Suffolk County Vector Control
and Wetlands Management Long Term Plan
and Generic Environmental Impact Statement
Task 12

For the:

Wertheim National Wildlife Refuge
Water Management Demonstration Project
Data Report and Summary 2003-2007

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Submitted to:
Suffolk County Department of Environment and Energy
Suffolk County Department of Public Works
Suffolk County Department of Health Services

Cashin Associates, PC

SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT
LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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APPENDICES

Appendix A Cumulative Data Set 2003-2007

Appendix B Photo Stations Photographs

List of Abbreviations and Acronyms

BACI	Before-After-Control-Impact
Bti	*Bacillus thuringiensis var israelensis*
EEE	Eastern Equine Encephalitis
ELAP	Environmental Laboratory Approval Program
GIS	Geographic Information System
GPS	Global Positioning System
NYSDEC	New York State Department of Environmental Conservation
OMWM	Open Marsh Water Management
PBO	Piperonyl Butoxide
PEHL	Suffolk County Public and Environmental Health Laboratory
SCDHS	Suffolk County Department of Health Services
SCVC	Suffolk County Department of Public Works, Division of Vector Control
SVOC	Semi-Volatile Organic Compound
USACE	United States Army Corp of Engineers
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
VOC	Volatile Organic Compound
WNV	West Nile Virus

Abstract

Monitoring at the four areas that constitute the Wertheim National Wildlife Refuge Water Management Demonstration Project site began in late summer 2003. Area 1 was altered in March 2005 and Area 2 was altered in February-March 2006. The monitoring program collected two seasons pre-treatment data for Area 1 and three seasons for Area 2. The completion of monitoring in 2007 means there is three seasons post-treatment data for Area 1 and two seasons for Area 2. Area 3 and Area 4 were not altered and serve as control sites.

This project was intended to test local effects from several marsh management methodologies, including filling parallel mosquito ditches, installing ponds, and re-engineering or creating tidal channels. These changes to salt marshes can be used as alternatives to pesticide applications for mosquito control, and also may improve several important ecological functions associated with salt marshes.

The preliminary monitoring data analysis indicates that the project has been very successful to date, especially in Area 1. Mosquito production was reduced across both treatment areas. Fish abundance was increased, as the project improved the physical habitat preferred by the fish, and increased water circulation, thereby improving overall water quality. The avian monitoring indicates that a variety of shore and wading birds are using the marshes. Several species of State concern were observed, including the short eared owl, the northern harrier, the seaside sparrow, and the black skimmerre is evidence that different kinds of birds are utilizing the marshes, although it is not clear if this will be a long-term effect. In Area 1, the area affected by an invasive nuisance marsh plant, *Phragmites australis*, was reduced. The physical alterations to the marsh appeared to be persistent and stable, and showed little need for further maintenance. Generally, marsh vegetation in the areas where construction occurred either appeared to have recovered or showed promise of a return to normal marsh conditions. The net effect of the project appeared to be to increase the diversity of typical salt marsh habitat types found across the marsh, as was intended by the project design team.

Not all results were in line with expectations. Invertebrate numbers appeared to have been reduced, especially for those species found on the marsh surface. This may be from increased fish and bird foraging, and so may not indicate any reason for concern. The vigor and extent of *Spartina patens*, a characteristic marsh plant, appears to have been reduced in Area 2, especially in 2007. There are some indications that, generally, Area 1 may have become drier post-treatment, but Area 2 may have become wetter. If this is so, it would help explain some of the divergence in results between the two Areas. One difference between the two areas was that a back channel was installed along the upland edge of Area 1 to improve tidal flow and limit *Phragmites* invasion. This feature was not deemed necessary in Area 2 because there was no upland edge there. It is possible that the back channel allows better drainage between floodings in Area 1 and so has resulted in a drier marsh than Area 2.

The project has clearly met its primary goals: a substantial decrease in the need for pesticide applications, improvements in habitat diversity, reduction in the extent of *Phragmites*, and important improvements in fish production and diversity of bird use of the marsh. Monitoring is expected to continue in 2008.

