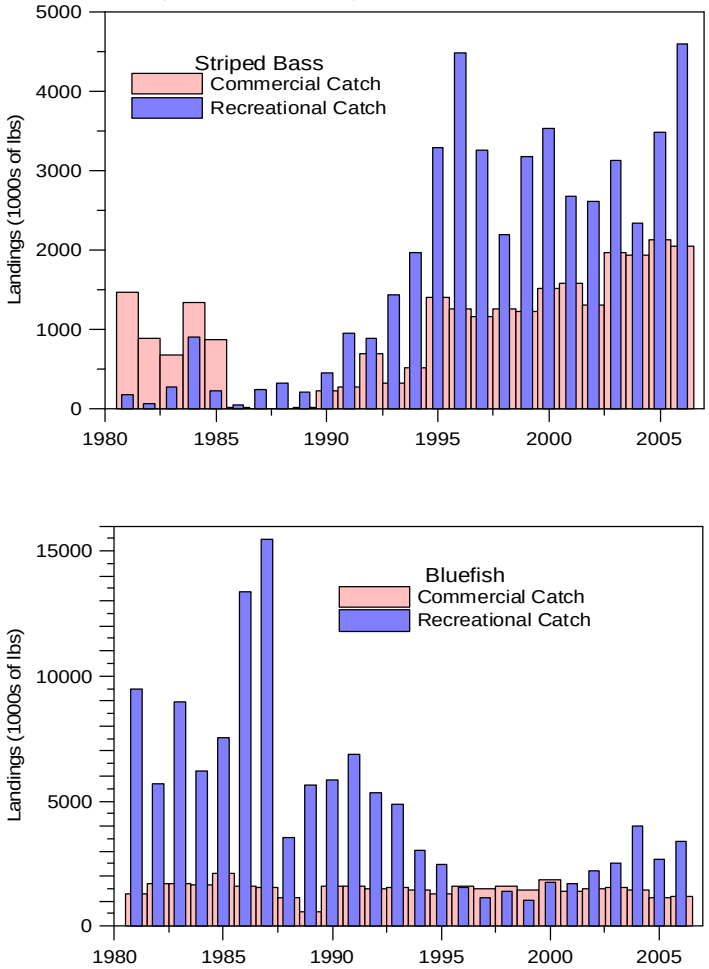
4.2.1.4. Recreational Finfishing

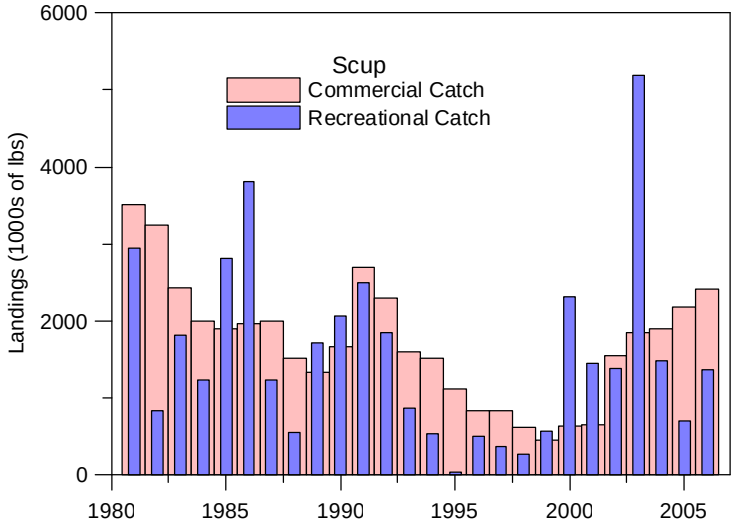
The National Marine Fisheries Service's Marine Recreational Fishing Statistics Survey estimated that over a half-million recreational anglers made more than 4.6 million fishing trips in New York's marine waters in 2004 (National Marine Fisheries Service, Fisheries Statistics Division, personal communication, December 2007). The most sought after finfish species by recreational anglers include summer flounder (fluke), striped bass, black sea bass, blackfish (tautog), bluefish, snapper, weakfish and porgy (scup). Plum Gut provides significant and diverse habitat for marine fishes and is a regionally important recreational fishing area (USFWS, 1991).

Recreational finfishing does not require a permit or license from NYSDEC; however, catch limits, size limits, and seasonal closures are regulated by NYSDEC for specific marine species (Table 35). The summer flounder season

was closed by NYSDEC in September 2007 when the federal quota for this species was met. The closure was implemented to prevent over-harvest of summer flounder and the fishery will remain closed until further notice from NYSDEC. The quota for the commercial summer flounder fishery was met in October 2007, at which point that fishery was closed. In recent years, the commercial harvest has far exceeded the recreational harvest. The catch for several finfish species has decreased dramatically since the 1980s for both commercial and recreational fishermen. (Figure 30). The suggestion raised by researchers at the University of Rhode Island that the declining winter flounder populations (among others) in this area may be associated with rising water temperatures is discussed by Daley (2007).

Figure 30. Commercial and Recreational Harvest of Selected Fish Species, 1981 – 2006 (NMFS statistics)





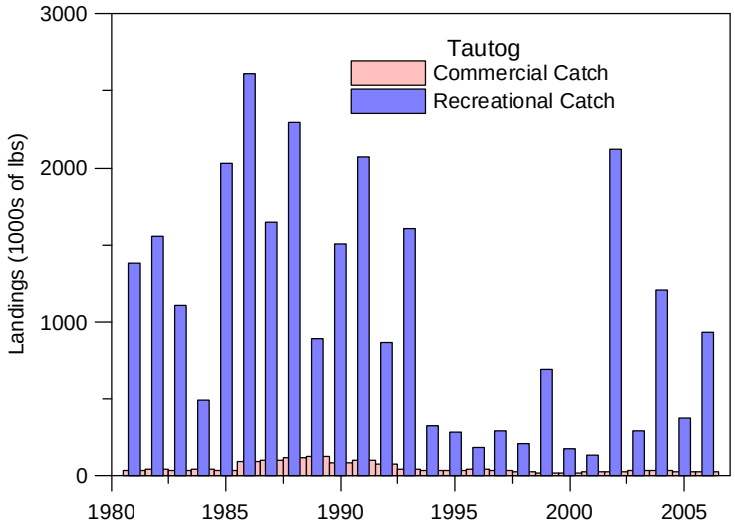


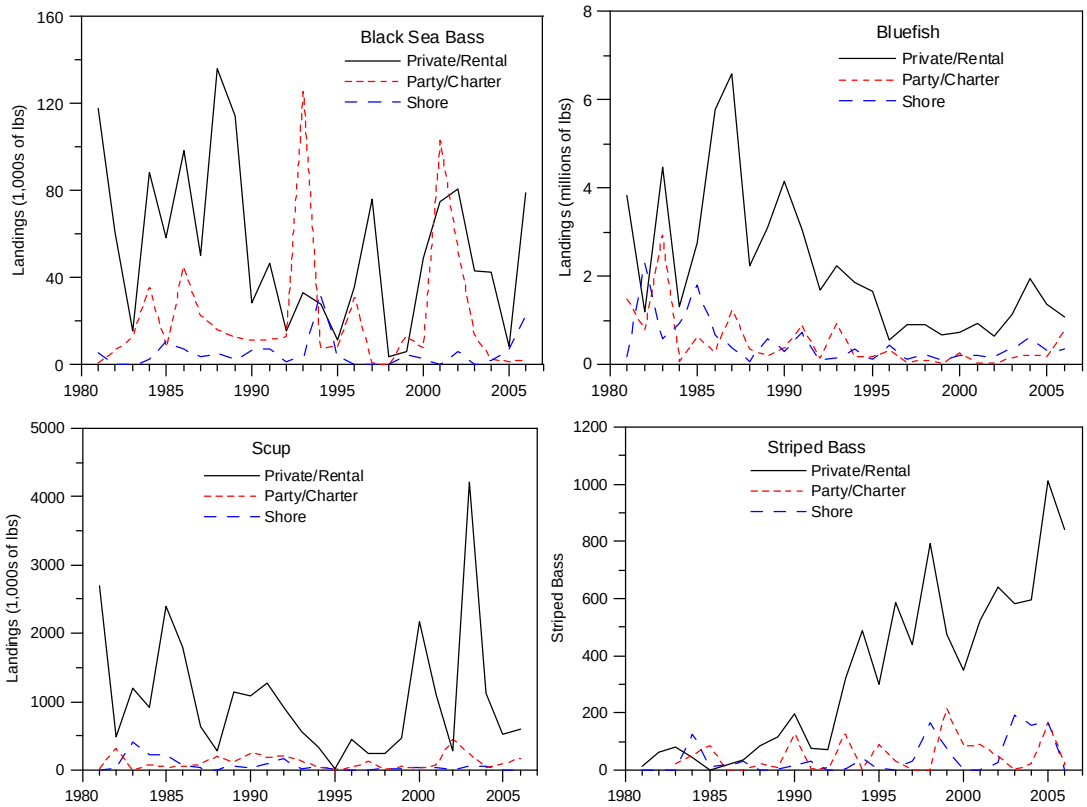
Table 35. NYSDEC Seasonally-regulated Recreational Marine Species as of September, 2007

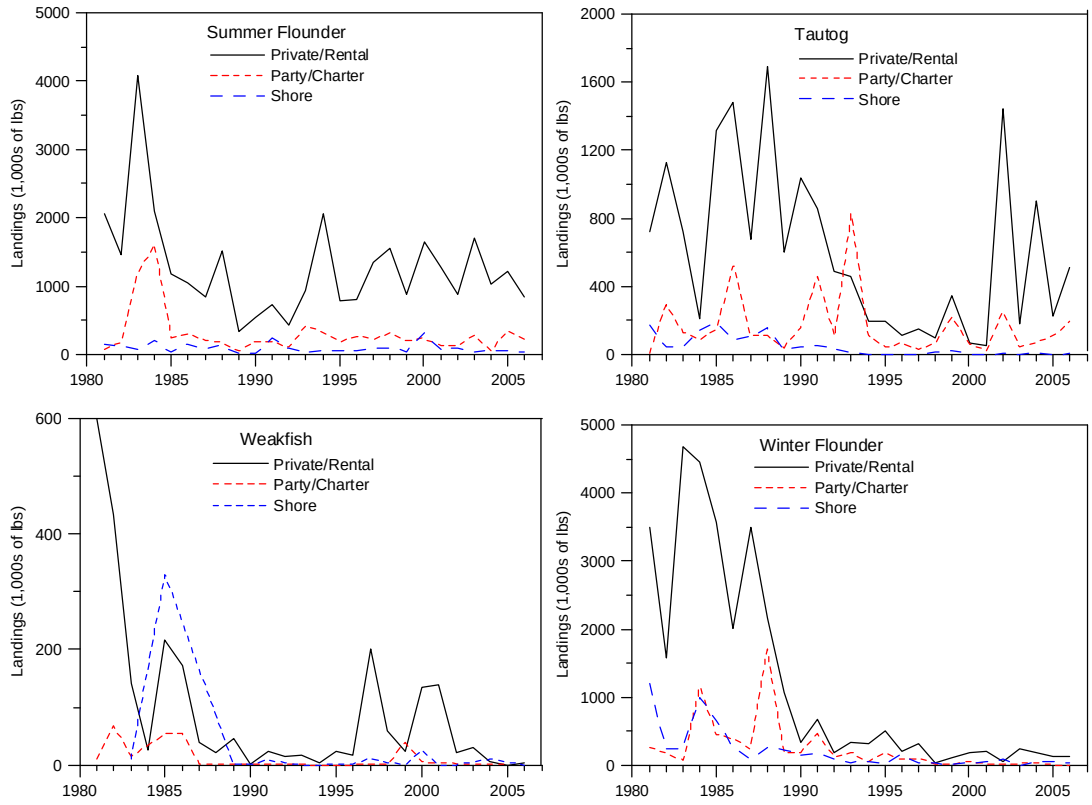
Species	Open Seasons
Summer flounder (fluke)	No possession allowed
Winter flounder	April 1 - May 30
Tautog (blackfish)	Oct. 1 - May 31
Striped bass	Apr 15 - Dec 15
Atlantic sturgeon	Moratorium
Scup (Porgy)	June 1 - Oct 31
Oyster toadfish	July 16 - May 14

Source: 6NYCRR §40.1

As illustrated in Figure 28, the recreational catch of several species of fish, including the winter flounder, weakfish, and bluefish, has declined since peaks in the 1980s, while for others, including the summer flounder, black sea bass, scup and tautog, the catch has been cyclical. The successful rebound of the striped bass population has been attributed to strict catch regulations. Private/rented vessels are responsible for the largest percentage of the recreational catch, followed by party/charter boats. Shore based fishing comprises only a small portion of the harvest. The statistics presented in Figure 31 are for fish harvested in New York State "inland" waters, defined by the NMFS as "other bodies of saltwater besides the oceans. Included were sounds, inlets, tidal portions of rivers, bays, estuaries and other areas of salt or brackish water."

Figure 31. Recreational Finfish Landings from New York "Inland" Waters, 1981 – 2006 (NMFS statistics)





During the January 2008 meeting of the Shinnecock Marlin and Tuna Club, the proposed Lease Program was discussed and several recreational fishermen who fish the Peconic and Gardiners Bays mapped areas where they frequently fish. The club's overall consensus is that they are not opposed to the proposed program, but access to the following areas was of concern:

- Deep water area in the center Great Peconic Bay - a location where recreational fishermen troll for bluefish from May through July;
- Areas along the south cut past Robins Island - a location where recreational fishermen anchor for scup and weakfish from May through July;
- The waters just east of Robins Island - a location where recreational fishing for fluke and scup occurs all summer long;
- The deep water area located in the southern portion of Little Peconic Bay - a location where recreational fishermen anchor up for scup;

- Both sides of the cut past Jessup Neck - a location where recreational fishermen drift for fluke; and
- Portions of Southold Bay, Pipes Cove and the cut past Greenport - a location where recreational fishermen fish for fluke, especially during the spring and early summer.

4.2.1.5. Commercial and Recreational Boating

Commercial vessel operations present within the estuary include ferry services, commercial fishing fleets, and charter/party boats. Commercial fishing fleets are discussed above in the Commercial Fishing section. Ferry services operating within the estuary consist of the Cross Sound Ferry (Orient), the Plum Island Ferry (Orient), the North Ferry Company (Shelter Island-Greenport), and the South Ferry Inc. (Shelter Island – Village of North Haven). All of the ferry services operate year-round, with seasonal and holiday schedule variations. The Shelter Island ferries operate more frequently, generally on a 15-minute basis, with additional trips on holiday weekends. The South Ferry Inc. daily schedule extends slightly longer than the North Ferry Co., operating approximately one hour earlier and extending approximately two hours later.

Non-fishing charter/party boats operating in the estuary offer nature cruises, sunset cruises, moonlight cruises, historical tours, and custom-designed parties for special occasions. Tours of local lighthouses are conducted throughout Gardiners Bay near Orient Point, Plum Island, Little Gull Island, Race Rock and Long Beach. Lighthouse tours are generally conducted on a limited basis during the warmer months. Some party fishing charter boats conduct separate recreational cruises and tours as an additional source of income.

Educational tours are conducted by the Atlantis Marine World Aquarium (Riverhead) aboard the Atlantis Explorer Tour Boat along the Peconic River and Flanders Bay. Tours are conducted by Atlantis Marine World Aquarium staff and run twice a day for approximately 2.5 hours from May through October.

The Peconic Estuary is a popular destination for tourists and local summer recreational boating enthusiasts. The summer boating season typically runs from April 1st through October 31st. The increase in recreational boating activities throughout the estuary over the years has resulted in extensive vessel traffic at popular boating areas, particularly during the weekends of the summer boating season. Concentrations of recreational boaters mostly occur in popular boating areas such as Cutchogue Harbor, the Flanders Bay Complex, Greenport Harbor, Sag Harbor, Southold Bay, and Three Mile Harbor. Congestion in the Sag Harbor area occurs where the navigational channels meet (Cashin Associates, 1996b).

Popular recreational activities associated with recreational boating occurring within the Peconic Estuary include water skiing, wake boarding, wind surfing, personal watercraft (i.e. jet skies), kayaking, swimming, and overnight mooring. The estuary contains approximately 40 marinas located within the bays and inlets to accommodate the boating population (CitiDexLI-EastEnd.com, accessed on January 7, 2008).

According to a vessel inventory performed by the USEPA (2002), it was estimated that 11,247 vessels were docked or moored in the Peconic Estuary. Table 36 represents the approximate number of recreational and commercial vessels, including estimated transient vessels reported in the USEPA inventory.

Table 36. Recreational and Commercial Vessels Occupying the Peconic Estuary

Waterbody	Number of Vessels
Orient Harbor	281
Greenport Harbor	1,026
Southold Bay	1,319
Hog Neck Bay	251
Cutchogue Harbor Complex	699
Southold	449
Flanders Bay Complex	572
Red Creek Pond	187
Cold Springs Pond	341
Bullhead Bay/Sebonac Complex	76
North Sea Complex	253

Noyac Sea Harbor	300
Sag Harbor Complex	1,867
Three Mile Harbor	1,262
Accabonac Harbor	56
Napeague Harbor	20
Lake Montauk	1,274
Dering Harbor	381
Coecles Harbor	287
West Neck Harbor	346
TOTAL	**11,247**

Source: USEPA, 2002

4.2.1.6. Other Maritime Uses

The study area contains extensive habitat for waterfowl, including wetlands and open waters, and seasonal waterfowl hunting occurs throughout the area. A permit from NYSDEC is required for duck hunting, which is permitted over open waters of the estuary, although guns cannot be used within 500 feet of residential areas. The taking of sea ducks in the study area is restricted to the Special Sea Duck Area, designated by NYSDEC, which consists of the open waters of the Great Peconic Bay and the associated bays eastward from a line running from Miamogue Point in the Town of Riverhead to Red Cedar point in the Town of Southampton. Sea duck hunting occurs mainly from aboard a boat, but limited shoreline access is permitted at Cedar Point County Park in East Hampton (M. Bleech, NY Game and Fish, January 2006). This area offers floating and land-based blinds offered to hunters by lottery. Waterfowl hunting season dates for 2007-2008 are listed in Table 37.

