MISSISQUOI NWR
MARSH AND WATER MANAGEMENT PROGRAM EVALUATION
AUGUST, 1987

I. REFUGE DESCRIPTION

Missisquoi National Wildlife Refuge is located approximately 50 miles north of Burlington, Vermont on the eastern shore of Lake Champlain near the Canadian border.

This 5,839 acre refuge, established in 1943, occupies much of the Missisquoi River delta and consists of marsh, open water, and wooded swamp (MAP No.1). It is divided by numerous channels and remnants of old water courses, some of which have been closed off by silt deposition. Silt and sand carried down the river during the spring floods created the delta now covered with marshes and timber. Channels were cut naturally at the river's mouth, thus extending the river into the lake. As water velocity dropped, the lighter particles of fine silt were deposited farthest back in the slack-water on each side of the main channel. This light material was rich in plant nutrients. Quite often a section of the lake was enclosed by the higher deposits along the sides of main channels, forming marshes protected from wind and waves. These are the marshes which produce aquatic plants most favored by waterfowl and which have become an attraction to birds migrating through the Lake Champlain watershed.

The refuge is comprised of five distinct areas. These include Cranberry Pool, Big Marsh Slough, the river mouth (Metcalf and Shad Islands), Charcoal Creek-Long Marsh Slough and Maquam Swamp. Most units are similar in that they are surrounded by deciduous hardwoods and contain an open water channel around which an emergent zone of vegetation exists. Big Marsh Slough, Charcoal Creek and Maguam Swamp also have vast expanses of woody shrubs connecting their main channels to the deciduous hardwood borders.

The refuge is comprised of the following habitat types:

Wooded swamp-	1,880 acres
Shrub swamp-	1,700
Shallow fresh marshes-	907
Deep fresh marshes-	512
Non-irrigated green browse- (perennial)	265
Open fresh water-	200
Grasslands (introduced)-	178
Commercial forests-	108
Brush-	77
Buildings, roads, and parking lots-	12
	5,839

Water management at Missisquoi NWR currently occurs on 1,250 acres or about 21 percent of the refuge. Two water management units (WMU's) comprise this area (Map No. 2): Goose Bay Pool/Big Marsh Slough (Unit 1: 700 acres) and Cranberry Pool (Unit 2: 550 acres). In addition to these WMU's, three others totaling 1,990 acres have been proposed for development, all in Maquam Swamp (Map No. 2): Unit 3, northern portion- 850 acres; Unit 4, southern section- 1,000 acres; and, Unit 5, western area- 140 acres. The floodplain and marshes of the Missisquoi Delta not only provide a major resting and feeding area for migrating waterfowl, they also provide habitat for migratory wading and passerine birds, as well as raptors. Muskrat, beaver, raccoon, and white-tailed deer are also common species on the refuge.

Program review participants were:

Refuge- Robert A. Zelley, Refuge Manager and John Gallegos, Assistant Refuge Manager.

Refuges and Wildlife- Willard "Bill" Leenhauts, Refuges Central Biologist and Gerry Atwell, Refuges North Biologist.

Vermont Fish and Wildlife Department- Thomas Myers, Waterfowl Biologist (consultant).

II. MARSH AND WATER PROGRAM HISTORY

Prior to the first dike construction in the 1950's, all unimpounded refuge marshes were subject to flooding when adjacent water levels rose above 96.00' Mean Sea Level (MSL) during high water periods of the Missisquoi River and Lake Champlain. Water levels along Lake Champlain average 95.00' MSL prior to spring ice break-up with the annual high water peak averaging 99.15' MSL, usually during the fourth week of April. Crests exceeding 101.00' MSL have been recorded.

A brief history and description of each pool follows:

WMU #1- Goose Bay Pool/Big Marsh Slough

The Goose Bay Pool dike was completed in 1959; the diking for Big Marsh Slough in the early 1950's. The Goose Bay Pool sub-impoundment is 100 acres and the Big Marsh Slough is 600 acres. Two imcomplete dike sections (gut plugs) partially impound the 700 acre main unit. One, an 800' section, closes off the drainage flow in Big Marsh Slough and contains a 4' corregated metal pipe (CMP) outlet equipped with stop-logs that has silted in and been inoperable for many years. The second plug, a 2,000' dike, separates Goose Bay Pool from Goose Bay. The remaining perimeter consists of a natural levee formed by the banks of Dead Creek. The two sub-impoundments are separated by a low, narrow ridge that follows the meanders of an old river channel; however, they have been connected by a 25' wide ditch that enables them to function as a

single unit. The lake level controls the water level in this Unit until the lake drops below the perimeter elevation of approximately 96.00' MSL (usually by July 1). Thereafter, water levels in Unit #1 are maintained by rainfall and, depending on Lake Champlain levels, retain levels of 18"-24" higher than the lake.

In 1968 a beaver dam was built across the man-made ditch that linked the two pools. Since this dam resulted in the maintenance of more desirable water levels in Goose Bay Pool (2"-4" higher than Big Marsh Slough), it has been left intact. At present, drainage of Unit # 1 is only possible through the use of pumps, which has yet to be attempted.