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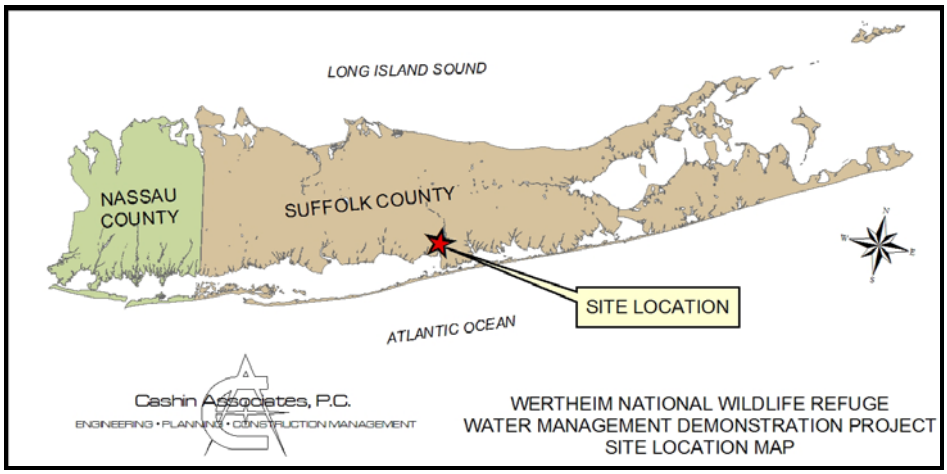
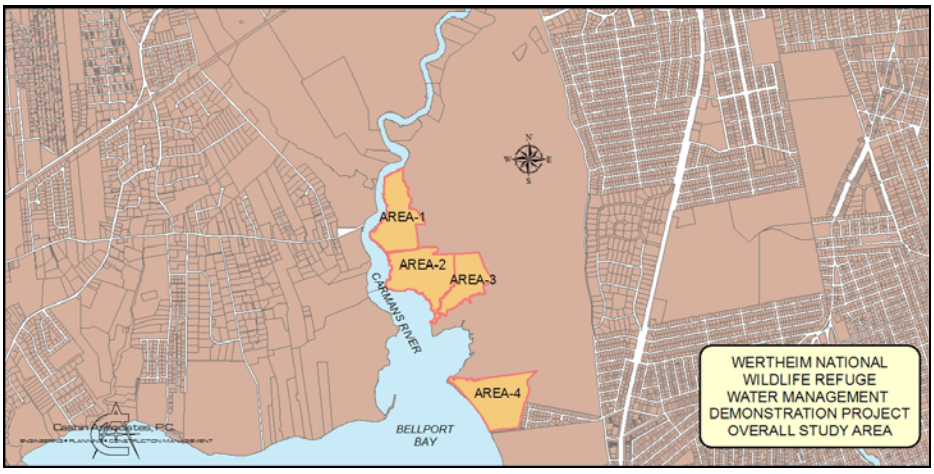
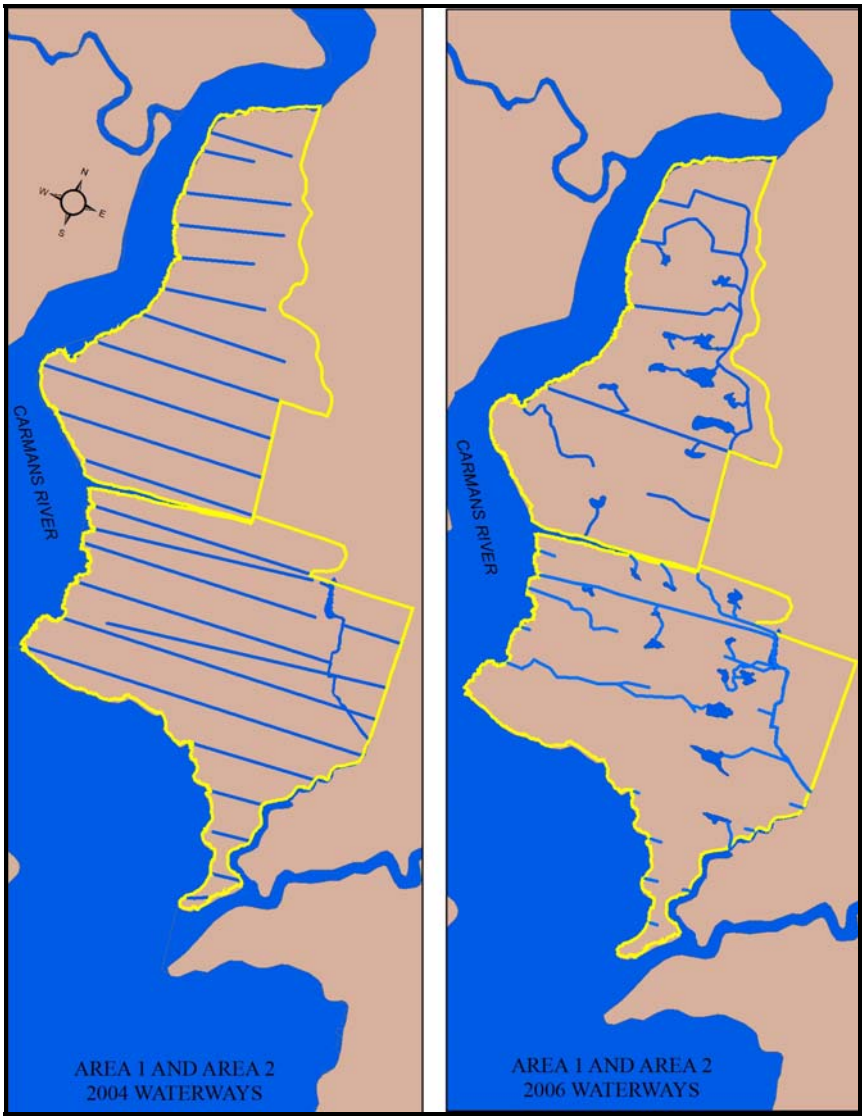
Executive Summary