Table 37. NYSDEC 2007-2008 Waterfowl Hunting Seasons

Species	Season dates
Ducks, Coot and Mergansers	Nov 29 – Jan 27
Sea Ducks	Oct 13- Jan 27
Canada Geese	Sept 4 – Sept 30
Snow Geese	Nov 1 – Feb 15
Brant	Dec 9 – Jan 27

Source: NYSDEC, Waterfowl Hunting Seasons and Regulations 2007-2008

4.2.1.7. Parks and Heritage Areas

Several state and county-owned parks located throughout the East End of Long Island abut the shoreline of the Peconic and Gardiners Bays. Several parks offer recreational water-related activities such as bathing areas, fishing, waterfowl hunting (in-season), scuba diving, and sailing. Many of the parks also offer scenic vistas of the estuary and waterfront access. In addition, the Elizabeth A. Morton National Wildlife Refuge is located on Jessup Neck, a peninsula situated between Noyac Bay and Little Peconic Bay. The refuge is 187 acres in size and supports critical wildlife habitats such as the Kemp's Ridley sea turtle, as well as migratory shorebirds, raptors and songbirds. The Conscience Point National Wildlife Refuge, located in North Sea, is 60-acres in size and contains one of the few maritime grassland communities on Long Island. This refuge supports migratory birds and waterfowl, and grassland-dependent birds such as the blue-winged and prairie warblers (USFWS website, www.fws.gov/northeast/longislandrefuges/consciencepoint.html, accessed on February 15, 2008). State and county-owned public parks that abut the tidal waters of the Peconic Estuary are listed in Table 38.

Table 38. State and County-Owned Parks Abutting the Tidal Waters of the Peconic Estuary

Name	Location	Size (acres)	Water-related Amenities
Cedar Beach County Park	Southold	68	Scenic vistas, boat ramp
Cedar Point Beach County Park	East Hampton	607	Saltwater fishing (surf and shore casting) scuba diving, waterfowl hunting, outer beach access
Hither Hills State Park	Montauk	168	Bathing beach, fishing, hunting
Hubbard County Park	Flanders	1,800	Waterfowl hunting
Indian Island County Park	Riverhead	275	Saltwater fishing
Meschutt Beach County Park	Sag Harbor	10.5	Bathing beach; windsurfing; sailing
Napeague State Park	Napeague	1,364	windsurfing
Northwest Harbor County Park	East Hampton	337	Scuba diving

Orient Beach State Park	Orient	342	45,000 ft of frontage on Gardiners Bay; swimming; fishing; scenic viewing deck.

The New York State Historic Preservation Office (SHPO), a bureau of the New York State Office of Parks, Recreation and Historical Preservation, maintains information relating to historic properties in New York State including historic buildings, structures, sites, districts, and objects. Archaeological Sensitivity Maps created by SHPO define areas within the state where the discovery of archeological sites is predicted. Exact locations of the sites are not depicted on the map, since they are protected from disclosure by Section 304 (16 USC 4702-3) of the National Historic Preservation Act of 1966 and Section 427.8 of the implementing regulations for the State Historic Preservation Act of 1980. Random buffer zones are placed at each mapped location in order not to disclose the exact location of the site. Archaeological sensitive sites have been identified throughout the study area; specifically, along the shorelines of Flanders Bay, Great Peconic Bay (east), Little Peconic Bay (including Robins Island), Hog Neck Bay, Noyac Bay, Shelter Island Sound (including Shelter Island), Northwest Harbor, Orient Harbor, Gardiners Bay (north of Three Mile Harbor, and south of Long Beach), and Gardiners Island (New York State Historic Preservation Office website, www.nysparks.state.ny.us/shpo/, accessed on September 20, 2007).

In 1998, the north shore portion of Long Island (extending eastward from Queens to Plum Island) was designated as the Long Island North Shore Heritage Area, under the New York State Heritage Area System, for the purposes of preservation, education, recreation and economic revitalization (Long Island North Shore Heritage Area, 2006). The designation was based on the geological, natural, scenic, and historic features associated with the area, and because of its proximity to New York City. The "Harvest Coast" portion of the North Shore Heritage Area includes the eastern end of Long Island, from Calverton to Plum Island, and includes Robins Island (Shelter Island is excluded). This designated heritage area does not extend into the open waters of the Peconic Estuary.

4.2.1.8. Aesthetic Values

In addition to recreational and economic values, the Peconic Estuary offers aesthetic qualities that are valued by community residents, second homeowners, and visitors. Although over 50% of the uplands and shoreline surrounding the estuary are developed or under cultivation (The Nature Conservancy, http://www.nature.org/wherewework/northamerica/states/newyork/preserves/art21962.html, accessed on January 11, 2008), the embayments throughout the estuary provide scenic views of beaches, wetlands, uplands, open water, and other land masses including Robins Island, Shelter Island, Plum Island, and Gardiners Island.

In recognition of the scenic value of the coast, the NYS Coastal Management Program identifies and evaluates areas of the coast that are of aesthetic significance for designation as a Scenic Area of Statewide Significance (SASS). The Town of East Hampton recently developed a Scenic Resources Protection Plan (August 2007) to identify scenic areas of state-wide significance. Five SASSs, all within the Town of East Hampton, have been designated in the Peconic Estuary: Northwest Creek, Three Mile Harbor, Accabonac Napeague and Gardiners Island.

Sebonac Creek and Cow Neck, ranked by the Town of Southampton (2005) as among the most scenic areas within the town, offer panoramic vistas of the estuarine environment, including wetlands, upland forests, and open sky.

4.2.2 Impacts

4.2.2.1. Loss of Harvest Area

Shellfish aquaculture structures, on or off-bottom, could preclude the use of the water column and underwater land for commercial fishermen (trawling), shellfishing (the potting of lobsters and whelks, the raking and tonging of hard clams and oysters, and the dredging of bay scallops) as well as recreational fishermen. In addition, if a lease site becomes abandoned, aquaculture gear left

suspended in the water column or on the bay bottom could break free and impact fishing vessels and associated gear (i.e. trawls).

On the other hand, shell bottom habitats are considered to be essential fish habitats by many state and federal management agencies because they provide hard substrate for the attachment of many species that would not be present in areas consisting only, or mainly, of soft sediments (Coen, 2007). The overall ecological result of the presence of shellfish habitat is an enhanced biodiversity as compared to surrounding areas. Such habitats could be created by the on/in bottom culture of certain species of shellfish (i.e. oysters) resulting in a positive impact on essential fish habitats.

Also, as reported by Dealteris, et al. (2004), the abundance and species richness exhibited in areas of aquaculture gear is greater than that found in eelgrass habitat, which in turn was greater than that found on a non-vegetated site. The findings of the report indicated that shellfish aquaculture gear provides habitat for many native species of recreationally and commercially important fish and invertebrates in their early life history stages throughout the year.

4.2.2.2. Maritime Traditions

Any restriction on access to public underwater land will impact some of the maritime traditions associated with the Peconic Estuary. For generations, local residents have supported their families by harvesting marine life from the public waters of the estuary.

Over 11,000 recreational boaters and fishermen frequent the Peconic Estuary during the summer boating season (USEPA, 2002). The placement of aquaculture gear (e.g.,. suspended cages, marker buoys, etc.) in the water column could impact navigation and the ability of recreational boaters to visit desired areas such as Cutchogue Harbor, the Flanders Bay Complex, Greenport Harbor, Sag Harbor, Southold Bay, and Three Mile Harbor. The required 1,000 ft. distance from the

shoreline, and already in place laws regulating the placement of structures, should alleviate this problem.

The proposed lease program could also restrain the use of traditional, and still employed shellfish harvesting tools, such as the scallop dredge, near leased underwater lands. Suspended transient aquaculture gear and associated marker buoys could cause obstructions for scallop dredges if they lie within the desired dredge path. However, known scallop beds, along with historical and potential scallop areas, have been identified throughout the study area and have been excluded from the areas proposed for new aquaculture leases.

Dip nets are used to scoop up shellfish from the water and are deployed by hand from a boat or from the shore. Dip netting is considered to be a traditional scallop harvesting technique, and is not likely to be affected by leases beyond 1,000 ft. from shore.

It should be recognized that shellfish cultivation has been practiced since the 19th century in the Peconic Estuary, and should itself be considered a maritime tradition that the proposed program will likely help preserve and rejuvenate. As early as the 1840s, oystermen began experimenting with planting oysters in the Great South Bay in an attempt to revive a declining natural oyster stock (Lang, undated). Transplanting of oysters from Great South Bay and Connecticut helped make the Peconic Estuary the largest producer of oysters in the state during the late 1920s and early 1930s (Kassner, unpublished). However, by the 1950s and 1960s, oyster production in Suffolk County bays reached a low due to the appearance of "small form" phytoplankton that clogged the gills of oysters, inhibited feeding and resulted in unmarketable shellfish meat (Anderson and Spatz, 1997). Small form phytoplankton in Great South and Moriches Bays (and, presumably, the Peconic Estuary) were determined to have been stimulated by the introduction of duck wastes (Ryther 1954), resulting in increased regulation of duck farms, and the closure of all but one farm within the Peconic Estuary. This

duck farm, on Meetinghouse Creek, has reduced its nutrient input significantly. Hard clam cultivation flourished during the mid-20th century as a result of a decline of oysters. Hard clam relay programs were a key component in the estuary's hard clam fishery in the 1980s.

In summary, aquaculture activities under the proposed Lease Program may restrict public access to certain underwater lands and, therefore, may interfere with some existing maritime traditions including recreational boating, commercial and recreational finfishing and shellfishing. However, in addition to the siting of leases beyond 1,000 ft. from shore, the avoidance of currently productive and/or fished areas, and current regulations regarding the placement of structures in navigable waters, the moderate growth suggested in Section 2.5 *Proposed Program Components* comprises such a small percentage of the overall public underwater lands of the Peconic Estuary that no significant adverse impact to the maritime traditions is expected.

4.2.2.3. Changes in Employment Opportunities/Incomes

As fishery opportunities decline and state/federal catch and license regulations increase, the ability to earn a sustainable income harvesting wild marine life has become more difficult. Some fishermen and baymen have become displaced and have been forced to pursue non-fishery related jobs to supplement their income (e.g. the second-home and service economy which dominates the region) (Lang, undated). Such was the case during the mid-1980s when Brown Tide severely impacted the scallop industry. Prior to the Brown Tide, baymen derived a significant portion of their income from the scallop industry; however, the industry has not fully recovered and baymen have had to pursue other means of income.

Shellfish aquaculture can provide an alternative marine-based livelihood for displaced fishermen and baymen, offering much of the independence and personal freedom that they value as a way of life. Baymen can make the transition to shellfish cultivation because it draws on many of the same skills as fishing, and

the boats and fishing equipment in which they are already invested can be modified for use in shellfish aquaculture (Terra Aqua, 2003). In 1995, Cornell Cooperative Extension developed a pilot mariculture training program to encourage small-scale aquaculture that would supplement baymens' declining incomes. A significant number of program participants continued with aquaculture, and those who did not admitted to having a new sense of respect for aquaculturists (Lang, undated).

4.2.2.4. Value of Fishery Resources

Although wild shellfish are currently viewed as a premium product, increased production of cultured shellfish, and the potential to culture a higher quality product, could increase the demand for cultured product over wild harvests, decreasing wild harvest value (Hoagland et al., 2003). On the other hand, shellfish prices are governed by out of state suppliers, and the shellfish industry on Long Island is loosing ground to out-of-state aquaculture operations.

4.2.2.5. Potential Supplemental Income for Baymen

The majority of the people currently turning to aquaculture are baymen (Suffolk County, 2002). Shellfish aquaculture allows for the cultivation of a renewable resource, while largely adhering to the independent baymen lifestyle. In the past, scallop shucking offered baymen a source of additional income prior to the decline of the scallop industry in the mid-1980s. This loss of income could be offset by aquaculture processing (i.e. oyster shucking).

Other marine-related industries (i.e. marinas, boat repair, shellfish hatcheries) may also benefit monetarily from an increase in a shellfish industry in the estuary.

4.2.2.6. Shoreline Facilities

Shellfish cultivation will expand the marine-based economy and create related job opportunities. It will contribute to the retention of marine-related jobs, such as seafood processing, marine mechanics, boat repair, and aquaculture gear manufacturing. An increase in shellfish aquaculture fisheries will likely increase

the demand for shoreline facilities to provide access to the waterfront for aquaculturists.

4.2.2.7. Conflicts Over Lease Boundaries

Conflicts between lessees and other users of the bay (including other lease holders) could occur if it is believed that a lease holder is operating beyond the extent of the lease boundaries.

4.2.3 Mitigation

4.2.3.1 Performance Standards

To ensure that leases are actively used for shellfish aquaculture, each lease applicant will be required to submit annual reports to the County that must include documentation of the types and quantities of shellfish being cultivated and harvested on the subject lease, the time periods of cultivation and harvesting, and other information deemed appropriate by the County. The County will also establish a time period within which aquaculture activities must be initiated after the execution of a lease. Failure to meet minimum performance levels and timeframe can result in termination of the lease.

4.2.3.2. Limit Acreage/Area

Under the proposed program, the area in which a lease may be placed has been delineated to reduce impacts to commercially harvested areas of local significance. This includes naturally productive finfish and shellfish areas (as shown on Figure 2).

Leases administered in the underwater lands within the Town of East Hampton will be limited to private oyster grants and lands identified as suitable for aquaculture by the Town of East Hampton Commercial Fisheries Advisory Committee (EHCFAC) and the Town Board, to address concerns regarding maritime traditions and local independent baymen and fishermen.

In addition, the 1,000 foot shoreline buffer for new leases will limit the potential significant adverse impacts to the scenic vistas identified throughout the estuary.

4.2.3.3. Limit Lease Size

As previously discussed under mitigations in Section 4.2.1, new aquaculture leases under the proposed program will be limited to 5- or 10-acre size plots, with the exception of private oyster grants, in which the lease would overlay a portion of or the entire the grant parcel (specific provisions for leases on grants are stated in Section 2). The decision to limit the amount of acreage available for new leases was based on the concerns of commercial baymen and recreational users of the bay that were brought forth during the public scoping period (as described in Section 2). These concerns were generally socio-economic fears of the potential development of monopolies in the aquaculture industry, but also included concerns regarding the potential for over-dredging and over-harvesting of natural stocks that may be present on the lease.

A conservative growth rate of one percent of the existing total aquaculture acreage will only allow for 60 acres available for new aquaculture leases per year for the first five years of the program. The proposed lease sizes and amount of underwater land available under the proposed program will reduce conflicts with commercial fishermen and other users of the bays. The rationale for overlaying leases on the entire acreage of an oyster grant is that they are permitted by law to bottom-culture oysters (as discussed in detail in Section 3.2.1).

4.2.3.4. Mark Lease Areas

In order to mitigate potential conflicts regarding ownership of leased public underwater land, all lease sites will be required to have a survey conducted by a NYS licensed land surveyor before the issuance of the lease is finalized. The survey will clearly identify the location and boundaries of a lease for proper placement on County-controlled bottomlands. In addition, boundaries of leases will be properly marked in a standardized fashion, according to County specifications.

4.2.3.5. Cooperation Among User Groups

Cooperation among lease holders and commercial fishermen, particularly whelk fishermen, would help mitigate potential conflicts associated with the loss of harvest areas. Since whelks are a common predator of shellfish, allowing whelk fishermen to deploy conch pots on a lease site would also be beneficial to the lease holder, in terms of predator control. Commercial conch fishermen currently harvest conch off several private grant parcels within the estuary in cooperation with the grant holder (K. Rivara, East End Marine Farmers Association, personal communication, February 2008).

4.2.3.6 Phased Expansion of Leases on Formerly Issued Grants

If a grant has not been used for shellfish aquaculture within a designated time period (has been fallow for an extended time), it can enter the Lease Program in a limited phased process. This will provide for expansion of shellfish aquaculture, but minimizes potential conflicts with other users of the estuary. The schedule and extent of expansion in such a lease would be based on the extent of any conflicts that materialize, and will provide for an opportunity for public review and comment through the lease application public notice process. This phased approach will mitigate impacts that could be associated with the rapid conversion of formerly unused grants for active aquaculture.

4.3 Transportation

4.3.1 Existing Conditions/Setting

4.3.1.1. Boating Activities

The Peconic Estuary is a popular area for recreational and commercial boating. Recreational boating activities through the estuary include sailing, motor boating, mooring, personal watercraft use (jet skis), fishing/shellfishing, swimming, and water skiing. Of all bays in the estuary, recreational fishing and boating occurs the most in Great Peconic Bay, and the least in Flanders Bay (Opaluch et al., 1999). As discussed earlier, commercial fishing, charter/party boats, and four ferry services also utilize the estuary.

4.3.1.2. Navigation

Boaters plying the waters of the Peconic Estuary depend upon a functional network of unobstructed navigation channels to provide safe routes between points of origin and destinations. The US Army Corps of Engineers is responsible for maintaining the navigability and ecological integrity of navigable waters within the Peconic Estuary. Suffolk County is responsible for maintaining channels that extend into creeks, canals, inlets, and basins. Some channels have been formed naturally, but many have been created to expand the range of available routes.