Specific written water management programs for WMU #1 were not instituted until 1960. At that time, water levels were maintained as close as possible to the maximum of 96.00' MSL to retard growth of woody vegetation and to aid in stabilizing desirable vegetation associations. A total of 150 acres of brush was cut on the higher marsh in 1960 by two crawler tractors with brushcutters. In 1964 the emphasis shifted from brush control to providing the most habitat for brooding, as well as migrant duck populations; however, water levels were maintained as high as possible.

No further work was done on either the Goose Bay Pool or Big Marsh Slough dike systems. As a result, Big Marsh Slough consistently maintained lower levels than either Goose Bay or Cranberry Pools throughout the 1970's and up to the present. Management during these past 16 years has consisted of simply keeping the stop-logs of the Big Marsh Slough WCS in place to retain as much water as possible. The beaver dam in the connecting ditch has remained up to the present and keeps water levels in Goose Bay Pool an average of 2"-4" higher than Big Marsh Slough.

WMU #2- Cranberry Pool

Cranberry Pool dike construction began in the late 1960's and was terminated in 1970 with 9,000' of dike along the Missisquoi River yet to be completed. A 550 acre impoundment had been created with water retention possible below 99.25' MSL. This unit is enclosed along its eastern half by a 2.8 mile earthen dike that contains two fully operable 4' CMP WCS's with each outlet's invert at 93.00' MSL.

Low areas subject to overtopping occur across and just north of the Mac's Bend boat launch site, to a point nearly one mile south along the Goose Pen Channel area. Water levels in excess of 99.25' MSL over-top this area and flood Cranberry Pool up to the river level. Lake level records for the past 77 years show that the 99.25' MSL height is exceeded during 52 percent of the years; consequently, the existing dike system does not always permit effective water level management during high water.

Draining Cranberry Pool through its two WCS's is dependent upon lower water levels in the Missisquoi River/Lake Champlain system, since the Pool can only be dewatered to the current outside local water level.

Water management criteria were first drafted for WMU #2 in 1969. The criteria centered around lowering the water levels to an objective that provided a near maximum puddle duck marsh (0-2'deep) while still maintaining as much semi-dry marsh and timber as possible for waterfowl nesting. This was to be accomplished while avoiding a rise in water levels that would kill timber and brush. An awareness of the value of buttonbush as important waterfowl brood cover became evident in these criteria.

Although a management level of 96.50' MSL was established in the mid-1970's, a 6" buffer was retained for evapo-transpiration during the summer. This modified level of 97.00' MSL has been maintained to the present but lake levels do not begin to approach the water management objective until mid-June. Under present objectives, the management level should be reached by or during the beginning of the waterfowl nesting season in early April so that a maximum of above water areas would be available for puddle-duck nesting.

III. WATER MANAGEMENT OBJECTIVES

The water management units are intended to advance this field station's principal wildlife management objective: converting lower value wetlands into productive waterfowl habitat (statement of Missisquoi NWR Management Objectives-1969). The objective further states that, "Water levels in impounded areas will be managed to provide optimum habitat conditions for nesting waterfowl and for migrants." Further down on the same page: "To meet waterfowl objectives, it will be necessary to provide as many acres of water as possible up to (a) two feet water-depth.....the design level should provide for the exclusion of river flood waters."

Current management schemes work within these objectives but are handicapped by the inoperative WCS at Big Marsh Slough and the incomplete diking system at both WMU's.

In answer to the marsh and water management review questionnaire, the staff ranked marsh and water objectives as follows (ranked from 0-10 with 10 being most important):

Duck production-	10
Other migratory wildlife	9
Endangered or threatened species	8
Consumptive recreation-	7
Furbearers-	7
Resident wildlife-	6
Non-consumptive recreation-	5
Economic benefits-	3
Resident fish-	1
Goose production-	1
Duck overwintering-	0
Goose overwintering-	0
Migratory fish-	0

The main marsh and water management objective is to provide optimum habitat conditions for nesting and migrating waterfowl. With this in mind, production and peak population estimates are presented below (Tables 1, 2 and 3 and Figure 1):

TABLE 1. ANNUAL WATERFOWL PEAK POPULATIONS MISSISQUOI NWR, 1964

Mallards	500
Black duck	7,500
Gadwall	---
Pintail	165
GWT	250
BWT	100
Widgeon	150
Shoveler	---
Wood duck	200
Ring-necked duck	1,200
Hooded merganser	25
American goldeneye	---
All other ducks	---

TABLE 2. ANNUAL WATERFOWL PEAK POPULATIONS
MISSISQUOI NWR, 1981-1986

	1981	1982	1983	1984	1985	1986
Mallard	6,500	9,100	5,440	8,700	5,000	2,860
Black Duck	3,500	4,900	3,060	4,100	3,100	1,410
Gadwall	50	325	275	100	430	40
Pintail	550	400	800	200	100	110
GWT	250	400	250	300	525	310
BWT	225	250	300	350	300	50
Widgeon	250	600	1,000	300	750	310
Shoveler	25	50	35	50	40	10
Wood duck	1,500	1,500	1,200	1,600	1,300	920
Ring-necked duck	8,200	8,500	7,685	4,000	4,000	11,250
Hooded Merg.	100	75	75	50	125	50
American Goldeneye	400	300	200	150	197	160
All other Ducks	---	---	---	130	127	160
Total	21,550	26,400	20,320	20,030	15,994	17,640