In August 2003, monitoring was begun at Areas 1-4 of the Wertheim National Wildlife Refuge (Shirley, New York) in anticipation that Suffolk County, in conjunction with the US Fish and Wildlife Service (USFWS), would conduct marsh management on at least part of the salt marsh. This work was conducted through Cashin Associates, PC (Hauppauge, New York), as the consultant to Suffolk County for the Vector Control and Wetlands Management Long-Term Plan. An application was submitted to New York State to modify the marsh in order to increase natural mosquito control processes and to enhance other aspects of salt marsh functions perceived by the USFWS to be important to its stewardship of the site as a Federal migratory bird refuge. The application was reviewed by New York State Department of Environmental Conservation (NYSDEC), National Marine Fisheries Service, and the US Army Corps of Engineers in due course, and appropriate permits were issued.

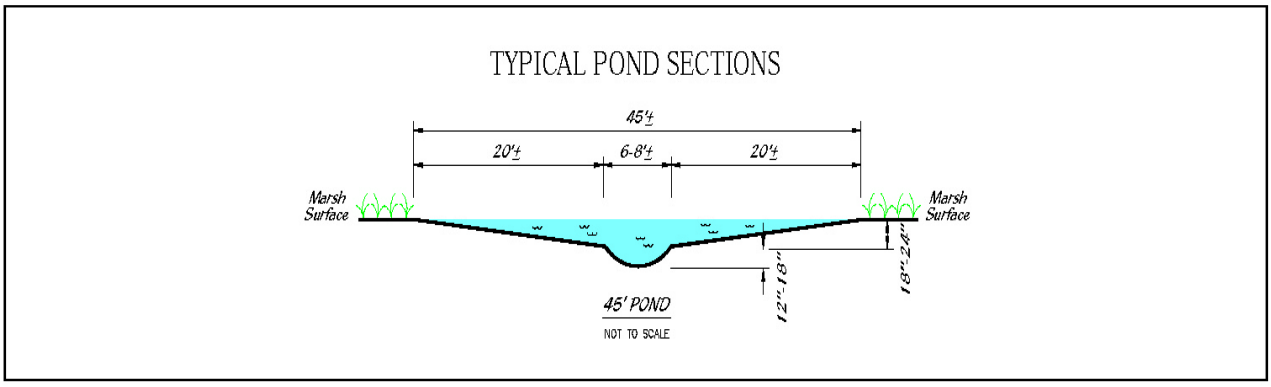




In March, 2005, alterations were made to approximately 16 hectares (40 acres) of salt marsh (Area 1), and in February and March of 2006, to Area 2, which has a total size of approximately 18 hectares (45 acres). The changes included the filling of nearly all of the pre-existing mosquito control ditches in the marsh, removal of plugs installed during previous projects at the end of some of the ditches, alteration of any remaining ditches to "naturalize" them by adding curves and other features found in natural waterways in salt marshes, construction of ponds of various sizes, creation of tidal channels to mimic naturally occurring salt marsh creeks, the digging of shallow connections between the ponds and the tidal channels, and use of excess fill from the ponds to smooth hummocky high marsh terrain that had been found to provide habitat for larval mosquitoes.