4.3.2 Impacts

4.3.2.1. Hazards to Navigation

Suspended shellfish aquaculture gear currently used within the Peconic Estuary is typically set below the water surface at a depth that allows for boat passage through the site. Submerged gear (i.e. single cages, trawls of multiple cages) within the Peconic Estuary is required by NYSDEC to have attached floating devices (i.e. buoys, markers) to mark the presence of an underwater hazard. An increase in the number of shellfish aquaculture leases in the estuary would increase the amount of buoys and markers, creating more navigational hazards.

Certain types of shellfish aquaculture gear (i.e. floating rafts, upwellers) common throughout the northeast region are positioned at or near the water surface. If such gear is permitted under the proposed lease program, large water surface structure hazards could exist in a random pattern throughout the bays. If not properly marked with buoys, this type of gear could become a danger to boaters during periods of poor visibility.

4.3.2.2. Restrictions on Use

The placement of private aquaculture gear in public waters will preclude the use of the water column and underwater land for commercial and recreational fishermen, lobstermen, and conchmen. Floating gear could impact recreational activities, such as boating, windsurfing, and waterskiing.

4.3.3 Mitigation

4.3.3.1. Standards for Marking

Corner boundaries of a lease site and navigational hazards (i.e. submerged aquaculture gear) should be properly identified with standardized markers. Markers should also be installed where submerged gear poses a hazard to navigation. The need for maintenance and repair of lease markers will likely increase during high estuary use periods. Impairment of commercial boating traffic (i.e. ferries) will be prevented by not permitting the placement of leases in navigational channels or along ferry routes.

4.3.3.2. Notification

Notification of a lease application will be made available to the public, all five east-end Towns, and NYSDEC during a specified public comment period to provide input on the operational design of the proposed lease, the effects on existing uses and the estuarine environment prior to approval by the County. Input and comment provided by the Towns within a specified time period will be taken into consideration by the County during the lease application review and approval process.

Under the New York State Navigation Law (NY CLS §35 Aids to Navigation), lease applicants are required to obtain a permit for the placement of floating objects (e.g. surface markers and buoys) in state navigable waters. Each permit application is reviewed and approved by the state so long as it does not pose a hazard to navigation. The Army Corps of Engineers (ACOE) requires a permit for the placement of buoys and other shellfish aquaculture structures (e.g. floats, racks, trays) (72 FR 11146) in navigable waters, as regulated under Section 10 of the Rivers and Harbors Act. Under the ACOE permit, all buoys and markers placed in navigable waters must be marked in accordance with 33 CFR 64, and the applicable US Coast Guard office must be notified.

4.3.3.3. Limit Placement of Structures

To mitigate hazards and impacts associated with floating aquaculture gear under the proposed program, navigational channels and areas of intense navigational use have been identified as socio-economically sensitive areas where the placement of leases would not be permitted. In addition, any navigational hazards associated with aquaculture gear (e.g. fencing, water-column netting, densely placed stakes) would be required to be clearly marked to alert boaters near the lease site.

Submerged gear should be placed in the water column at a depth that will not impede navigation and that will ensure access for other users of the bay. Submerged gear will not be permitted to be placed within or on the edge of a navigable channel. The proposed program will provide adequate setbacks from navigation channels for leases to reduce potential significant adverse impacts to navigation.

4.3.3.4. Require Buffers

To reduce potential navigational impacts to commercial and recreational fishermen, leases will not be placed in areas where known finfish, crustacea, and natural shellfish stocks are produced regularly and harvested on a commercial

basis. Buffers from heavily trafficked navigation channels (i.e. ferry routes, canal entrances, main channels) will minimize interference with these uses.

4.4 Visual Setting

4.4.1 Existing Conditions/Setting

4.4.1.1. Buoys and Structures on Surface

The estuarine waters are riddled with navigational aids and markers during certain commercial fishing seasons (e.g. whelk potting). Navigational aids are mainly concentrated along main channels, at the mouth of creeks and inlets, or within harbors and include channel markers and buoys, speed zone markers, mooring buoys, and special anchorage area markers. The US Coast Guard is responsible for placing navigational buoys and channel markers within federal navigational channels. Moorings and anchorage markers are regulated under town jurisdiction.

All submerged fishing gear (i.e., traps, pots) that pose a hazard to navigation are required by NYSDEC to have a floating buoy or identification marker. Commercial and recreational submerged fishing gear such as crab pots, whelk pots, and lobster pots are dispersed throughout the estuary and are relocated on a continuous basis. Currently all shellfish aquaculture operations within the open waters of the Peconic Estuary typically involve gear submerged beneath the water surface, identified with floating markers.

Two buoys that mark submerged sensors, set as close to the surface as possible without interfering with boat traffic, have been placed in the Peconic Estuary by the Suffolk County Department of Health Services, Office of Ecology. The sensors continually record chlorophyll-a concentrations, temperature, salinity, and dissolved oxygen, and the data are telemetered to the Office of Ecology.

4.4.2 Impacts

4.4.2.1. Loss of Aesthetic Values/Qualities

Boundary markers for lease sites are important for navigational issues; however, a large number of markers could interfere with the visual resources of the estuary identified earlier in Section 4.2.1, Aesthetic Values. Some off-bottom culture gear involves numerous markers or floatation devices that intrude upon the visual resources of the water surface. Certain types of shellfish aquaculture gear used throughout the northeast involve floating structures (i.e. rafts, bags), floats (i.e. upwellers), or structures exposed during low tide (i.e. intertidal racks). Intertidal shellfish racks can have a significant impact on the viewshed of the bay when exposed during low tide, however, as the proposed leases will be a minimum of 1,000 feet from shore this is not an issue. Floating racks typically consist of a rectangular-shaped Styrofoam floating device that holds a limited number of shellfish bags. Rafts are tethered together, typically forming long parallel lines along the water surface. Floating rafts are generally exposed to the water surface during warm months, which can be negatively viewed by seasonal recreational users. Floating bags and racks tend to attract large numbers of gulls that use the bags as roosting platforms (Friends of West Bay, Inc., 2007), and the fouling of the bags by the birds would impact water views and aesthetics.

Suspended longlines typically used in mussel culture involve a series of buoys attached along the length of the main line, and may also involve surface rafts, which can measure up to approximately 30 x 300 feet (Massachusetts Office of Coastal Zone Management, 1995). Some suspended longlines have the capability of holding up to 400 strings, requiring numerous floating devices. (Massachusetts Office of Coastal Zone Management, 1995).

FLUPSY systems, used to grow oyster seed to a plantable size, are the most obtrusive of shellfish aquaculture gear in terms of watershed views. FLUPSYs, when used in open waters, generally consist of a square wooden float with a hollow center. The middle of the float is open and contains multiple ‘silos’ (each

culturing oyster seed) set just below the water surface. The float allows for a platform on which the grower can work and tend to the crop. FLUPSYs are generally utilized in sheltered waterbodies near shore, and are not located in the open waters of the estuary.

4.4.3 Mitigation

4.4.3.1. Visual Buffers and Setbacks from Critical Viewsheds

The 1,000-foot shoreline buffer will minimize the view of floating markers and buoys associated with submerged aquaculture gear from the shoreline and important scenic vistas. Visual impacts from large floating structures or gear can be mitigated by restricting the use of such gear where aesthetic values would be significantly impacted. Markers or buoys associated with submerged gear should be visually unobtrusive, standardized, and deployed in a minimum amount per lease site. In addition, underwater lands in high traffic areas, mooring areas, and popular fishing areas have been excluded as part of the process to develop the proposed program.

4.5 Use and Conservation of Energy

It is believed that the proposed action will not unduly impact the use and conservation of energy. Energy use associated with shellfish aquaculture would include the use of fuel and electricity incidental to facility development, operation and maintenance, and processing and transport of product. As costs affect profit margins, it is in the grower's best interest to keep energy costs to a minimum. This might include such things as equipping their boats with energy-efficient outboard engines.

4.6 Solid Waste Management

While shellfish aquaculture operations may generate some solid waste, it is not expected to have a significant impact on solid waste management. Solid waste that may be associated with a shellfish aquaculture operation includes damaged, defective, or superfluous material produced through normal operations (e.g. roping; netting, buoys,

cage materials). If processing of the cultured shellfish occurs at an on-shore facility, then shell waste would be created and would require proper disposal or re-use.

The Lease Program will not generate unusually large amounts of solid waste, and the miscellaneous debris generated can be handled by standard soil and waste disposal practices already in place in the east end towns.

4.7 Acquisition of Land

It is believed that the proposed action will not impact the acquisition of land. The proposed program will not involve the taking of underwater lands, but rather the issuance of leases to allow for use of the underwater lands. Underwater lands leased under the proposed program, with the exception of private oyster grants, will remain under governmental ownership.

4.8 Groundwater Resources

It is believed that the proposed action will not impact groundwater resources.

4.9 Air Quality

It is believed that the proposed action will not impact air quality.

4.10 Summary of Potential Impacts and Mitigations

The following tables (Table 39 and 40) summarize the potential significant adverse impacts and beneficial impacts of the proposed program.

Table 39. Potential Significant Adverse Impacts of the Proposed Program

PARAMETER	POTENTIAL SIGNIFICANT ADVERSE IMPACTS	MITIGATION
Benthos:	Change in benthic assemblages and/or bottom habitat from on-bottom structures and harvest methods	Limit lease number and size; NYS permit conditions
Natural shellfish stocks:	Introduction of exotic species - competition with indigenous species; introduction of pathogens; gene pool contamination	NYSDEC Policy of Acceptable Origin of Shell and Shellstock for Introduction in New York
Primary productivity	Decreased phytoplankton population	Limits on lease number and size
Nutrients	Nutrient depletion	Limits on lease number and size
Water quality	Increased turbidity; resuspension of sediment contaminants; oxygen depletion	Limits on lease number, size and placement
Sediment characteristics	Scouring of bay bottom; enhanced local deposition of organic material; transportation of contaminants	Limits on lease number and size
Submerged aquatic vegetation (SAV)	Physical removal by harvesting; decreased light due to suspended sediment and overlying gear	Limits on lease placement
CNRAs & protected species	Physical disturbance to sensitive habitats; impacts to foraging areas; displacement of protected species	Limits on lease placement
Migratory waterfowl and other bird populations	Physical disturbance to sensitive habitats; disturbance to foraging areas	Limits on lease placement
Commercial fishing industry	Restricted access to commercial harvest areas; impact on prices paid for wild harvest	Limits on lease placement; cooperation among user groups

Recreational fishing/ recreational boating	Restricted access to desired fishing locations and popular mooring areas	Limits on lease placement; ongoing municipal input
User activities/maritime traditions	Restricted access to fishing/shellfishing and recreational areas; conflicts with ownership of underwater lands	Limits on lease placement; ongoing municipal input
Parks and heritage areas	Impacts to sensitive wildlife habitats and recreational uses	Limits on lease placement
Navigation	Increase in number of navigational buoys and surface water hazards	Limit lease number, size and placement; mark lease boundaries
Aesthetic values	Increased number of navigational buoys, surface structures; impacts to NYS Scenic Areas of Statewide Significance.	Limits on lease placement; limits on lease number
Energy	No significant adverse impacts are anticipated	Limits on lease number and size

Table 40. Potential Beneficial Impacts of the Proposed Program

PARAMETER	POTENTIAL BENEFICIAL IMPACTS
Ecology	Release of larval shellfish into water-column Increase in filter-feeders that will improve water quality Increase in species diversity near aquaculture structures Increase in benthic community below aquaculture sites Creation of juvenile fish habitat
Enhanced recruitment	Potential for cultured species to supplement wild shellfish stocks
Economy	Expansion of the marine-based economy Employment opportunities for baymen Potential source of supplemental income for baymen Increase in security for existing aquaculture operations
Maritime traditions	Continuation/restoration of the tradition of aquaculture in the Peconic Estuary
Seafood production	Increase in the production of harvestable shellfish Improved choices for the consumer of seafood products Local production which reduces the need for imported supply

THIS PAGE INTENTIONALLY LEFT BLANK

Section 5
Alternatives

5.1 Overview of Alternatives Analysis

A discussion of alternatives to the proposed action is required by SEQRA. It is important to discuss reasonable alternatives to the project, or portions of the project, that achieve the same or similar objectives of the project sponsor (i.e., Suffolk County). The purpose of the alternatives analysis is to provide comparative assessment of the impacts of each alternative. A "no action" alternative must always be discussed and is especially relevant for governmental actions involving the expenditure of public funds. For the preparation of Generic EISs, the alternatives analysis must address alternative actions at the conceptual stage, and because of the broad scope of future site specific actions following a Generic EIS, hypothetical scenarios are appropriate for the alternatives analysis.

During the scoping process and follow-up development of the proposed alternative, several alternatives were identified for consideration in the Draft GEIS. As a generic EIS, the use of specific types of equipment, technologies and other site related activities could not be performed. Site selection under the proposed aquaculture plan will be performed at a later stage through a lease application review process by the County, and the process will be subject to public and agency review. Furthermore, specific lease sites will be subject to permit application review, most importantly by the NYSDEC, which is the issuing agency for aquaculture permits.

As required by SEQRA, alternatives to the proposed County Lease Program were identified and are addressed below in this section. The alternatives considered include a minimum lease program (1A), a no action alternative (2), an elimination of aquaculture alternative (3), and an unlimited growth alternative (4). These alternatives represent the range of hypothetical alternatives to the proposed action.

5.2 Alternative 1A – Minimum Lease

Alternative 1A represents a reduced scale shellfish aquaculture lease program. It provides for the establishment of leases only on sites where aquaculture is presently or has recently been conducted (i.e., grants and temporary assignments). The restrictions of the 2004 Leasing Law still apply, specifically the exclusion of areas 1,000 feet from the shore, areas identified as productive for other fisheries, and areas where significant conflicts with other users of the estuary cannot be avoided.

This alternative allows the conversion of all NYSDEC Temporary Marine Assignments and private oyster grants that meet the 2004 Leasing Law requirements into leases issued under the Suffolk County Aquaculture Lease Program.

Aquaculture 1A Components

- Currently the combined acreage of these two entities (grants and assignments) is approximately 5,982 acres (including acreage within the 1,000 ft buffer) which is approximately 5.4 percent of the 110,000 acres of underwater land within the study area of the Peconics and Gardiners Bays.
- Those assignments that appear to be within the 1,000 ft shoreline buffer are not within the jurisdiction of this program and will not be considered for leasing. However, the area directly offshore of 1,000 ft in the same general area of the assignment (within the cultivation zone) will be made available for leasing.
- Some of the grants have a portion of their acreage located within the 1,000 ft shoreline buffer. Those portions of the grants that are within the 1,000 ft shoreline buffer zone will be excluded from the lease program. However, all of the remaining acreage of those grants that is located in the cultivation zone will be permitted to participate in the County Lease Program.

- Private grant owners will be allowed to apply for an aquaculture lease for species other than oysters and will follow the same guidelines for leases being offered that are not on grants.

Assessment

This alternative is similar to the proposed alternative in that it will provide for establishment of County leases for grants and temporary assignments. It differs in one important way – it does not provide for any expansion of aquaculture into new areas of the estuary. The impacts of this alternative would be comparable to the impacts of the proposed action, as discussed in Section 4 of this GEIS, because the total acreage of underwater lands committed to aquaculture is comparable under both scenarios. This alternative would provide an increased level of security and business stability to existing grant and assignment holders by providing a means for their participation in the County Lease Program. Although impacts of this alternative are comparable to that of the proposed action (Alternative 1B), Alternative 1A is deemed to be unacceptable because it does not satisfy an important mandate of the 2004 Leasing Law, which is to provide for an expansion of aquaculture in the Peconic/Gardiners Bay system.

Also in contrast to Alternative 1B, this alternative would not have a provision for educational/experimental leases and municipal leases for shellfish resource restoration, which represent beneficial impacts associated with the proposed action. This alternative was not considered further because it did not meet the primary objective of the 2004 Leasing Law.

5.3 Alternative 1B – Minimum Lease with Moderate Growth

This alternative involves the conversion of NYSDEC Temporary Marine Assignments situated outside of the 1,000 ft shoreline buffer into County leases, allows private grant holders located outside the 1,000 ft shoreline buffer to participate in the County Lease Program, and also provides for future growth of the industry by permitting additional use of underwater lands for aquaculture

within defined limits. This alternative would make available approximately an additional 300 acres of bottom land for new entities at the end of the first five year period, and another approximately 300 acres at the end of 10 years. The program components outlined below make reference to the draft map entitled *Suffolk County Aquaculture Lease Program Shellfish Cultivation Zone Alternative 1B, January 24, 2008* (refer to Figure 3) and specifically the Shellfish Cultivation Zone which identifies areas suitable for additional lease placement based on environmental and socio-economic considerations.

This alternative is the proposed action, which is the subject of this DGEIS. The full description of this alternative, its program components, and associated impacts are given in Sections 1 through 4 of this document.

5.4 Alternative 2 – No Action

Under this No Action Alternative, Suffolk County would not institute a Shellfish Aquaculture Lease Program for the Peconic and Gardiners Bays and no Shellfish Cultivation Zone Map would be adopted. Access to bottom lands for aquaculture would be obtained under current practices.

No ecological or physical impacts would be expected under the No Action Alternative. It would not provide any further stability or security to existing aquaculture activities, and it would not provide a program for expansion of aquaculture. The temporary assignments would be subject to annual approval by the NYSDEC, and growth would be limited by the constraints of the temporary assignment program. Socio-economic benefits of an expanded and improved aquaculture program would not be realized. The beneficial impacts of expanded aquaculture on the ecology of the estuary, such as those related to water quality and improved spawning stock, would not be realized. A positive impact of this alternative is that there would be no expenditure of County funds required to implement and manage a lease program; conversely, there would be no revenue generated by lease fees and economic activity. Although this alternative would

not have significant environmental impact beyond that of current conditions, the no-action alternative was deemed unacceptable because it does not meet the fundamental objectives of the 2004 Leasing Law.

5.5 Alternative 3 – Elimination of Existing Aquaculture Activities in the Peconics and Gardiners Bays

Under Alternative 3, Suffolk County would not institute a Shellfish Aquaculture Lease Program for the Peconics and Gardiners Bays and no Shellfish Cultivation Zone Map would be adopted. In addition, temporary marine area use assignments would no longer be issued by NYSDEC in the Peconic Estuary and all existing temporary assignments would be terminated. Shellfish aquaculture would be limited to oyster cultivation on existing oyster grants.

Existing shellfish aquaculture businesses currently operating under temporary assignments would be forced to cease operations. The termination of the existing shellfish aquaculture businesses would have adverse economic impacts on existing aquaculture operations and companies/individuals who provide supplies to those operators, including hatcheries that provide seed. This alternative would not have beneficial impacts to the bay's ecology, or to socio-economic conditions of the area that are associated with an expansion of aquaculture. Furthermore, this alternative is not viable due to the fact that Suffolk County does not have legal authority to terminate the NYSDEC temporary assignment program if no County Lease Program is adopted.

This alternative was deemed unacceptable because it does not meet the objectives of the 2004 Leasing Law, it would have adverse socio-economic impacts, and would not have the beneficial impacts associated with aquacultural activity.

5.6 Alternative 4 – Unlimited Lease Growth

This alternative would provide for the unlimited growth of aquaculture throughout the Peconic Bay/Gardiners Bay system.

This alternative would involve the conversion of all NYSDEC Temporary Marine Assignments and private oyster grants that meet the 2004 Leasing Law requirements into leases issued under the Suffolk County Aquaculture Lease Program and would allow for the addition of new leases throughout the entire estuary without excluding areas that are environmentally or socio-economically sensitive. Under this alternative, the amount of new leases would not be restricted to a defined growth rate, and a cap on new leases would not be implemented.

This alternative would have adverse impacts in numerous areas:

- Impacts on ecological resources would be greater than that of the proposed action because the amount of underwater land committed to aquaculture would be potentially many times larger than that associated with the proposed action.
- Lessons learned from a phased program would be unavailable, and the potential for the occurrence of irreversible ecological effects would be magnified.
- Impacts to other users of the estuary would be intensified because aquaculture would expand into areas presently used by other groups including commercial fishermen, recreational boaters, and other commercial operations. In contrast, the proposed action is designed to minimize conflict with other users of the estuary.
- This alternative could have adverse impacts to economic conditions if expanded aquaculture suppressed product value because of overproduction.
- This alternative would conflict with other jurisdictions, such as those associated with Town Local Waterfront Revitalization Plans because leases could potentially be placed in areas deemed by LWRPs as environmentally or socio-economically important
- Enforcement needs would be substantially greater than those for the proposed alternative, because of the greater potential for user conflicts, gear conflicts,

abandoned gear, vandalism and theft, and unauthorized activity by aquaculture operations.

- Alternative 4 would meet the objectives of the 2004 Leasing Law by providing for an expansion of aquaculture, but would be in contradiction of the law by not providing for protection of existing fisheries and environmental conditions in the estuary. Alternative 4 has been deemed unacceptable because it would not comply with all the objectives of the 2004 Leasing Law and would potentially have adverse impacts to environmental and socio-economic conditions.

This alternative is not considered feasible since it is an extreme alternative that would likely cause conflicts with other commercial and recreational users of the estuary.

5.7 Summary of Impact Analysis of Alternatives

Alternatives 1A through 3 have the least potential for significant adverse environmental, socio-economic and cultural impacts. The expansion of aquaculture activities under the proposed action, Alternative 1B, will reduce the potential of significant adverse impacts through specific mitigation measures, as discussed in detail in Section 4. The potential for significant adverse impacts associated with Alternatives 1A and 2 would also be minimal since the extent of shellfish aquaculture operations would be equal to or less than what currently exists. The elimination of aquaculture activities under Alternative 3 would result in potential significant adverse socio-economic impacts to the local shellfish industry and to baymen currently earning their income from the industry. The greatest amount of significant adverse impacts would occur under Alternative 4, based on the extreme scale of aquaculture activities. The following table (Table 41) represents the total acreage conceivable for each alternative and the potential impacts that would likely occur for each.

Table 41. Total Conceivable Acreage and Potential Impact Outcomes for Each Alternative

ALTERNATIVE	Alt. 1A Minimum Lease	Alt. 1B Minimum Lease Moderate Growth	Alt. 2 No Action	Alt. 3 Elimination of Aquaculture	Alt. 4 Unlimited Lease Growth
Total Conceivable Acreage of Leased Underwater lands per Alternative:	5,581	6,341	≤ 160	0	110,000
Potential Major Negative Impacts					
Geology	N	N	N	N	Y
Benthos	N	N	N	N	Y
Water column	N	N	N	N	Y
Water quality	N	N	N	N	Y
Submerged Aquatic Vegetation	N	N	N	N	Y
Sediment transport	N	N	N	N	Y
CNRAs	N	N	N	N	Y
Protected species	N	N	N	N	Y
User activities	N	N	N	N	Y
Potential Minor Negative Impacts					
Introduction of shellfish pathogens/diseases	N	N	N	N	Y
Harvest method impacts	N	N	N	N	Y
Sediment characteristics & benthos impacts	N	N	N	N	Y
Phytoplankton composition & nutrient cycling	N	N	N	N	Y
Restrictions on public access	N	N	N	N	Y
Maritime traditions	N	N	N	Y	Y
Employment/ incomes	N	N	N	Y	Y
Wild fishery industry	N	N	N	N	Y
Navigation	N	N	N	N	Y
Aesthetic values	N	N	N	N	Y
Energy	N	N	N	N	Y
Beneficial Impacts					
Economy (direct and support sectors)	N	Y	N	N	Y
Employment opportunities	N	Y	N	N	Y
Maritime traditions	N	Y	N	N	Y
Ecology	N	Y	N	N	N
Seafood production	N	Y	N	N	Y

Section 6.

Cumulative and Growth Inducing Impacts

6.1 Existing Aquaculture, Fishing/Shellfishing

The following describes and assesses how the adoption and implementation of the *Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay* will affect the existing level of aquaculture, fishing/shellfishing.

As leasing in the Peconic Estuary will be limited to sites beyond one-thousand feet from shore, intertidal issues are irrelevant. Also, it is extremely important to keep in mind that the magnitude of aquaculture proposed is neither intensive nor extensive, and that cumulative impacts, including on and off-site impacts (discussed in Section 4) are proportional to both the number and spatial extent of culture operations.

Much of the information concerning the cumulative impacts of shellfish aquaculture is found in the non-peer reviewed "gray" literature, which generally suggests that the impacts are largely scale related, with small scale operations often affecting only the area directly under the site (*i.e.*, "footprint" related), although multiple small sites may coalesce to disturb entire habitats (Vandermeulen et al. 2006).

Vandermeulen et al. note that aquaculture has "the potential to negatively impact sensitive marine habitats," and suggest that the effects can be controlled by a *bay scale management approach* which "places shellfish aquaculture within the context of other human activities in the system, including watershed activities that may affect the bay." They note that:

> "Bay wide management allows for the selection of reference sites (or even protected sites) to gauge impacts and protect sensitive habitats, and focuses monitoring methods at an appropriate scale to capture cumulative impacts. Bay wide management is also the only way to *control the pace of aquaculture development* and determine when the carrying capacity has

been reached – it is a true opportunity for *adaptive management that is informed by monitoring as a feedback loop*. The advantage to industry with this framework is a more informed (and therefore more predictable) management regime and a built in estimate of carrying capacity which allows for economically viable industry expansion, rather than overdevelopment and subsequent deterioration of bivalve growth rates or collapse." (italics have been added)

In their discussion of the effects of oyster culture on eelgrass, Vandermeulen et al. (ibid.) note that "once oyster aquaculture has been established on site, monitoring of sediment, eelgrass and native oyster health should occur for at least two years prior to the expansion of aquaculture operations. Expansion should be iterative, based upon proof of no harm with each iteration."

Although they are specifically addressing oyster culture and eelgrass beds, the concept of iterative expansion, if any, based on proof of "no harm" as determined by on site monitoring, combined with bay-wide (estuary-wide) management can be applied to any aquaculture operation and sensitive habitat.

The adoption and implementation of the *Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay* is likely to increase the area of estuary utilized for aquaculture operations, but carefully considered and controlled expansion, based on the iterative principle described above, can help protect sensitive habitats, avoid immediate and cumulative adverse impacts on present finfishing and/or shellfishing activities, and prevent industry overgrowth. While areas of bottom and surface water will become unavailable for finfishing or shellfishing, the lease program is designed to avoid currently, and potentially productive areas.

6.2 Shore-side Requirements

Shore-side requirements include access roads, docking space for boats, and staging areas for equipment. Facilities required may include hatcheries, grow-out facilities, product processing areas, and equipment storage buildings. The requirements are scale dependent

and related to economic viability, *i.e.*, how much infrastructure is required to develop a sufficiently profitable aquaculture operation? Individual hatcheries and grow-out facilities are unlikely to be necessary if seed can be obtained elsewhere at a reasonable price. Available shoreline real estate is both scarce and expensive, and adequate shoreline offloading and staging area could potentially negate the need for facilities, including processing and storage facilities, that could be sited farther inland. Roads required to access the shoreline offloading and staging areas must be constructed if not already available.

That many east end town and village Local Waterfront Revitalization Plans (LWRPs) include preservation of important water-dependent uses such as commercial fishing docks, fish-packing operations and other shore side infrastructure (a primary policy objective of East Hampton Town's LWRP), suggests that municipal assistance might be provided to ensure that the necessary shore side infrastructure can be accommodated.

For the proposed project, it is anticipated that existing shoreline facilities can accommodate the increase in shellfish aquaculture activities likely to occur over the next 10 years or more. Certain commercial facilities associated with fishing of wild stocks have declined in use as wild stocks have declined (e.g. bay scallops), and aquaculture activities may help to off-set some of this loss.

THIS PAGE INTENTIONALLY LEFT BLANK

Section 7
Unavoidable Adverse Impacts

Section 4 of this document evaluated the potential significant adverse impacts of the proposed *Shellfish Aquaculture Lease Management Program* and identified appropriate measures to mitigate each potential impact. Although most of the potential adverse impacts associated with the proposed Lease Program could be mitigated, few unavoidable impacts remain. The magnitude of these unavoidable impacts, however, like cumulative effects, is scale related.

Five unavoidable impacts have been identified under the proposed Lease Program and are listed below. Table 42 summarizes the unavoidable impacts and the mitigation measures that will lessen the degree of each impact.

1. Restricted Navigation

Leases in heavily trafficked areas and navigational channels were excluded from the Lease Program; however, in some areas, leases will restrict vessel navigation and boaters will be required to navigate around the boundaries of the lease. The degree of this impact is likely to be minimal, since leases will be limited in size and scale.

2. Loss of Access to Bottomlands

Recreational fishing for finfish would not be prohibited, and could benefit by the habitat provided by aquaculture structures. Commercial fishermen will be prohibited to harvest shellfish from leased grounds. At the lease holder's discretion, commercial whelk fishermen may be permitted to deploy conch pots on the lease site, an action that would be beneficial to the lease holder in terms of shellfish predator control. Shellfish harvesting at a lease site by recreational or commercial fishermen will only be permitted on bottomlands of off-bottom culture sites.

3. Loss of Access to Water Column

Commercial and recreational fishermen, as well as other recreational uses, would be restricted in some areas where submerged aquaculture gear would pose a hazard to such uses. However, the degree of this impact is likely to be minimal, since leases will be limited in size and scale.

4. Loss of Bottomlands to Other Species

Other benthic species, including SAV, may be precluded from a lease site; particularly those lease sites using on-bottom culture activities. SAV beds may be impacted by the direct placement of gear on the bay bottom or from shading effects from suspended gear. The degree of impacts to eelgrass is expected to be minimal, since leases will not be issued in areas of known eelgrass beds. In addition, no lease will be permitted within 1,000 ft of the shoreline where the majority of historic and current eelgrass beds are known to occur. Bottom-dwelling finfish will be restricted from areas where aquaculture gear (e.g. cages) rest directly on the bay bottom. The degree of impacts to bottom-dwelling finfish is expected to be minimal, since leases will be limited in size and scale.

5. Utilization of Shoreline Areas

Shellfish aquaculture will require the use of shoreline areas for the off-loading and staging associated with aquaculture operations. Off-loading and staging efforts will most likely take place at existing shoreline facilities, such as marinas and public boat ramps.

6. Escape of Cultured Bivalves

Hard clam culture involves broadcasting (i.e. planting) seed on the bay bottom. During this broadcasting process, it is not uncommon for some seed to intermittently escape into the wild (Blue Ocean Institute website, accessed from http://www.blueocean.org/seafood/species/65.html on February 7, 2008). However, the NYSDEC policy requires the use on native shellfish species only; therefore, any

escape would pose minimal, if any, risk to native populations or ecosystems. Escape via broadcast spawning may help to repopulate native shellfish populations.

Table 42. Unavoidable Impacts and Mitigation Measures

Impact	Mitigation
Restricted navigation	Maintain as small a footprint as possible and avoid important navigational areas (channels, approaches, etc.)
Loss of bay bottom to other users	Maintain as small a footprint as possible and restrict lease to non-used areas
Loss of water column to other users at some sites	Maintain as small a footprint as possible and restrict lease to non-used areas
Loss of bay bottom to other species	Avoid areas known to support, or are likely to support environmentally, economically, or recreationally important species
Utilization of shoreline area for off-loading and staging	Locate non-water dependent structures and activities inland. Consider cooperative facilities to minimize number of sites and to obtain economy of scale
Escape of Cultured Bivalves	NYSDEC Policy of Acceptable Origin of Shell and Shellstock for Introduction in New York

THIS PAGE INTENTIONALLY LEFT BLANK

Section 8
Irreversible and Irretrievable Commitment of Resources

The DGEIS will evaluate if the adoption and implementation of the *Shellfish Aquaculture Lease Program in Peconic and Gardiners Bays* would result in any irreversible and irretrievable commitments of resources.

It is believed that the proposed action will not result in an irreversible and irretrievable commitment of resources.

THIS PAGE INTENTIONALLY LEFT BLANK

Section 9
References

Alves, D. 2007. Aquaculture in Rhode Island 2006 Yearly Status Report. Coastal Resources Management Council, Wakefield, RI. 47 pp. http://www.crmc.state.ri.us/pubs/pdfs/aquareport06.pdf. Accessed 2/4/08.

Anderson, J., Spatz, M. 1997. Peconic Bay System Aquaculture. Economics Analysis, Inc. Prepared for the Peconic Estuary Program. Suffolk County Department of Health Services, Riverhead, NY. 55 pp.

Andrews, J. D. 1966. Oyster mortality studies in Virginia. V. Epizo- otiology of MSX, a protistan pathogen of oysters. Ecology 47: 19- 31.

Anestis, A., Lazou, A., Pörtner, H.O., Michaelidis, B. 2007**.** Behavioral, metabolic, and molecular stress responses of marine bivalve *Mytilus galloprovincialis* during long-term acclimation at increasing ambient temperature. Am J Physiol Regul Integr Comp Physiol 293: 911-92.

Arnold, W.S., White, M.W., Norris, H.A., Berigan, M.E. 2000. Hard clam (Mercenaria spp.) aquaculture in Florida, USA: geographic information system applications to lease site selection. Aquacult. Eng., 23: 203-223.

ASMFC 1998. Fishery Management Report No. 32, Management Report for Horseshoe Crab.

ASMFC 2000. Fishery Management Report No. 32a, Management Report for Horseshoe Crab.

ASMFC 2001. Fishery Management Report No. 32b, Management Report for Horseshoe Crab.

ASMFC 2004. Fishery Management Report No. 32c, Management Report for Horseshoe Crab.

ASMFC 2006. Fishery Management Report No. 32d, Management Report for Horseshoe Crab.

ASMFC 2007. Addendum XI to Amendment 3 to the American lobster fishery management plan.

Associated British Ports (ABP) Research 1997. Environmental Assessment of the deepening of Swansea Channel. ABP Research Report No. R701.

Atlantic States Marine Fisheries Commission. 2007. The Importance of Habitat Created by Molluscan Shellfish to Managed Species along the Atlantic Coast of the United States. Habitat Management Series #8 May 2007.

Auster P.J., Malatesta, R.J., Langton, R.W., Watling, L., Valentine, P.C., Donaldson, C.L.S., Langton, E.W., Shepard, A.N. & Babb, I.G. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish population. *Reviews in Fisheries Science,* 4: 185-202.

Baker, S.M., Heuberger, D., Phlips, E.J. and Sturmer, L.N. 2002. Water quality and its role on hard clam production. Cooperative Extension Services: University of Florida, Institute of Food and Agricultural Sciences.

Balla, R., L. Bavaro, C. deQuillfeldt and S. Miller. 2005. Peconic Estuary Program Environmental Indicators Report. Peconic Estuary Program. Riverhead, NY. 88pp.