Pre-construction Ditches and Post-construction Waterways



As specified in the NYSDEC permit, the monitoring at the site was to be conducted to determine if certain measures of success were met. There have been three seasons of post-treatment monitoring in Area 1 (2005-2007), and two seasons in Area 2 (2006-2007). These data sets have been compared to pre-treatment monitoring data (2003-2004 for Area 1, and 2003-2005 for Area 2) and those data collected in the control areas, Area 3 and Area 4 from 2003-2007. Various tests were conducted on the data to determine if the results were statistically significant or not, and trends and patterns have been extracted to explain the results.

The following monitoring analysis report and cumulative data report has found the following with respect to the five measures of success listed in the NYSDEC permit application (*in italics in the sections that follow*):

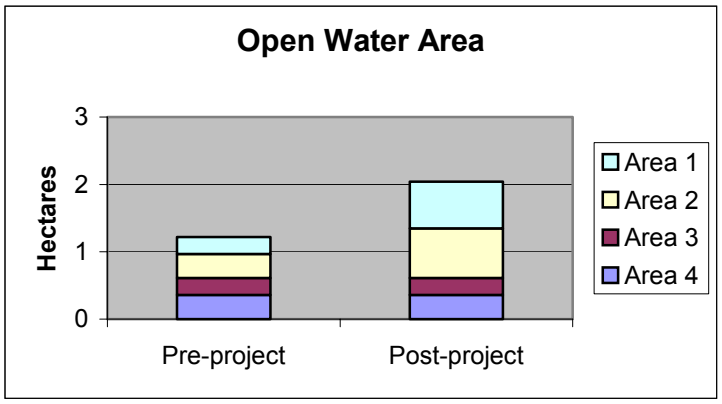
(1) Marsh characteristics are enhanced

Major marsh characteristics that are indicative of a persistent salt marsh (sedimentation rates, percent open water, general vegetation patterns) should not diverge between the treatment areas and the control areas. Significant differences should be explicable in terms of overall, beneficial changes in conditions at Area 1 and Area 2, such as a reduction in the area of Phragmites. Open water created at the site should be limited to areas designated as ponds on the project plans and not be the result of water retained in pannes on the marsh causing extensive die-off of marsh vegetation.

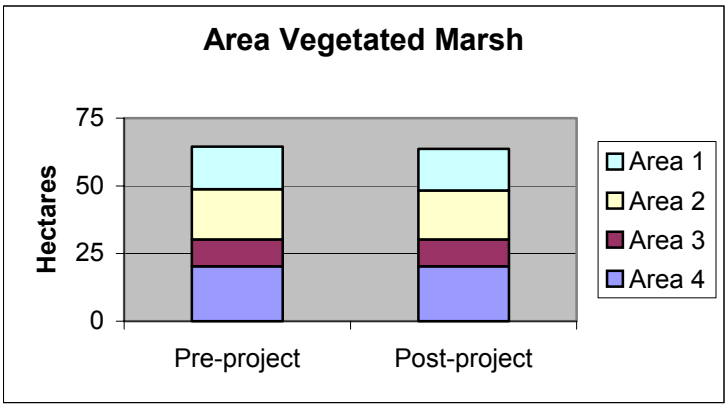
Although the current data sets are not conclusive and final, it is clear that the project generally enhanced some characteristics of the salt marsh, as was intended in the project design. Overall

trends in vegetation and overall marsh structure, quantified in this monitoring project, appear to be following the general qualitative trends observed at similar projects across the northeast US.

The project successfully executed its planned design, and increased the proportion of marsh occupied by water by approximately 1 percentage point in each of the Areas. Some wet pannes have developed, but there are indications that these are ephemeral features, as they are vegetating. Lessons learned from the construction of Area 1 minimized initial panne formation in Area 2. The ponds are not eroding, and there has only been minor bank instability in some channels and spur ditches.