Barber, B.J., Davis, C.V., Crosby, M.A. 1998. Cultured oysters, Crassostrea virginica, genetically selected for fast growth in the Damariscotta River, Maine, are resistant to mortality caused by juvenile oyster disease (JOD). Journal of Shellfish Research 17: 1171-1175.

Barber, B.J., Langan, R., Howell, T.L. 1997. Haplosporidium nelsoni (MSX) Epizootic in the Piscataqua River Estuary (Maine/New Hampshire, U.S.A.). Journal of Parasitology 83: 148-150.

Barnes, D., K. Chytalo, S. Hendrickson. 1991. Final Policy and Generic Environmental Impact Statement on Management of Shellfish in Uncertified Areas Program. NYSDEC. Division of Marine Resources. Stony Brook, NY. 79 pp.

Bartoli, M., Nizzoli, D., Viaroli, P., Turolla, E., Castaldelli, G., Fano, E.A., Rossi, R. 2001. Impact of Tapes philippinarum farming on nutrient dynamics and benthic respiration in the Sacca di Goro. Hydrobiologia 445:203-212.

Battelle. 2006. Final Report for Peconic Bay Pathogens TMDL. Prepared for U.S. Environmental Protection Agency. Oceans and Coastal Protection Division. 147 pp.

Black, K. P. and G. D. Parry. 1999. Entrainment, Dispersal, and Settlement of Scallop Dredge Sediment Plumes: Field Measurements and Numerical Modeling. Canadian Journal of Fisheries and Aquatic Science 56:2271-2281.

Boesch, D.F., Anderson, D.M., Horner, R.A., Shumway, S.E., Tester, P.A., Whitledge, T.E. 1997. Harmful algal blooms in coastal waters: options for prevention, control and mitigation. NOAA Coastal Ocean Program Decision Analysis Series No. 10.

Boettcher, K.J., Geaghan, K.K., Maloy, A.P., Barber, B.J. 2005. Roseovarius crassostreae sp. nov., a member of the Roseobacter clade and the apparent cause of juvenile oyster disease (JOD) in cultured Eastern oysters. International Journal of Systematic and Evolutionary Microbiology 55: 1531-1537.

Boettcher K., Smolowitz R., Lewis E., Allam B., Dickerson H., Ford S., Huq A., Reece K., Rivara G., Maloy A., Woodley C. 2006. Juvenile Oyster Disease (JOD) in *Crassostrea virginica*: synthesis of knowledge and recommendations. Journal of Shellfish Research 25(2): 683-686.

Bricelj, M., Kuenstner, S.H. 1989. Effects of the "brown tide" on the feeding physiology and growth of bay scallops and mussels, p. 491-509. In E. M. Cosper et al. [eds.], Novel phytoplankton blooms: Causes and impacts of recurrent brown tides and other unusual blooms. Springer.

Bricelj, V.M., Ford, S.E., Borrero, F.J, Perkins, F.O., Rivara, G., Hillman, R.E., Elston, R.A., Chang, J. 1992. Unexplained mortalities of hatchery-reared, juvenile oysters, Crassostrea virginica (Gmelin). Journal of Shellfish Research 11: 331-347.

Broekhuizen, N. Zeldis, J., Stephens, S.A., Oldman, J.W., Ross, A.H., Ren, J., James, M.R. 2002. Factors related to the sustainability of shellfish aquaculture operations in the Firth of Thames: a preliminary analysis. NIWA Client Report: EVW02243 pp. 112. National Institute of Water and Atmospheric Research Ltd., Hamilton, New Zealand.

Broekhuizen, N., Ren, J., Zeldis, J., Stevens, S. 2004. Ecological sustainability assessment for Firth of Thams shellfish aquaculture: Tasks 2-4 – Biological Modelling. Aukland Regional Council Technical Publication No. 253. 62 pp. + app. http://www.arc.govt.nz/shadomx/apps/fms/fmsdownload.cfm?file_uuid=6051900B-BCD4-1A24-95FB-27D8A2F2DBB4&siteName=arc. Accessed 10/16/07.

Bruno, J.F.; Bertness, M.D. 2001. Habitat modification and facilitation in benthic marine communities, *in*: Bertness, M.D. *et al.* (Ed.) (2001). *Marine community ecology*. pp. 201-218,

Buggé D, Allam B. (2007). Effects of starvation and macroalgae extracts on the survival and growth of Quahog Parasite Unknown (QPX). Journal of Experimental Marine Biology and Ecology 348: 60-69.

Bullard, S.G., Lambert, G., Carman, M.R., Byrnes, J., Whitlatch, R.B., Ruiz, G., Miller, R.J., Harris, L., Valentine, P.C., Collie, J.S., Pederson, J., McNaught, D.C., Cohen, A.N., Asch, R.G., Dijkstra, J., Heinonen, K. 2007. The colonial ascidian Didemnum sp. A: Current distribution, basic biology and potential threat to marine communities of the northeast and west coasts of North America. Journal of Experimental Marine Biology and Ecology 342: 99-108.

Burkholder, J.M. 1992. Water Column Nitrate Enrichment Promotes Decline of Eelgrass Zostera marina: Evidence from Seasonal Mesocosm Experiments. Marine Ecology Progress Series, Vol. 81, pp. 162-178.

Burkholder, J.M., H.B. Glasgow, E.J. Noga & C.W. Hobbs. 1993. The Role of a New Toxic Dinoflagellate in Finfish and Shellfish Kills in the Neuse and Pamlico Estuaries. Report No. 93-08, Albemarle-Pamlico Estuarine Study. Raleigh, North Carolina Department of Environment, Health & Natural Resources and U.S. Environmental Protection Agency - National Estuary Program, 58 pp.

Burreson, E.M., Stokes, N.A., Carnegie, R.B., Bishop, M.J. 2004. Bonamia sp. (Haplosporidia) found in non-native oysters Crassostrea in Bogue Sound, North Carolina. Journal of Aquatic Animal Health 16: 1-9.

Burreson, E.M., Stokes, N.A. and C.S. Friedman. 2000. Increased virulence in an introduced pathogen: *Haplosporidium nelsoni* in the eastern oyster *Crassostrea virginica*. J. Aquatic Animal Health 12: 1-8

Burreson, E.M., Avarez, R.S., Martinez, V.V., Macedo, L.A. 1994. Perkinsus marinus (Apicomplexa) as a potential source of oyster Crassostrea virginica mortality in coastal lagoons of Tabasco, Mexico. Diseases of Aquatic Organisms 20: 77-82.

Burreson, E.M. 1997. Molecular evidence for an exotic pathogen: Pacific origin of *Haplosporidium nelsoni* (MSX), a pathogen of Atlantic oysters. In: M. Pascoe (ed.). 10th International Congress of Protozoology, The University of Sydney, Australia, Monday 21 July - Friday 25 July 1997, Programme & Abstracts. Business Meetings & Incentives, Sydney, p. 62. (Abstract).

Burreson, E.M., Ragone Calvo, L.M. 1996. Epizootiology of Perkinsus marinus disease of oysters in Chesapeake Bay, with emphasis on data since 1985. Journal of Shellfish Research 15: 17-34.

Burreson, E.M., Andrews, J.D 1988. Unusual intensification of Chesapeake Bay oyster diseases during recent drought conditions. In: OCEANS '88. 'A Partnership of Marine Interests'. Proceedings. Virginia Institute of Marine Science; 799-802.

Butler, P.A. 1954. Summary of our knowledge of the oyster in the Gulf of Mexico. Fisheries Bulletin 55: 479-489.

Butler, P.A. 1949. Gametogenesis in the oyster under conditions of depressed salinity. Biological Bulletin 96: 263-269.

Buttner, J., Flimlin, G. and Webster, D. 1992. Aquaculture Systems for the Northeast, Northeast Region Aquaculture Center, NRAC Fact Sheet No. 120-1992.

Caddy, J.F. 1973. Underwater Observations on Tracks of Dredges and Trawls and Some Effects of Dredging on Scallop Ground. J. Fish. Res. Bd. Can. 30: 173-180.

Carlton, J.T. 1999. Molluscan invasions in marine and estuarine communities. Malacologia 41: 439-454.

Carlton, J.T. 1989. Man's role in changing the face of the ocean: biological invasions and implications for conservation of near-shore environments. Conservation Biology 3: 265-273.

Cashin Associates. 1996a. Final Submerged Aquatic Vegetation Study. Peconic Estuary Program. Suffolk County Department of Health Services. Riverhead, New York.

Cashin Associates. 1996b. Village of Sag Harbor- Harbor Management Plan. Prepared for the Village of Sag Harbor. Sag Harbor, NY.

Cashin Associates. 2002. Final Environmental Impact Statement for the Suffolk County Department of Public Works Maintenance Dredging Program (Draft).

Castel, J., Labourg, P.J., Escaravage, V., Auby, I., Garcia, M.E. 1989Influence of seagrass beds and oyster parks on the abundance and biomass patterns of meio- and macrobenthos in tidal flats.

Cembella, A.D.; Bauder, A.; Lewis, N.; Lawrence, J.; Manuel, J.; Lobsiger, U. 1997. Population dynamics and spatial distribution of phycotoxic microalgae asscociated with shellfish aquaculture sites in Nova Scotia. Presented at the Oceans 1997, 557.

Cerrato, R.M., Caron, D.A., Lonsdale, D.J., Rose, J.M., Schaffner, R.A. 2004. Effect of the northern quahog Mercenaria mercenaria on the development of blooms of the brown tide alga Aureococcus anophagefferens. Mar. Ecol. Prog. Ser. 281: 93-108.

Chamberlain, J., Weise, A.M., Dowd, M., Grant, J. 2006. Modeling approaches to assess the potential effects of shellfish aquaculture on the marine environment. Canadian Science Advisory Research Document 2006/032 50p.

Chanley, P.E. 1957. Survival of Some Juvenile Bivalves in Water of Low Salinity. Proc. National Shellfish Association, Vol. 48.

Chinabut, S., T. Somsiri, C. Limsuwan, and S. Lewis. 2006. Problems associated with shellfish farming. Rev. Sci. Tech. Off. Int. Epiz., 2006, 25 (2), 627-635.

Coast and Geodetic Survey. 1958. Tidal Current Chart, Long Island Sound. U.S. Department of Commerce. Serial No. 574 12 p.

Coen, L.D., Grizzle, E.R. 2007. The Importance of Habitat Created by Molluscan Shellfish to Managed Species along the Atlantic Coast of the United States. Atlantic States Marine Fisheries Commission Habitat Management Series #8.

Coen, L., Bobo, M.Y., Richardson, D., Anderson, W.D. 2004. Sheet for QPX (Quahog Parasite Unknown). South Carolina Department of Natural Resources, 10pp. http://www.dnr.sc.gov/marine/mrri/shellfish/QPX.pdf. Accessed 2/26/08.

Coen, Loren. 1995. A Review of the Potential Impacts of Mechanical Harvesting on Subtidal and Intertidal Shellfish Resources. South Carolina Department of National Resources. Marine Resources Research Institute. 46 pp.

Cole, R.G., Grange, K.R. 1996. Under the mussel farm. Seafood New Zealand, November: 25-26.

Colgan, C. S., Baker, C., Butterfield, N., & Cote, M. 2002. Assessing Maine's technology clusters. Portland, ME: University of Southern Maine, Edmund S. Muskie School of Public Service, Center for Business and Economic Research.

Cosper, E.M., Dennison W.C., Carpenter, E.J., Bricelj, V.M., Mitchell, J.G., Kuenstner, S.H., Colflesh, D. Dewey, M. 1987. Recurrent and persistent brown tide blooms perturb coastal marine ecosystem. Estuaries and Coasts 10: 284-290.

Cotroneo, N. 2007. Boat Rescuers Report Success Herding Dolphins in L.I. Waters. NY Times, January 2007.

Crago, T. 2000. Shellfish disease and aquaculture: scientists, managers, and growers take on the challenges. WHOI Sea Grant. http://seagrant.mit.edu/2ifbysea/issues/spring00/disease.html. Accessed on 2/1/08.

Cranford, P., Dowd, M., Grant, J., Hargrave, B., McGladdery, S. 2003. Ecosystem level effects of marine bivalve aquaculture. In: A Scientific Review of the Potential Environmental Effects of Aquaculture in Aquatic Ecosystems, Vol. I.: 51-95. Canadian Technical Report of Fisheries and Aquatic Sciences 2450, Fisheries and Oceans Canada, Ottawa.

Cummings, V.J.; Thrush, S.F.; Hewitt, J.E.; Funnell, G.A. 2001. Variable effect of a large suspension-feeding bivalve on infauna: experimenting in a complex system. *Marine Ecology Progress Series 209*: 159-175.

Currie, David and G. Parry. 1996. Effects of scallop dredging on a soft sediment community: a large-scale experimental study. Victorian Fisheries Research Institute. Marine Ecology Progress Series. Vol. 134: 131-150.

Dahl, S.F., Allam, B. 2007. Laboratory transmission studies of QPX disease in the hard clam: Development of an infection procedure. Journal of Shellfish Research 26: 383-389.

Dahlbäck, B.; Gunnarsson, L.Å.H. 1981. Sedimentation and sulphate reduction under mussel culture. Marine Biology 63: 269-275.

Daley, B. 2007. Rising temperatures throw nature a curve. The Boston Globe, Nov.13.

Davies, DeWitt S. 1980. Suffolk County's Role in the Development of Long Island's Oyster Industry: Concepts and Practices in Management of Shellfish Resources. p9.

Davis, C.V., Barber, B.J. 1999. Growth and survival of selected lines of eastern oysters, Crassostrea virginica (Gmelin) 1791) affected by juvenile oyster disease. Aquaculture 178: 253-271.

Davis, H.C. 1958. Survival growth of clam and oyster larvae at different salinities. Biological Bulletin 114: 296-307.

Dealteris, J.T., Kilpatrick, B.D., Rheault, R.B. 2004. A comparative evaluation of the habitat value of shellfish aquaculture gear, submerged aquatic vegetation and a non-vegetated seabed. Journal of Shellfish Research 23: 867-874

Dennison, W.C., G.J. Marshall and E. Wigand. 1989. Effect of Brown Tide Shading on Eelgrass (Zostera marina L.) Distributions. UMCEES Contribution No. 2035. Horn Point Environmental Labs, Center for Environmental and Estuarine Studies, University of Maryland, Cambridge, MD, pp. 675-692. In Cosper, E.M., V.M. Bricelj, and E.J. Carpenter. Novel Phytoplankton Blooms: Causes and Impact of Recurrent Brown Tides and Other Unusual Blooms. Springer-Verlag, Berlin, Germany.

Deslous-Paoli, J.M., Souchu, P., Mazouni, N., Juge, C., Dagault, F. 1998. Relations milieu-ressources: impact de la conchyliculture sur un environnement launaire mediterraneen (Thau). Oceanol. Acta 21: 831-843.

DFO. 2006. Assessing Habitat Risks Associated with Bivalve Aquaculture in the Marine Environment. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/005.

Dijkstra, J, Harris, L.G., Westerman, E. 2007. Distribution and long-term temporal patterns of four invasive colonial ascidians in the Gulf of Maine. Journal of Experimental Marine Biology and Ecology 342: 61-68.

Draper, C., Gainey, L., Shumway, S., Shapiro, L. 1990. Effects of Aureococcus anophagefferens ("brown tide") on the lateral cilia of 5 species of bivalve molluscs, p. 128-l 31. In Toxic marine phytoplankton: Proc. 4th Int. Conf. Elsevier.

Drobeck, K.G. and M.L. Johnston. 1982. Environmental Impact of Hydraulic Escalator Dredging on Oyster Communities. Final Report to Maryland Department of Natural Resources. UMCEES Reference No. 82-5 CBL. Solomons, Maryland. 97 p.

Eastern Oyster Biological Review Team. 2007. Status review of the eastern oyster (Crassostrea virginica). Report to the National Marine Fisheries Service, Northeast Regional Office. February 16, 2007. 105 pp.

Eble, editors. The Eastern Oyster Crassostrea virginica. Maryland Sea Grant College, University of Maryland, College Park, Maryland. pp. 467-513.

Economic Analysis, Inc., (EAI) 1999. Recreational and Resource Economic Values for the Peconic Estuary System, Prepared for the Peconic Estuary Program.

Everett, R.A., Ruiz, G.M., Carleton, J.T. 1995. Effect of oyster mariculture on submerged aquatic vegetation: an experimental test in a Pacific Northwest estuary. Mar. Ecol. Prog. Ser. 125:205-217.

Eleftheriou, A. and M.R. Robertson. 1992. The Effects of Experimental Scallop Dredging on the Fauna and Physical Environment of a Shallow Sandy Community. Neth. J. Sea Res. 30: 289-299.

Energy and Environmental Analysts (EEA), Inc. 1999. Eelgrass Habitat Criteria Study Volume I. Peconic Estuary Program. Suffolk County Department of Health Services. Office of Ecology Riverhead, New York.

Eversole, A.G.,1987. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (mid-Atlantic): Hard Clam." U.S.Fish and Wildlife Service Biological Report 82(11.75).U.S.Army Corps of Engineers TR EL-82-4

Fay, C.W., R.J. Neves, and G.B. Pardue. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic) – bay scallop. US Fish and Wildlife Service, Division of Biological Services, FWS/OSB-82/11.12. US Army Corps of Engineers, TR EL-82-4. 17 pp.

Felsing, M. and T. Petch. 2007. Report to Environment Committee - Potential ecological impacts of the marine farming of fish. File No. 22 03 74.

Ferreira, J.G., Duarte, P., Ball, B. 1998. Trophic capacity of Carlington Lough for oyster culture – analysis by ecological modeling. Aquatic Ecology 31: 361-378.

Ferreira, J.G., Hawkins, A.J.S., Bricker, S.B. 2007a. Management of productivity, environmental effects and profitability of shellfish aquaculture – the Farm Aquaculture Resource Management (FARM) model. Aquaculture 264: 160-174.

Ferreira, J.G., Hawkins, A.J.S., Monteiro, P., Service, M., Moore, H., Edwards, A., Gowen, R., Lourenco, P., Mellor, A., Nunes, J.P., Pascoe, P.L, Ramos, L., Sequeira, A., Simas, T., Strong, J. 2007b. SMILE -Sustainable Mariculture in northern Irish sea Lough Ecosystems - Assessment of carrying capacity for environmentally sustainable shellfish culture in Carlingford Lough, Strangford Lough, Belfast lough, Larne Lough and Lough Foyle. IMAR Institute of Marine Research, Lisbon. 100 pp.

Flemer, D.A. 1970. Subsection Phytoplankton. Project B. Chesapeake Biological Laboratory Reference No. 69-15. 15p.

Flimlin, G. 2002. Nursery and Growout Methods for Aquacultured Shellfish. Northeast Regional Aquaculture Center, NRAC Publication No. 00-002

Flood, R. and R. Cerrato. 2007. Benthic Mapping and Habitat Classification in the Peconic Estuary, Phase II Interim, Report - November 2006 to July 2007. Marine Sciences Research Center. Stony Brook University. Stony Brook, NY. Prepared for The Nature Conservancy, Long Island Chapter.

Flood, R., J. Kinney, and M. Weaver. 2006. Underwater Landscape Evolution in the Peconic Bays (Long Island, NY) as revealed by High-Resolution Multibeam Mapping. American Geophysical Union, Fall Meeting 2006, abstract #H33B-1506.

Food and Drug Association, 2003. Guide for the Control of Molluscan Shellfish. National Shellfish Sanitation Program. U.S. Food and Drug Association, Department of Health and Human Services.

Ford, S.E. 1996. Range extension by the oyster parasite Perkinsus marinus into the northeastern United States: response to climate change? Journal of Shellfish Research 15: 45-56.

Ford, S.E., J.N. Kraeuter, R.D. Barber, G. Mathis, 2002. Aquaculture-associated factors in QPX disease of hard clams: density and seed source. Aquaculture 208:23-38

Ford, S.E., Ragone Calvo, L.M., Barber, R.D., Kraeuter, J.N. 1997. Evidence that QPX (Quahog Parasite Unknown) is not present in hatchery-produced hard clam seed. Journal of Shellfish Research, 16: 519-521.

Ford, S.E., Tripp, M.R. 1996. Diseases and defense mechanisms. In The eastern Oyster Crassostrea virginica (R.E.I. Newell, V.S. Kennedy, and A.F. Eble, eds.) Maryland sea grant College pp. 384-450.

Forrest, B.M., Creese, R.G. 2006. Benthic impacts of intertidal oyster culture, with consideration of taxonomic sufficiency. Env. Mon. Assess. 112: 159-176.

Francis, M.P. 1993. Does water temperature determine year class strength in New Zealand snapper (Pagrus auratus, Sparidae)? Fisheries Oceanography 2: 65–72.

Friends of West Bay, Inc., 2007. Maintaining the Balance Between Private Aquaculture and the Public's Use of the Three Bays: the need to ban floating bag systems and other equipment intensive aquaculture. Report #220. Friends of West Bay, Inc., Osterville, MA. 26 p.

Fulwieler, R.W., Nixon, S.W., Buckley, B.A., Granger, S.L. 2007. Reversal of the net dinitrogen gas flux in coastal marine sediments. Nature 448: 180-182.

Gainey, L.E., JR., Shumway, S.E. 1991. The physiological effect of Aureococcus anophagefferens ("brown tide") on the lateral cilia of bivalve mollusks. Biol. Bull. 181: 298-306.

Galtsoff, P.S. 1964. The American oyster, Crassostrea virginica Gmelin. Fisheries Bulletin 64: 1-480.

Getchis, T. S. 2007. Can Eelgrass and Shellfish Aquaculture Coexist? Balancing the Needs of Connecticut's Environment and Economy. Wrack Lines 7:2. http://www.seagrant.uconn.edu/WL11/eelgrass.pdf. Accessed 2/28/08

Getchis, T.S. 2005. What's putting some aquaculturists in a "foul" mood? Fouling organisms are taking their toll on marine aquaculture. Wrack Lines, 5: 8–10.

Gibbs, M.T. 2004. Interactions between bivalve shellfish farms and fishery resources. Aquaculture 240: 267-296.

Gibbs, M.M., Pickmere, S.E., Woods, P.H., Payne, G.W., James, M.R., Hickman, R.W., Illingworth, J. 1992. Nutrient and chlorophyll *a* variability at six stations associated with mussel farming in Pelorus Sound, 1984-1985. New Zealand Journal of Marine and Freshwater Research 26: 197-211.

Gibbs, M., Ross, A., Downes, M. 1992. Nutrient cycling and fluxes in Beatrix Bay, Pelorus Sound, New Zealand. New Zealand Journal of Marine and Freshwater Research, 2002, Vol. 36: 675–697.

Glude, J.B., 1955. The effects of temperature and predators on abundance of the soft-shell clam, Mya arenaria, in New England. Transactions of the American Fisheries Society 84: 13-26.

Gobler, C.J., Berry, D.L., Anderson, O.R., Burson, A, Koch, F., Rodgers, B.S., Moore, L.K., Goleski, J.A., Allam, B., Bowser, P., Tang, Y., Nuzzi, R. 2008. Characterization, dynamics, and ecological impacts of harmful Cochlodinium polykrikoides blooms on eastern Long Island, NY, USA. Harmful Algae 7: 293-307.

Godwin, W.F. 1973. Preliminary Draft: Environmental Impact Analysis of Proposed Hydraulic Clam Dredging Activity in the New River Estuary, Onslow County, North Carolina. Use of seed oysters to supplement oyster production in southern North Carolina, 19 pp.

Golen, R.F. Undated. Incorporating shellfish bed restoration into a nitrogen TMDL implementation plan. Charlton College of Business, University of Massachusetts Dartmouth. North Dartmouth, Massachusetts. 13 p.

Grant, J., Hatcher, A., Scott, D.B., Pocklington, P., Shafer, C.T., Winters, G.V. 1995. A multidisciplinary approach to evaluating impacts of shellfish aquaculture on benthic communities. Estuaries 18: 124-144.

Grange, K. R., Cole, R. G. 1997. Mussel farming impacts. Aquaculture Update 19: 1–3.

Grenz, C., Hermin, M., Baudinet, D., Daumas, R. 1990. In-situ biochemical and bacterial variation of sediments enriched with mussel deposits. Hydrobiologia 207: 153-160.

Grizzle, R.E., Langan, R., Howell, W.H. 1992. Growth responses of suspension-feeding bivalve mollusks to changes in water flow: differences between siphonate and nonsiphonate taxa. Journal of Experimental Marine Biology and Ecology 162:213-228.

Haamer, J. 1996. Improving water quality in a eutrophied fjord system with mussel farming. AMBIO 25: 356-362.

Hadley, N, Coen, L. Undated. Hard clams: *Mercenaria mercenary, M. campechiensis.* http://www.dnr.sc.gov/cwcs/pdf/Hardclam.pdf. Accessed 1/2/08.

Hall-Spencer, J.M. and P.G. Moore. 2000. Impact of scallop dredging on maerl grounds. In Effects of Fishing on Non-Target Species and Habitats, Kaiser, M.J. and S.J. de Groot (eds.). Blackwell, Oxford, UK.

Hardy, C.D. 1976. Preliminary description of the Peconic Bay Estuary. Marine Sciences research Center, State University of New York at Stony Brook. Special Report 3.

Hauton C, J.M Hall-Spencer and P.G Moore. 2003. An experimental study of the ecological impacts of hydraulic bivalve dredging on maerl. ICES Journal of Marine Science: 60(2):381-392; doi:10.1016/S1054-3139(03)00015-8.

Haskin, H.H., Stauber, L.A., Mackin, J.A. 1966. Minchonia nelsoni n. sp. (Haplosporida, Haplosporidiidae): causative agent of the Delaware Bay oyster epizootic. Science 153: 1414-1416.

Heck, K.L., Jr., Valentine, J.F. 2007. The primacy of top-down effects in shallow benthic ecosystems. Estuaries and Coasts 30: 371-381.

Hegaret H., Shumway S., Wikfors, G., Pate, S., Burkholder, J. 2006. Potential transport of harmful algae through relocation of bivalve molluscs. http://epa.gov/scienceforum/2006/pdfs/global_challenges_final_posters/GC-82_Shumway.pdf. EPA Science Forum. Accessed 10/2/07.

Hershner, C., Woods, H. 1999. Shallow Water Resource Use Conflicts: Clam Aquaculture and Submerged Aquatic Vegetation. Center for Coastal Resources Management, Virginia Institute of Marine Science, Gloucester Pt. VA, USA. Technical Report. 60 pp. http://ccrm.vims.edu/projreps/clamaqua_sav.pdf. Accessed 11/20/07.

Hirsh, Nina, L. DiSalvo, and R. Peddicord. 1978. Effects of Dredging and Disposal on Aquatic Organisms. US Waterways Experiment Station. Springfield, VA.. Technical Report DS-78-5. 41 p.

Hoagland, P., H.L. Kite-Powell and D. Jin. 2003. Woods Hole Oceanographic Institution: Business Planning Handbook for the Ocean Aquaculture of Blue Mussels. Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. 31 pp.

Hoffman, E.E., J.M. Klinck, V.M. Bricelj, J.N. Kraeuter, E.N. Powell, and S. Buckner. Undated. A modeling study of the Growth, Survival and Recruitment of hard clam (*Mercenaria mercenaria*) larval and post-settlement populations. Haskin Shellfish Research Laboratory. Rutgers University. Accessed from www.hsrl.rutgers.edu/ hardclam.html.

Hofstetter, R.P. 1977. Trends in population levels of the American oyster, Crassostrea virginica Gmelin on public reefs in Galveston Bay, Texas. Technical Series Number 10. Texas Parks and Wildlife Department, Coastal Fisheries Branch, Austin, TX. pp. 90.

Horsted, S.J., Nielson, T.G., Rieman, B., Pock-Steen, J., Bjornsen, P.K. 1988. Regulation of zooplankton by suspension-feeding bivalves and fish in estuarine enclosures. Marine Ecology progress series 48: 217-224. http://www.ices.dk/pubs/crr/crr265/crr265.pdf. Accessed 10/11/07.

ICES. 2007. Status of introductions of non-indigenous marine species to the North Atlantic and adjacent waters 1992–2002. ICES Cooperative Research Report No. 284. 149 pp. http://www.ices.dk/pubs/crr/crr284/CRR284.pdf. Accessed 10/11/07.

ICES 2004. Trends in important diseases affecting fish and mollusks in the ICES area 1998-2002. Prepared and edited by the Working Group on Pathology and Diseases of Marine Organisms. ICES Cooperative research Report No. 265. 26 pp.

ICES. 2003. ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2003 http://www.ices.dk/). Accessed 10/11/07.

ICES. 1995. ICES Code of Practice on the Introductions and Transfers of Marine Organisms 1994 / Code de Conduite du CIEM pour les Introductions et Transferts d'Organismes Marins 1994. Copenhagen K Denmark. www.ices.dk/pubs/itmo.pdf. Accessed 10/11/07.

ICES. 1994 Report of the ICES Advisory Committee on the Marine Environment, Annex 3. ICES Cooperative Research Report No. 204. 122 p.

Ingle, R. 1950. Summer growth of the American oyster in Florida waters. Science 112: 338-339.

Ingle, R.M., Dawson, C.E. 1952. Growth of the American oyster, Crassostrea virginica (Gmelin) in Florida waters. Bulletin of Marine Science Gulf and Caribbean 2: 293-404.

Inglis, G.J., Hayden, B.J., Ross, A.H. 2000. An overview of factors affecting the carrying capacity of coastal embayments. NIWA Client Report: CHC00/69. Prepared for the Ministry of the Environment by the National Institute of Water & Atmospheric Research, Christchurch, New Zealand.

Interim Final 10-Year Plan for the NOAA Aquaculture Program, November 2006

IUCN. 2000. IUCN guidelines for the prevention of biodiversity loss caused by alien invasive species. IUCN Information Paper 21 pp. http://www.issg.org/infpaper_invasive.pdf. Accessed 10/11/07.

Jamieson, G.S., L. Chew, G. Gillespie, A. Robinson, L. Bendell-Young, W. Heath, B. Bravender, A. Tompkins, D. Nishimura, and P. Doucette. 2001. Phase 0 Review of the Environmental Impacts of Intertidal Shellfish Aquaculture in Baynes Sound. Canadian Science Advisory Secretariat. Research Document 2001/125.

Kaiser, M.J., Laing, I., Utting, S.D., Burnell, G.M. 1998. Environmental impacts of bivalve mariculture. Journal of Shellfish Research 17: 59-66.

Kasner, Jeffrey. 1995. A History of the Shellfish Industries of the Peconic Estuary. Unpublished.

Kaspar, H.F.; Gillespie, P.A.; Boyer, I.C.; MacKenzie, A.L. 1985. Effects of mussel aquaculture on the nitrogen cycle and benthic communities in Kenperu Sound, Marlborough Sounds, New Zealand. Marine Biology 85(2): 127-136.

Kautsky, N. 1982. Growth and size structure in a Baltic Mytilus edulis population. Marine Biology 68: 117-133.

Kelaher, B.P. Castilla, J.C., Prado, L. 2007. Is there redundancy in bioengineering for molluscan assemblages on the rocky shores of central Chile? Revista Chilena de Historia Natural 80: 173-186.

Keller, A.A., Klein-MacPhee, G. 2000. Impact of elevated temperature on the growth, survival, and trophic dynamics of winter flounder larvae: a mesocosm study. Can. J. Fish. Aquat. Sci. 57: 2382–2392.

Kennedy, R.J., Roberts, D. 2006. Commercial oyster stocks as a potential source of larvae in the regeneration of Ostrea edulis in Strangford Lough, Northern Ireland. J. Mar. Biol. Assoc. U.K. 86:153-159.

Kraus, Richard. 1995. Status of Shellfish Aquaculture in Southeastern Massachusetts. Aquacultural Research Corporation. Dennis, Massachusetts. 3 p. Accessed from http://www.nefsc.noaa.gov/nefsc/publications/tm/tm109/tm109kraus.htm.

Kyte, M.A. and K. K. Chew. 1975. A Review of the Hydraulic Escalator Shellfish Harvester and its Known Effects in Relation to the Soft-Shell Clam, Mya arenaria. Washington Sea Grant Program WSG 75-2. University of Washington. 30 p.

Landry, T. 2002. The potential role of bivalve shellfish in mitigating negative impacts of land use on estuaries. In Effects of land use practices on fish, shellfish, and their habitats on Prince Edward Island, Can. Tech. Rep. Fish. Aquat. Sci 2408. Edited by D.K. Cairns. Pp. 155-157.

Lang, S. Undated. An Economic and Social Evaluation of an Oyster Mariculture Training Program for Long Island Commercial Fisherman. East End Economic and Environmental Institute, Inc. 88 p.

Lewis, D., Rivara, G. 1998. An Assessment of Shellfish Resources in the Tributaries and Embayments of the Peconic Estuary. Marine Program, Cornell Cooperative Extension of Suffolk County. Special Report 98-101.

Lewis, D., Kassner, J., Cerrato, R., Finch, R. 1997. An Assessment of Shellfish Resources in the Deep Water Areas of the Peconic Estuary. Marine Science Research Center. State University of Stony Brook. 28 p.

Long Island North Shore Heritage Area. 2006. Accessed on October 2, 2007 from http://linorthshoreheritagearea.com

Long Island Regional Planning Board. 1979. Assessment of Existing Mariculture Activities in the Long Island Coastal Zone and Potential for Future Growth.

Loosanoff, V.L. 1948. Gonad development and spawning of oysters (O. virginica) in low salinities. Anat. Rec., 101:55.

Loosanoff. V.L. and Engle, J.B. 1940. Spawning and setting of oysters in Long Island Sound in 1937 and discussion on the method for the predicting of the intensity and time of oyster setting. Bulletin of the United States Bureau of Fisheries 49: 217-255.

Loosanoff, V. L., H. C. Davis. 1950. Conditioning *V. mercenaria* for spawning in winter and breeding its larvae in the laboratory. Biological Bulletin 98(1): 60-65.

Lorio, Wendel, J.,Malone, S. Biology and Culture of the Northern Quahog (Mercenaria mercenaria), Southeastern Regional Aquaculture Center, SRAC Publication No. 433.

Losordo, Thomas M., J. Hinshaw, S. Gabel, M. Frinsko, S. Thompson, M. Sandfoss, M. Parker, D. Sloan. 2006. North Carolina Aquaculture Update 2005. Presentation for the 2006 NC Aquaculture Development Conference. Accessed from www.agr.state.nc.us/markets/aquaculture/statistics.htm# on January 15, 2008.

Lunz, R.G. 1938. Part I. Oyster Culture with Reference to Dredging operation in South Carolina. Rpt to US Engineer Office, Charleston, SC.

Lutz, R.A., Hidu, H., Drobeck, K.G. 1970. Acute temperature increase as a stimulus to setting in the American oyster, Crassostrea virginica (Gmelin). Proceedings of the National Shellfisheries Association 60: 68-71.