Changes in Open Water

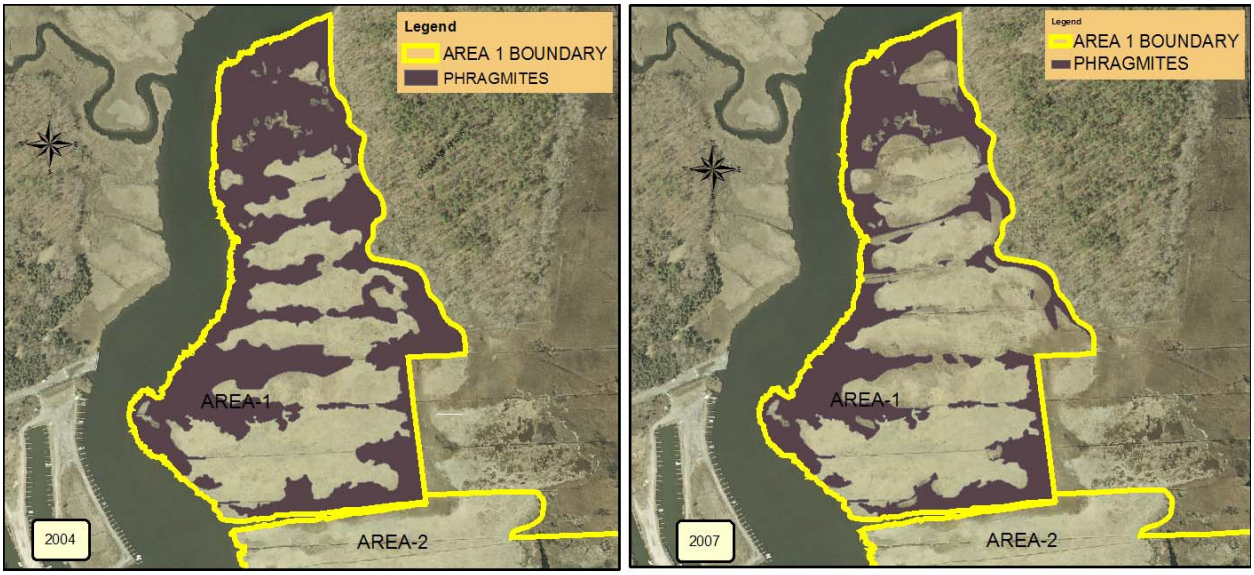


Changes in Vegetated Marsh Area

Limited pre-project data regarding sedimentation rates seems to indicate that the marshes were maintaining themselves with respect to sea level. Data collected in 2004 and 2007 indicates that sediment is accumulating faster on the marsh than would appear necessary to match sea level rise, but the sampling methodology does not account for all factors associated with overall marsh

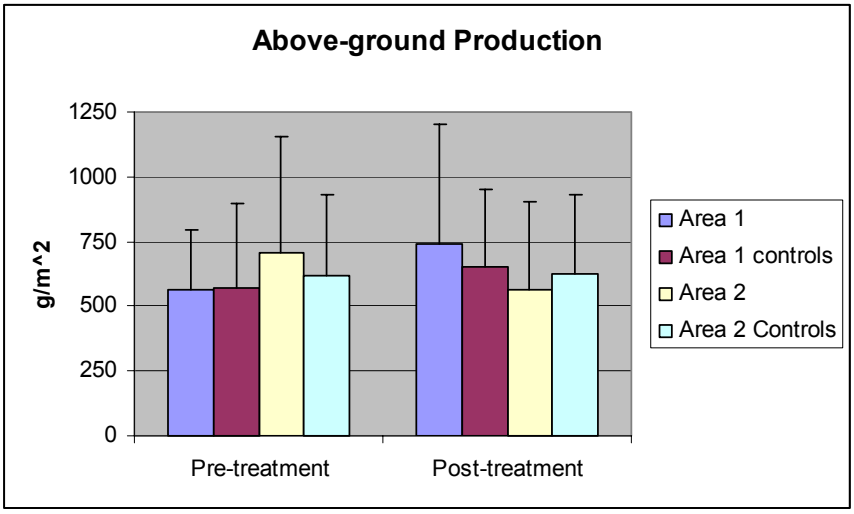
sedimentation. It is not known whether the lack of major storms over the monitoring period (storms often carry sediment into a marsh) is important in this respect. Also, the sample data showed a wide range of values, and it is not clear how this variation in accretion will affect overall, long-term sedimentation. There is no evidence that the project impaired sedimentation compared to control areas.