MacKenzie, C.L., A. Morrison, D.L. Taylor, V.G.Burrell, Jr., W.S. Arnold and A.T. Wakida-Kusonoki. 2002. Quahogs in Eastern North America: Part I, Biology , Ecology, and Historical Uses. Marine Fisheries Review. 64(2):55 pp.

MacPhail, J. S. 1961. A hydraulic escalator harvester. Fish. Res. Board Can. Bull. 128:24 p.

Malinowski, S. 2007. The incidence of juvenile oyster disease at Fishers Island Oyster Farm, Fishers Island, NY. Abstracts of Technical Papers of the Milford Aquaculture Seminar. Journal of Shellfish Research 25, 2: 682-683.

Malinowski, K.C. and Ramus, J. 1973. Growth of the green alga Codium fragile in a Connecticut estuary. Journal of Phycology 9:102-110.

Mallet, A.L., Carver, C.E., & Landry, T. 2006. Impact of suspended and off-bottom Eastern oyster culture on the benthic environment in eastern Canada. Aquaculture, 255, 362-373.

Maloy, A., S.E. Ford, R.C. Karney and K.J. Boettcher. 2007. *Roseovarius crassostreae*, the etiological agent of Juvenile Oyster Disease (now to be known as *Roseovarius*

Oyster Disease) in *Crassostrea virginica*. Aquaculture, Volume 269, Issues 1-4, 14 September 2007, Pages 71-83.

Mann, R, Evans, D.A. 2004. Site selection for oyster habitat rehabilitation in the Virginia portion of the Chesapeake Bay: A commentary. Journal of Shellfish Research 23: 41-50.

Mariculture Technologies, Inc. 1995. Draft Environmental Impact Statement Relating to the Proposed Finfish Aquaculture Project for the Production of Summer Flounder (*Paralichthys dentatus*), prepared by Peconic Associates and Suffolk Environmental Consulting, Inc.

Martin, J.L.M., Sornin, J.M., Marchand, M., Depauw, N., Joyce, J. 1991. The siginificance of oyster biodeposition in concentrating organic matter and contaminants in the sediment. In Aquaculture and the Environment, Special Publication of the European Aquaculture Society, No. 14. Edited by N. Depauw and J. Joyce. Pp. 207.

Massachusetts Office of Coastal Zone Management. 1995. Massachusetts Aquaculture White Paper - Shellfish Bottom and Off-Bottom Culture. Boston, MA. 14 p.

Mattice JS, Bosworth W. 1979. Modified Venturi Suction Sampler for Collecting Asiatic Clams. The Progressive Fish-Culturist: Vol. 41, No. 3 pp. 121-123.

Mattsson, J., Lindén, O. 1983. Benthic macrofauna succession under mussels, Mytilus edulis L. (Bivalvia), cultured on hanging long-lines. Sarsia 68: 97-102.

McKindsey, C.W., Anderson, M.R., Barnes, P., Courtenay, S., Landry, T., Skinner, M., 2006a. Effects of shellfish aquaculture on fish habitat. Canadian Science Advisory Secretariat Research Document 2006/011: 84 p.

McKindsey, C.W., Thetmeyer, H., Landry, T., Silvert, W. 2006b. Review of recent carrying capacity models for bivalve culture and recommendations for research and management. Aquaculture 261: 451–462.

McKindsey, Christopher W., T. Landry, F. O'Beirn, and I. Davies. 2007. Bivalve Aquaculture and Exotic Species: a review of ecological considerations and management issues. Journal of Shellfish Research, Vol. 26, No. 2, 281-294

McKown, K., Burgess, R., Heins, S. 2006. Fishery dependent monitoring of the American lobster (Homarus americanus) and horseshoe crab (Limulus polyphemus) in the marine district of Long Island, NY. USDOC, NOAA, NMFS Northeast Region State Federal & Constituent Programs Office, Interjurisdictional Fisheries Act of 1986, Title III of P.L. 99-659, Completion Report. http://www.nero.noaa.gov/statefedoff/grants/InterjurisdictionalFisheriesAct/NA03NMF4070198.pdf. Accessed 12/17/07.

Menge, B.A., Daley, B.A., Lubchenco, J., Sanford, E., Dahldoff, E., Haplin, P.M. Hudson, G., Burnaford, J.L. 1999. Top-down and bottom-up regulation of New Zealand rocky intertidal communities. Ecological Monographs 69: 297-330.

Monica J. Powers, Charles H. Peterson, Henry C. Summerson, Sean P. Powers. 2007. Macroalgal growth on bivalve aquaculture netting enhances nursery habitat for mobile invertebrates and juvenile fishes, Marine Ecology Progress Series, Vol. 339: 109-122.

Moore, K. A. and R. J. Orth. 1997. Evidence of widespread destruction of submersed aquatic vegetation (SAV) from clam dredging in Chincoteague Bay, Virginia. Report to the Virginia Marine Resources Commission. 6 pp.

Morreale, Stephen J., and E.A. Standora. 1994. Occurrence, movement and behavior of the Kemp's ridley and other sea turtles in New York waters. Final Report to NYS Department of Environmental Conservation, Return a Gift to Wildlife Program, April 1988-March 1993.

Morreale, Stephen J., C.F. Smith, K. Durham, R. DiGiovanni, and A. Aguirre. 2005. Assessing Health, Status and Trends in Northeastern Sea Turtle Populations. Interim report, September 2002 through November 2004. Protected Resources Division. Department of Natural Resources. Cornell University, Ithaca, NY. 41 pp.

Morrisey, D.J.; Swales, A. 1996. Towards the development of guidelines for the sustainable management of aquaculture in the Auckland Region. No. 170 p.

Mullen, D.M., and J.R. Moring. 1986 Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic) - Sea Scallop. U.S. Fish and Wildlife Service, Biol. Rep. 82 (11). U.S. Army Corps of Engineers, TR EL-82-4.

Murray, Thomas. 2005. Economic Activity Associated with Clam Aquaculture in Virginia – 2004. Department of Fisheries Science. Virginia Institute of Marine Science. Gloucester Point, VA. Report No. VSG-05-05. 14 pp.

Murray, Thomas J., and Michael J. Oesterling. 2006. Virginia shellfish aquaculture; situation and outlook report: Results of the Virginia shellfish aquaculture crop reporting survey 2004-2006. Virginia Institute of Marine Science. Gloucester Point, VA. Report No. VSG-06-05. 5p.

Murray, Thomas and M. Oesterling. 2007. Virginia Shellfish Aquaculture Situation and Outlook Report, Results of the Virginia Shellfish Aquaculture Crop Reporting Survey 2005-2007. Virginia Institute of Marine Science. Gloucester Point, VA. Report No. VSG-07-02.

National Marine Fisheries Service. Guide to Essential Fish Habitat Designations in the Northeastern United States. National Oceanic and Atmospheric Administration, Northeast Region. Accessed on August 8, 2007 from www.nero.noaa.gov/hcd/STATES4/ConnNYNJ.htm

National Oceanic and Atmospheric Administration. 2006. U.S. Commercial Landings.

National Research Council. 2002. Effects of Trawling and Dredging on Seafloor Habitat. Committee on Ecosystem Effects of Fishing: Phase I - Effects on Bottom Trawling on Seafloor Habitats. Ocean Studies Board. Division of Earth and Life Studies. Library of Congress Control Number: 2002105183.

Natural Heritage Program. NYSDEC. Division of Fish, Wildlife and Marine Resources. Personal communication, June 2007.

Nature Conservancy. 2002. Final Report Peconic Bays Aquaculture Advisory Committee.

Naylor, R.L., Williams, S.L., Strong, D.R. 2001. Aquaculture—a gateway for exotic species. Science 294: 1655-1656.

NEMAC. 2001. Northeastern Massachusetts Aquaculture Center NEMAC News, Vol. 2. http://www.salemstate.edu/biology/aquaculture/newsletter3.pdf. Accessed 2/1/08.

New York State Department of Agriculture and Markets 2004. Commissioner promotes "pride of New York seafood". http://www.agmkt.state.ny.us/AD/release.asp?ReleaseID=1349. Accessed 12/17/07.

New York State Historic Preservation Office. http://www.oprhp.state.ny.us/nr/main.asp accessed on 9/26/2007.

Newell, R.I.E. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North and Mid-Atlantic) -blue mussel. U.S. Fish and Wildlife Service. Biol. Rep. 82 (11.102). US Army Corps of Engineers, TR E1-82-4. 25 pp.

Newell, R.I.E. 2004. Ecosystem influences of natural and cultivated populations of suspension-feeding bivalve molluscs: A review. Journal of Shellfish Research 23: 51-62.

Newell, R.I.E., Kennedy, V.S., Shaw, K.S. 2007. Comparative vulnerability to predators, and induce defense response, of eastern oyster Crassostrea virginica and non-native Crassostrea ariakensis oysters in Chesapeake Bay. Marine Biology 152: 449-460.

Newell, R.I.E., Langdon, C.J. 1996. Mechanisms and physiology of larval and adult feeding. In: V.S. Kennedy, R.I.E. Newell and A.F. Able, (eds.). The Eastern

Oyster Crassostrea virginica. Maryland Sea Grant College, University of Maryland, College Park. Pp. 185-229.

NMFS 2007. Commercial Fisheries Statistics. http://www.st.nmfs.noaa.gov/pls/webpls/MF_ANNUAL_LANDINGS.RESULTS. Accessed 12/17/07.

NOAA 2007. Monitoring Weather and Climate. http://www.cpc.noaa.gov/products/precip/CWlink/pna/JFM_season_nao_index.shtml. Accessed 2/20/08.

Nugues M.M., Kaiser, M.J., Spencer B.E., Edwards, D.B. 1996. Benthic community changes associated with intertidal oyster cultivation. Aquaculture Res. 27: 913-924.

Nuzzi, R. 2004. Cochlodinium polykrikoides in the Peconic Estuary. Harmful Algae News 27: 10-11.

Nuzzi, R. 2005. Nitrogen Trends in the Peconic Estuary, 1976 – 2004. Final Report in fulfillment of USEPA FY98 Nutrient Criteria Grant. Suffolk County Department of Health Services, Hauppauge, NY. 22 pp.

Nuzzi, R. 2007. Remote Sensing Aspects in Wetland Management. 10th Annual Watersheds & Wetlands Workshop, October 22 – October 25, 2007. Ocean City, MD.

Nuzzi, R., Waters, R.M. 2004. Long-term perspective on the dynamics of brown tide blooms in Long Island coastal bays. Harmful Algae 3: 279-293

NYSDEC 2007. ECL §40.5 Net fishery limits – mesh sizes and gear. http://www.dec.ny.gov/regs/4015.html. Accessed 12/10/07.

NYSDEC 2007b. ECL §40.6 Fish Pots or Traps. http://www.dec.ny.gov/regs/4015.html. Accessed 12/10/07.

NYSDEC. 1982. Assessment of New York's shellfish resources. Completion report prepared by New York State Department of Environmental Conservation for the National Oceanic and Atmospheric Administration. 161 pp.

NYSDEC. NYS Breeding Bird Atlas 2000-2005. Accessed from www.dec.ny.gov on September 10, 2007.

NYSDEC. Shellfish Area Updates, Recent Changes to Shellfish Area Descriptions. Accessed from http://www.dec.ny.gov/outdoor/7765.html on June 11, 2007.

NYSDEC Website: Part 59, State Boat-Launching Sites, Fishing-Access Sites and Fishing Rights Areas (No Date Provided) http://www.dec.ny.gov/ regs/3996.html Accessed 10/5/2007.

NYSDEC Website: 6 NYCRR Part 617, State Environmental Quality Review (Amended 6/26/2000) http://www.dec.state.ny.us/website/regs/part617.html Accessed 4/4/2007.

NYSDEC Website: Water Quality Certifications for Projects Requiring a Federal Permit (No Date Provided) http://www.dec.ny.gov/website/permits/6546.html Accessed 2/27/2008.

New York State Department of State. (1997). South Shore Estuary Reserve Technical Report Series: Underwater Lands and the Public Trust Doctrine.

New York State Department of State (NYSDOS) Division of Coastal Resources Web Site (Date Not Provided): Consistency Review http://www.nyswaterfronts.com/consistency.asp Accessed 12/3/2007.

NYSDOS Division of Coastal Resources Web Site (Copyright 2004): Coastal Resources Online, Federal Consistency http://www.nyswaterfronts.com/consistency_federal.asp Accessed 2/27/2008.

NYSDOS Division of Coastal Resources Web Site (Copyright 2004): Coastal Resources Online, Local Waterfront Revitalization Program (LWRP) http://www.nyswaterfronts.com/aboutus_LWRP.asp Accessed 9/11/2007.

NYSDOS Division of Coastal Resources Web Site (Copyright 2004): Coastal Resources Online, New York State Coastal Policies http://www.nyswaterfronts.com/consistency_coastalpolicies.asp Accessed 2/27/2008.

NYSDOS Division of Coastal Resources Web Site (Copyright 2004): Coastal Resources Online, State Consistency http://www.nyswaterfronts.com/consistency_state.asp Accessed 2/27/2008.

NYSDOS. 2002. Coastal Fish and Wildlife Habitat Assessment Forms.

Office of General Services (OGS), New York State (Copyright 2007) Web Site: Lands Underwater Program Frequently Asked Questions http://www.ogs.state.ny.us/realEstate/permits/luwfaq.html Accessed 12/5/2007.

OGS, New York State (Copyright 2007) Web Site: Rules and Regulations http://www.ogs.state.ny.us/aboutOgs/regulations/statutes/chapter2.html Accessed 9/18/2007.

Ogilvie, S.C., A.H. Ross, D.R. Schiel. 2000. Phytoplankton biomass associated with mussel farms in Beatrix Bay, New Zealand. Aquaculture 181: 71-80.

Oliver, J.S. and P.N. Slattery. 1973. Dredging, Dredge Spoil Disposal and Benthic Invertebrates in Monterey Bay. Unpublished report to Coastal Engineering Research Center, Virginia.

O'Neill, Raymond. 2001. Management of Contaminated Dredge Material. CIVE477 Senior Seminar. Drexel University.

Opaluch, James, T. Grigalunas, J. Diamantides, M. Mazzotta, and R. Johnston. 1999. Recreational and Resource Economic Values for the Peconic Estuary System Final Report. Economics Analysis, Inc. Prepared for the Peconic Estuary Program. Suffolk County Department of Health Services. Riverhead, NY. 137 pp.

Ottman, F., Sornin, J.M. 1985. Observations on sediment accumulation as a result of mollusk culture systems in France. In Proceedings of the International Symposium on Utilization of Coastal Ecosystems: Planning, Pollution and Productivity, 21-27 Nov. 1982, Rio Grande, Brazil. Edited by L.N. Chao and W.W. Kirby-Smith. Pp.329-337.

Parker, N. C. undated. History, Status, and Future of Aquaculture in the United States. Reviews in Aquactic Science 1 (1): 97-109.

Parker, P. 1981. History and Development of Surf Clam Harvesting Gear. National Oceanic and Atmospheric Administration. Technical Report. National Marine Fisheries Service Circ. No. 364. 15 p.

PEP Habitat Restoration Work Group. 2000. Habitat Restoration Plan for the Peconic Estuary. 184 pp. Sponsored by the United States Environmental Protection Agency under Sec. 320 of the Clean Water Act. Suffolk County Department of Health Services, Program Office.

Peconic Estuary Program (PEP). 2001. Peconic Estuary Comprehensive Conservation and Management Plan. 866 pp. Sponsored by the United States Environmental Protection Agency under Sec. 320 of the Clean Water Act. Suffolk County Department of Health Services, Program Office.

Peterson, C.H. 2002. Recruitment overfishing in a bivalve mollusk in North Carolina. Canadian Journal of Fisheries and Aquatic Science 59: 96-104.

Pickerell, C. and S. Schott. 2005. 2004 Eelgrass (Zostera marina) Long-Term Monitoring Program. Peconic Estuary Program Progress Report 6. Submitted to the Peconic Estuary Program Office. Suffolk County Department of Health Services. Office of Ecology.

Pickerell, C., S. Schott, and S. Wyllie-Echeverria. 2003. Buoy-Deployed Seeding: A New Approach to Restoring Seagrass Using Seed. Submerged Aquatic Vegetation Propagation Workshop. Maritime Institute, Baltimore, MD.

Pillay, T.V.R. 2004. Aquaculture and the Environment. Blackwell Publishing, Oxford, 196 p.

Pörtner, H.O., Kunst, R. 2007. Climate change affects marine fishes through the oxygen limitation of thermal tolerance. Science 315: 95-97.

Powell, E. and K. Ashton-Alcox. 2004. A Comparison Between a Suction Dredge and a Traditional Oyster Dredge in the Transplantation of Oysters in Delaware Bay. The National Shellfisheries Association. Vol. 23, No. 3. pp. 803.

Powers, Monica J., Peterson, Charles H., Summerson, Henry C., Powers, Sean P. 2007. Macroalgal growth on bivalve aquaculture netting enhances nursery habitat for mobile invertebrates and juvenile fishes; Marine Ecology Progress Series Vol. 339: 109-122

Pregnall, M.M. 1993. Regrowth and recruitment of eelgrass (Zostera marina) and recovery of benthic community structure in areas disturbed by commercial oyster culture in the South Slough National Estuarine Research Reserve, Oregon. M.Sc. Thesis, Bard College, Annandale-On-Hudson, New York.

Primary Industries and Resources, South Australia (PIRSA). 2005. PIRSA Aquaculture, Response to Submissions Received for Elliston & Ceduna Abalone Aquaculture Applications. Department of the Environment and Natural Resources. Australian Government. Ref: FA00026, FA00027, FA00020 & FA00021. 14p.