The project has altered vegetation found on the marsh. Many of these alterations are generally viewed as positive: a major reduction in the extent and vigor of *Phragmites* was generally achieved.



WERTHEIM NATIONAL WILDLIFE REFUGE
WATER MANAGEMENT DEMONSTRATION PROJECT
AREA 1 MARSH COMPOSITION (PHRAG) 2004 - 2007

There are increased numbers of plant species across the marsh generally. Construction activity and the filling of ditches caused some areas of the above-water marsh to be bare of plants, and some of these areas have been slow to revegetate. There are some indications that Area 1 and Area 2 are not responding to the alterations consonantly; in particular, there are suggestions that the area and vigor of *Spartina patens* marsh may have decreased in Area 2, and overall productivity may have been reduced as a result. The differences in production appear to be within the range of natural variability and variability in the measurements. In any case, these data are certainly preliminary, and a full evaluation requires waiting for full recovery of all areas affected by construction.



Changes in Above-ground Seasonal Vegetation Production

As has been the case at projects elsewhere in the northeast US, revegetation of areas affected by the movement of construction equipment or where fill operations occurred has required more than one season. However, revegetation is clearly underway. In general, the project areas are somewhat more diverse in plant cover than the control sites; whether this will be a long-lasting effect of the project, or has to do with opportunistic responses to the clearing of areas of the marsh, remains to be seen.

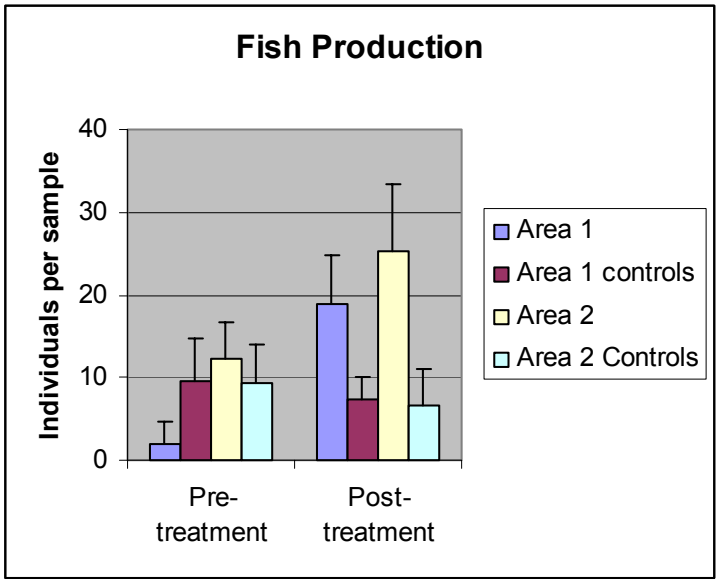
The waterways in the altered areas of the marsh no longer have a linear, engineered appearance, and the extent of *Phragmites* has been reduced. There are more diverse appearing areas on the marsh due to the installation of ponds. The aesthetic goals of the project have thus been largely realized, especially with continuing revegetation of denuded areas.

(2) Biological productivity is improved

Measures of the biological health of the marsh (fish use of appropriate habitat, invertebrate diversity, vegetation patterns and productivity, bird presence and diversity) should be maintained or improve following the marsh alteration. Decreases in any parameter must be explicated in terms of other, beneficial trends – so that any loss of productivity is acceptable due to the benefits provided to other organisms.

Fish use of Area 1 and Area 2 has increased. Overall species compositions have been variable, but mummichogs and sheepshead minnow use of the marsh has been fostered post-treatment.

The data suggest that a much greater number of fish are found in all four Areas post-treatment, so the impact does not appear to have resulted from relocation of existing resources (note the figure uses standard error for the error term).



Changes in Fish Caught Per Sample

Red-winged Blackbird in Area 2

Bird sampling suffered from some technical sampling issues; the data do not strongly support any change in overall avian use of Area 1, although in the short-term, it seems likely that increased shorebird foraging on bare ground and perhaps increased waterfowl and wading bird use of ponds changed the population structure in 2005 for Area 1 and in 2006 and 2007 for Area 2. The nearby impoundment is probably the most important control on avian populations in this part of the marsh, and that was not

affected by this project. The available data suggest passerine use of the marsh has not changed. Some important listed species have also maintained or perhaps increased their use of the treatment areas.