Pryor, M., Parsons, G.J., Couturier, C. 1999. Temporal patterns of larval and post-set distributions of the blue mussel (*Mytilus edulis* / *M. trossulus*) and the starfish *Astarias vulgaris*) on New Foundland mussel culture sites. Journal of Shellfish Research 18: 311.

Qian H., Liu Q., Allam B., Collier J.L. (2007). Molecular genetic variation within and among isolates of QPX (Thraustochytridae), a parasite of the hard clam (*Mercenaria mercenaria*). Diseases of Aquatic Organisms 77: 159-168.

Quast, W. D., M. A. Johns, D. E. Pitts, Jr., G. C. Matlock, and J. E. Clark. 1988. Texas oyster fishery management plan. Fishery Management Plan Series Number 1. Texas Parks and Wildlife Department, Coastal Fisheries Branch, Austin, Texas. pp. 178.

Quick, J.A. Jr. 1977. Fungus disease of oysters. In: Disease Diagnosis and Control in North American Marine Aquaculture (C.J. Sinderman, ed.). Elsevier Sci. Publ. Co., Amsterdam. Pp 198-203.

Ragone Calvo, L.M., Burreson, E.M. 2002. QPX susceptibility in hard clams varies with geographic origin of brood stock. Virginia Sea Grant Marine Resource Advisory No, 74 VSG-02-18.

Rawson, P., Feindel, S. 2006. Assessment of coldwater performance for selected stocks of the American oyster (Crassostrea virginica). University of Maine/Industry Cooperative Oyster Breeding Program, Final Report. 42 pp.

Relyea, D. 2007. JOD at Oyster Bay, New York. Abstracts of Technical Papers of the Milford Aquaculture Seminar. Abstracts of Technical Papers of the Milford Aquaculture Seminar. Journal of Shellfish Research 25, 2: 683.

Richardson. 1984. Agitation Dredging: Lessons and Guidelines from Past Projects. US Army Corps of Engineers. Technical Report HL-84-6. 141 p.

Riemann, B., Nielsen, T.G., Horsted, S.J., Bjørnsen, P.K., Pock-Steen, J. 1988. Regulation of phytoplankton biomass in estuarine enclosures. Marine Ecology Progress Series 48: 205-215.

Rivara, G. and Czyzyk, S. 2007. Field transmission of juvenile oyster disease on Long Island and flow/density/mortality studies. Abstracts of Technical Papers of the Milford Aquaculture Seminar. Journal of Shellfish Research 25, 2: 683.

Rodhouse, P.G., Roden, C.M. 1987. Carbon budget for a coastal inlet in relation to intensive cultivation of suspension-feeding bivalve mollusks. Marine Ecology Progress Series 36: 225-236.

Rose, C.D. 1973. Mortality of market-sized oysters (Crassostrea virginica) in the vicinity of a dredging operation. Chesapeake Science 14:135-138.

Ross, A.H. 2002. Statement of Evidence before the Court. No. 18 p.

Ruffin, K. K. 1995. The effects of hydraulic clam dredging on nearshore turbidity and light attenuation in Chesapeake Bay, Maryland. MS Thesis, University of Maryland. 97 p.

Rumrill, S.S., Poulton, V.K. 2004. Ecological role and potential impacts of molluscan shellfish culture in the estuarine environment of Humboldt Bay, CA. Western Regional Aquaculture Center - Humboldt Bay Annual Report 2004.

Ryder, J.A. 1885. A new system of oyster culture. Science 6: 465-467.

Ryther, J. 1954. The ecology of phytoplankton blooms in Moriches Bay and Great South Bay, Long Island New York. Biological Bulletin 106: 198-209.

Seed, R., 1976. Ecology. Pages 13-65 in B.L. Bayne, ed. Marine mussels: their ecology and physiology. Cambridge University Press, New York.

SEMAC 2004. Best Management Practices for the Shellfish Culture Industry in Southeastern Massachusetts, Version 09-04a. 100pp. http://www.capecodextension.org/semac/pdfs/BMP_Manual.pdf. Accessed 2/1/08

Shumway, S.E. 1996. Natural environmental factors. In: V.S. Kennedy, R.I.E. Newell and A.F. Simenstad, C.A. Fresh, K.L. 1995 Influence of intertidal aquaculture on benthic communities in Pacific Northwest estuaries: scales of disturbance. Estuaries 18: 43-70.

Simard, N., M. Hardy, 2004. The Laurentian Channel as an alternative ballast water exchange zone: risks, analysis and recommendations. DFO, Canadian Science Advisory Secretariat, Research Document, 2004/120, 79 p.

Simenstad, C.A, C.D. Tanner, R.M. Thom, and L.L. Conquest. 1991. Estuarine habitat protocol assessment. Battelle Marine Sciences Laboratory, Sequim, Washington. Prepared for the Miscellaneous 50 Conceptual Model Development for Bank Stabilization in Freshwater Systems Reports Series, U.S. Environmental Protection Agency. 205 pp.

Simenstad, C.A., Fresh, K.L. 1995. Influence of intertidal aquaculture on benthic communities in Pacific northwest estuaries: scales of disturbance. Estuaries 18: 43-70.

Snowe, O. US Senator for Maine. Red tide Puts Shellfishermen in the Red. Weekly Senate Update for the week of July 1 through July 8, 2005. Accessed from http://snowe.senate.gov/wzu07-01-05.htm.

Smayda, T.J., Borkman, D.G., Beaugrand, G., Belgrano, A. 2004. Response of marine phytoplankton populations to fluctuations in marine climate. In *Marine Ecosystems and Climate Variation, the North Atlantic, a Comparative Perspective* (Stenseth, N.C., Ottersen, G, Hurrell, J.W., Belgrano, A., eds.). Oxford University Press, pp 49-58.

Spencer, B., Gough, C. 1978. The growth and survival of experimental batches of hatchery-reared spat of Ostrea edulis L. and Crassostrea gigas Thunberg using different methods of tray cultivation. Aquaculture 13: 293-312.

Spencer, B.E., Kaiser, M.J., Edwards, D.B. 1996. The effect of Manila clam cultivation: the early cultivation phase. Aquaculture Res. 27: 261-276.

Spencer, B.E., Kaiser, M.J., Edwards, D.B. 1997. The effect of Manila clam cultivation: observations at the end of the cultivation phase. J. Appl. Ecol. 34: 444-452.

Spencer, B.E. 2002. Molluscan Shellfish Farming. Blackwell Publishing, Malden, 272 p.

Stanley, J.G. and R. DeWitt. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) - hard clam. US Fish and Wildlife Service. FWS/OBS-82/11.18. US Army Corps of Engineers, TR EL-82-4. 19 pp.

Stenton-Dozey, J.M., Jackson, L.F., Busby, A.J. 1999. Impact of mussel culture on macrobenthic community structure in Saldanha Bay, South Africa. Marine Pollution Bulletin 39: 1-12.

Suffolk County Aquaculture Committee. 2001. Staff Summary of Testimony. Suffolk County Aquaculture Committee Public Hearing December 6, 2001.

Suffolk County Department of Health Services (SCDHS). 1992. Brown Tide Comprehensive Assessment and Management Program. Volumes I, II, and III. Marine Sciences Research Center, SUNY Stony Brook, NY. 122 p.

Suffolk County Department of Health Services (SCDHS). 2007. Total Maximum Daily Loads for Nitrogen in the Peconic Estuary Program Study Area, Including Waterbodies Currently Impaired Due to Low Dissolved Oxygen; the Lower Peconic River and Tidal Tributaries; Western Flanders Bay and Lower Sawmill Creek; and Meetinghouse Creek, Terrys Creek and Tributaries. Peconic Estuary Program. Suffolk County Department of Health Services. Office of Ecology, Yaphank, NY. 102 pp.

Suffolk County Department of Planning. 2008. Suffolk County Shellfish Aquaculture Lease Program in Peconic Bay and Gardiners Bay: Underwater Land Title Search Data Report. Hauppauge, New York.

Suffolk County Department of Planning. 2003. Survey Plan for Shellfish Cultivation Leasing in Peconic and Gardiners Bays. Hauppauge, New York.

Suffolk County Department of Planning. 2002. Policy Guidance for Suffolk County on Shellfish Cultivation in Peconic and Gardiners Bays. Report of the Suffolk County Aquaculture Committee. Suffolk County Department of Planning. Hauppauge, NY. 82 p.

Szekielda, K.H. 2006. Near Real-Time Monitoring System Consulting Services for Brown Tide Using Remote Sensing. Progress Report 1 to the SCDHS

Tallman, J.C., Forrester, G.E. 2007. Oyster grow-out cages function as artificial reefs for temperate fishes. Transactions of the American Fisheries Society 136: 790-799.

Tarnowski, Mitchell. 2001. A Literature Review of the Ecological Effects of Hydraulic Escalator Dredging. Fisheries Technical Report Series No. 47. Maryland Department of Natural Resources. Fisheries Service, Shellfish Program.

TechLaw. 2001. The Economic Contribution of the Sport Fishing, Commercial Fishing, and Seafood Industries to New York State (Final). Prepared for the Sea Grant College of State University of New York and Cornell University. Stony Brook, NY. NYSGI-T-01-001. 84 pp.

Tenore, K.R., Boyer, L.F., Cal, R.M., Corral, J., Garcia-Fernandez, C., Gonzalez, N., Gonzales-Gurriaran, E., Hanson, R.B., Krom, M., Lopez-Jamar, E., McClain, J., Pamatmat, M.M., Perez, A., Rhoads, D.C., de Santiago, G., Tietjen, J., Westrich, J., Windom, H.L. 1982. Coastal upwelling in the Rias Bajas, N.W. Spain, contrasting benthic regimes of the Rias de Arosa and de Muros. Journal of Marine research 40: 701-772.

TerrAqua Environmental Science and Policy, LLC (TerrAqua). 2003. Potential Impacts of Small-Scale Commercial Mariculture in Southampton Public Waters, Feasibility Study. Prepared for the Southampton Board of Trustees. Southampton, NY.

Tetra Tech, Inc. 1998. Three Dimensional Hydrodynamic and Water Quality Model of Peconic Estuary.

Tettelbach, S. T. and P. Wenczel, 1993. Reseeding efforts and the status of bay scallops Argopecten irradians (Lamark, 1819) populations in New York following the occurrence of "Brown Tide" algal blooms. Journal of Shellfish Research 12(2), 423-431.

Thayer, G.W., W.J. Kenworthy, and M.S. Fonseca. 1984. The Ecology of Eelgrass Meadows of the Atlantic Coast: a Community Profile. U.S. Fish and Wildlife Service. FWS/OBS-84/02. 147pp.

The Nature Conservancy. 2002. Final Report – Peconic Bays Aquaculture Advisory Committee

Timmons, Michael; Rivara, Greg; Baker, Dale; Regenstein, Joe; Schreibman, Martin; Warner, Philson; Barnes, Debra; Rivara, Karen, New York Aquaculture Industry: Status, Constraints and Opportunities, A White Paper. May 1, 2004

Tiner, R.W., H.C. Bergquist, D. Siraco, and B.J. McClain. 2003. An Inventory of Submerged Aquatic Vegetation and Hardened Shorelines for the Peconic Estuary, New York. U.S. Fish and Wildlife Services, Northeast Region, Hadley, MA. Prepared for the Peconic Estuary Program of Suffolk County Department of Health Services, Office of Ecology, Riverhead, NY. 47pp.

Toro, J.E. 1996. Phenotypic response of a cohort of Ostrea *chilensis* (Philippi 1845) to differing environmental conditions in three oyster farms in southern Chile. Aquaculture Research 27: 1-7.

Toro, J.E., Paredes, P.I., Villagra, D.J. 1999. Phytoplankton distribution and oyster, *Ostrea chilensis* (Philippi 1845), growth at Putemun Channel, southern Chile. New Zealand Journal of Marine and Freshwater Research 33: 499-513.

Toro, J.E., Sanhueza, M.A., Winter, J.E., Senn, C.M., Aguila, P., Vwergara, A.M. 1995. Environmental effects on the growth of the Chilean oyster Ostrea chilensis in five mariculture locations in the Chiloé Island, southern Chile. Aquaculture 136: 153-164.

Town of East Hampton Website: http://www.easthampton.ny.us/index.cfm Accessed 10/8/2007.

Town of East Hampton Website: Town Code (6/30/2007) http://www.easthampton.ny.us/code.htm Accessed 10/8/2007.

Town of East Hampton Website: http://www.easthampton.ny.us/index.cfm (Follow links to: Comp. Plan; Appendix C: Coastal Management Component) Accessed 10/8/2007.

Town of Riverhead Website: http://www.riverheadli.com/rthome.html [Follow Links to: Free Access to Town Code; Open Table of Contents; Part II General Legislation (Amended 3/20/2007)] Accessed 10/8/2007.

Town of Shelter Island Website: http://www.shelterislandtown.us/ [Follow Links to: Town Code; Table of Contents; Part II General Legislation (Amended 9/21/2001)] Accessed 10/8/2007.

Town of Southampton. 2005. Community Preservation Project Plan. Town of Southampton Community Preservation Fund. Southampton, NY.

Town of Southold. 2004. Town of Southold Local Waterfront Revitalization Program. Southold, NY.

Town of Southold Website: http://www.southoldtown.northfork.net/ [Follow Links to: Town Code; Table of Contents; Part II General Legislation (No Date Provided)] Accessed 10/8/2007.

Town of Southold Website: http://www.southoldtown.northfork.net/ [Follow Links to: Local Waterfront Revitalization Program] Accessed 10/8/2007.

Town of Southampton Website: http://www.southampton.ny.us/index.ihtml [Follow Links to: Town Code; Table of Contents; Part II General Legislation (6/12/1984)] Accessed 10/8/2007.

Ulrich, P.N., Colton C.M, Hoover, C.A., Gaffney, P.M., and A. G. Marsh. 2007. *Haplosporidium nelsoni* (MSX) rDNA Detected in oysters from the Gulf of Mexico and the Caribbean Sea. Journal of Shellfish Research 26: 195-199.

Underwood, A.J., Fairweather, P.G. 1989. Supply-side ecology and benthic marine assemblages. Trends in Ecology and Evolution 4: 16-20.

UNEP. 2005. Convention on Biological Diversity; Towards the development of a joint work plan for the management of marine invasive alien species. UNEP/CBD/SBSTTA/11/INF/10. 37 pp. www.gisp.org/about/docs/sbstta-11-inf-10-en.doc. Accessed 10/11/07.

United States Department of Commerce, Nation Oceanic and Atmospheric Administration, Interim Final 10-Year Plan for the NOAA Aquaculture Program (November 2006)

University of Delaware 2007. Commercial Whelk Fishery. http://www.ocean.udel.edu/horseshoecrab/Fisheries/whelkbait.html. Accessed 12/14/07.

US Environmental Protection Agency (USEPA). 2007. National Estuary Program Coastal Condition Report. Office of Water/Office of Research and Development. Washington, D.C. EPA-842/B-06/001. 486 p.

USEPA. 2006a. Final Report for Peconic Bay Pathogens TMDL. Prepared for USEPA Oceans and Coastal Protection Division. Prepared by Battelle, Duxbury, MA. 102 pp.

U.S. Environmental Protection Agency (USEPA). 2006b. Volunteer Estuary Monitoring, A Methods Manual. The National Estuary Program. March 2006. EPA-842-B-06-003.

USEPA. 2002. New York State Prohibition on Marine Discharges of Vessel Sewage; Receipt of Petition and Tentative Determination. Federal Register Environmental Documents. Volume 67, Number 44. FRL-7153-5. Pages 10208-10210.

U.S. Fish and Wildlife Service (USFWS). 1991. Northeast Coastal Areas Study: Significant Coastal Habitats of Southern New England and Portions of Long Island, New York. Southern New England-Long Island Sound Coastal and Estuary Office, Charlestown, RI.

Utting, S. 1988. The growth and survival of hatchery-reared Ostrea edulis L. spat in relation to environmental conditions at the on-growing site. Aquaculture 69: 27-38.

Vandermeulen, H., Jamieson, G., Ouellette, M. 2006. Shellfish aquaculture and marine habitat sensitivity case studies. Canadian Science Advisory Secretariat Research Document 2006/036. 62 pp.

Virginia Department of Environmental Quality. 2006. 2006-2010 Coastal Needs Assessment Report. Virginia Coastal Zone Management Program. Accessed from www.deq.state.va.us/coastal/assess.html on January 15, 2008.

Wang, T. and J. Overgaard. 2007. The Heartbreak of Adapting to Global Warming. Science 315: 49-50.

Webber, Alice, C. Grahn and B. Havens. June 1998. Species Composition, Seasonal Occurrence and Relative Abundance of Finfish and Macroinvertebrates Taken by Small-Mesh Otter Trawl in Peconic Bay, New York. NYSDEC, Division of Fish, Wildlife and Marine Resources.

Weber, A. and C. Grahn. 1995. Commercial Finfish and Crustacean Landings From Peconic and Gardiners Bay, New York: 1980-1992. New York State Department of Environmental Conservation, Division of Marine Resources, Bureau of Finfish and Crustaceans. East Setauket, NY. 10 pp.

Whetstone, J., L. Sturmer and M. Oesterling. 2005. Biology and Culture of the Northern Quahog Clam(Mercenaria mercenaria). Southern Regional Aquaculture Center Fact sheet Series Number 433.

Wilbur, A.I., Swartzenberg, J. 2003. Evaluating the reproductive output of oyster aquaculture: do commercial grow-out operations contribute to local recruitment? North Carolina Sea Grant Fisheries Resources Grant 01-AM-07, Final Report. http://www.ncseagrant.org/elements/research_files/01AM07.pdf. Accessed 10/09/07.