Invertebrate sampling suggests that marsh surface and water column populations have been reduced due to marsh alterations. Potential reasons include the increase in fish populations or increased foraging by birds, but the data could also support changes in environmental conditions as a root cause for much of the difference, because similar reductions were sometimes measured for the control areas. However, invertebrate populations are variable over short time periods due to hatches and emergences into adulthood, which also can affect sampling results. The dominant fish caught on the marsh are opportunistic feeders, and although it seems likely that the increased numbers of these fish have resulted in reduced larval mosquito populations, they may also have reduced other available invertebrate populations, too.

Vegetation patterns were changed somewhat, as mentioned above. A projection from the sampling data suggests that although productivity appears to have been reduced somewhat in Area 2, it increased in Area 1 post-treatment. Overall, there appears to be no decrease in productivity across the entire marsh post-treatment, and there may actually have been a slight overall increase in vegetation production, if all four Areas are considered together.

Area 1 Photostation 6-West, September 2005

Therefore, the project appears to have enhanced fish and some aspects of bird use of the marsh, as is generally noted for such projects. If the change in invertebrate populations is viewed as a shift in ecological resource partitioning (a probable result of increased fish populations), then the data are understandable and most likely acceptable for many

resource managers. Vegetation production appears to have increased for Area 1. The decrease measured for Area 2 was heavily influenced by several samples that included bare ground; as the marsh revegetates, differences from pre-treatment conditions may also decline.

(3) Physical alterations remain stable

The structures established in the water management project are expected to be persistent. It is recognized that the shallower sills may require periodic routine maintenance, but the cycle is expected to be several years in length. It is also recognized that some of the filled ditches may settle in a way that might require some additional grading. The project will be successful should the major ponds and waterways not require maintenance within the first five years post-project, and if the filled ditches do not re-open. Limited success would be judged if fewer than 50 percent of the ponds and waterways require maintenance once within the first five years.

The alterations made to the marsh have been stable to date. There have been no major erosive episodes, and the edges of ponds and channels have revegetated and appear to be well-anchored by plant roots. There was one corner of a channel where flow forces caused some slight undermining of the bank in 2006. The problem area did not expand in 2007.

(4) Fish habitats are improved

Fish use of the new waterways must be found to be equal to or greater than that measured for the mosquito ditches.

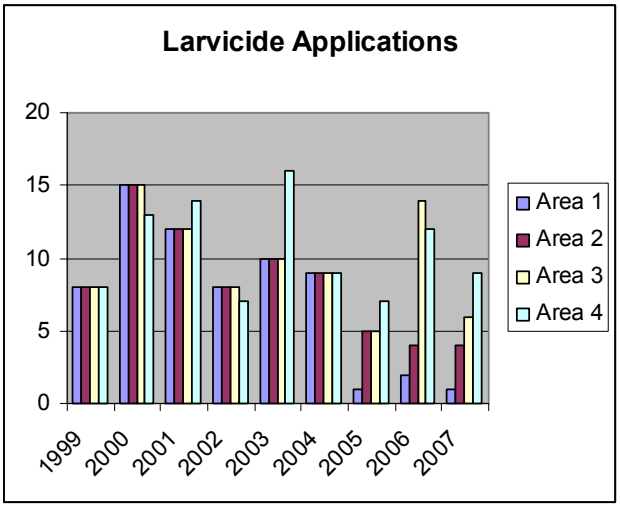
As mentioned above, fish use of the new waterways appears to be greatly enhanced compared to their use of the ditches. Water quality in the all of the new waterways is clearly at least equal to that in the ditches, and in most cases appears to be much better. However, water quality data also show that there are still instances of very high temperatures and very low dissolved oxygen levels in the new waterways, as is the case for all salt marsh waters. Subjective observations of water circulation suggest it is much more robust in the altered marsh areas. Larger fish have been observed in the altered areas, but have not been documented by the sampling efforts. Projections from the sampling data indicate that the project has robustly increased fish numbers in the study areas.

Fish Sampling in Early Summer 2005, Area 1

(5) Eliminate the need for larviciding the site

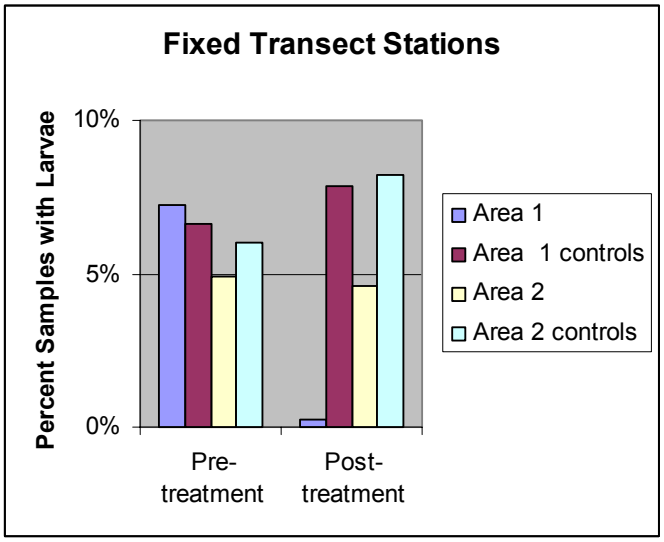
The mosquito control features of the project will benefit USFWS in meeting its goal for the cessation of chemical use on refuge property for mosquito control. This aspect will be measured through continued larval surveys of the project area for several years. Project success will be documented by a reduction in larval counts to the point that larviciding will not be necessary. USFWS has deemed that an average larvae count of less than 0.2 larvae/dip is considered acceptable control of mosquito breeding on this marsh. The project will be considered to have had limited success if larval counts decrease, but not to the point that still triggers larviciding on this site.

Larvicide applications have been reduced by 90 percent in Area 1 and 50 percent in Area 2. The overall decrease in larvicide applications was on the order of 75 percent, which is the goal for the Long-Term Plan for water management projects.

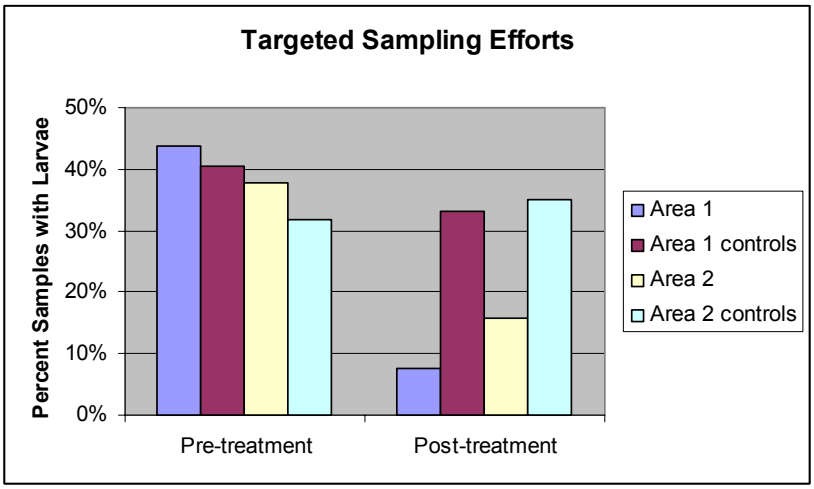


Trends in Larvicide Applications

Statistically significant decreases in mosquito breeding across Area 1 and Area 2 have been found. There are some indications (across several parameters) that the effectiveness of the mosquito control has been less in Area 2 than in Area 1. Suffolk County Vector Control is studying the data sets and field observations to determine if this is the result of some isolated issues (for instance, several old ditch plugs were not removed in waterways in Area 2) or if new larval habitats were created in Area 2 as a result of filling the ditches (which suggests that a design problem may exist).



Transect Stations Mosquito Presence Changes



Marsh-wide Surveys of Breeding Locations

The overall mosquito treatment goal for the project had been to eliminate the need for larviciding across the treatment areas. This broad goal has not yet been achieved for both Areas, but in Area 1 larvae have been reduced from a routine problem to a rare occurrence. In Area 2, the parts of the marsh that produced larvae pre-project rarely do so now and the larvae that remain appear less frequently and over a smaller portion of the marsh. If mosquito production were to be reduced across the breadth of the entire Refuge to the levels found in Areas 1 and 2, it is conceivable that the need to larvicide at all would be re-evaluated, and potentially found to be not needed.

Monitoring at the site will be continued in 2008.

Marsh Surface Invertebrate Sampling, 2007