Table 3. ESTIMATED WATERFOWL PRODUCTION
MISSISQUOI NWR 1981-86

	1981	1982	1983	1984	1985	1986
Wood duck	385	385	450	136*	322	281
Goldeneye	125	165	200	250	285	175
Mallard	345	200	200	200	114	118
Black duck	205	80	50	50	8	33
Blue-winged teal	70	65	100	100	5	35
Green-wing teal	---	---	---	---	---	27
Hooded merganser	15	25	20	24	30	10
Total	1,145	920	1,020	760	764	679

* May be due to error on new surveyor's part.

Both consumptive and nonconsumptive recreation occur as benefits of the marsh and water resources of the refuge. Total refuge visits in 1986 were estimated at 8,966. Many of these people walked the nature trail which wends its way adjacent to and across wetlands. In addi-

tion, hunting accounted for 1,198 waterfowl which represents approximately 4,792 activity hours of effort. A total of 1,626 acres (28 percent of the refuge) is open to migratory bird hunting.

IV. MANAGEMENT STRATEGIES

The primary strategy for managing refuge impoundments is water level manipulation; however, because of incomplete diking and an inoperative WCS, water levels cannot be adequately controlled.

In WMU #1, the Lake Champlain level controls the water level until the perimeter elevation of approximately 96.50' MSL is reached. The principal water sources are Dead Creek, Lake Champlain, and precipitation. The 4' CMP outlet, equipped with stoplogs, is not functional and serves no purpose. Very costly maintenance and upgrading are required upon it and the adjacent dike before they can be made serviceable.

Unlike WMU #1, control over water levels in WMU #2 is present until the Missisquoi River exceeds 99.25' MSL, at which point water enters Cranberry Pool over a low riverbank west of Goose Pen Channel. Two 4' CMP WCS's located just west of Dead Creek permit draw-down once exterior water levels recede below 99.25' MSL. A Refuge Water Management Plan that centers around Cranberry Pool was approved in 1986.

The current general water management policy is to lower the spring water levels to 97.20' MSL as soon as possible to provide puddle-duck nesting habitat, and holding the water at that level the rest of the year. This policy appears to best meet the objectives of the new Water Management Plan by providing the most acreage of open water with a depth of two feet or less. Waterfowl food and cover plants respond well to such a program, as do waterfowl, wading birds, and mammals. If spring flood-waters are excluded, the need for a draw-down during the waterfowl nesting season (early April-early June) would be precluded. Completion of the Cranberry dike along the northwesternand western low areas of Cranberry Pool would exclude those spring flood-waters and make this Unit more manageable.

V. PROBLEMS AND SOLUTIONS

The abundance and distribution of plants and animals associated with wetlands are controlled by soil nutrients, climate, the quality and quantity of water, and hydroperiod. The hydroperiod (seasonal and long-term availability of water)is undoubtedly the single most important factor that influences habitat conditions and the subsequent use by wildlife. At Missisquoi NWR the most obvious problem is not one of too little water but one of too much when spring

floods cannot be excluded from the WMU's. Managers have had to live with this dilemma, focusing their efforts mainly on waterfowl food and brood habitat production. Despite the impoundment deficiencies, refuge personnel have moved close to achieving some important aspects of the Marsh and Water Management Program objectives.

Following are marsh and water resource problem areas identified by the refuge staff. The subjects are prioritized and ranked from 0 to 10 with 10 being the worst problem.

A. Drainage capabilities (10)

1. WMU #1-

WMU #1 CMP has a 4'outlet with an invert of 92.00' MSL in the Big Marsh Slough dike. This WCS is completly silted in and has not been functional for several years. Because of incomplete impounding, the objective level of 97.00' MSL cannot be maintained. Water levels with in this unit are directly related to those of Lake Champlain until the lake drops below the perimeter elevation of 96.00' MSL, usually by July 1. Thereafter, pool levels are maintained by rainfall, usually remaining 18"-24" higher than the lake. At this stage, dewatering is not possible without pumping. Two large capacity pumps would be necessary: one operating from atop the Big Marsh Slough dike and the other from the lowest point of Goose Bay Pool dike. No data are available detailing the time to drain Unit #1 with pumps.

To allow the full range of management options as originally envisioned and designed, diking of this unit would have to be completed. In addition, either the nonfunctioning WCS should be renovated or a new one constucted. For the money involved, it probably would be more cost effective to construct a new WCS: Pumping may be possible but does not appear to be an efficient long term alternative.

2. WMU #2-

Unlike WMU #1, Unit #2 water levels can be controlled until the Missisquoi River exceeds 99.25 MSL, at which point river water enters the pool over the low bank west and north of Goose Pen Channel. Two 4' CMP WCS's permit the desired draw-down once river levels drop below the 99.25' MSL.

Station objectives stress that spring floodwaters should be excluded from Unit #2 to preclude the need for a draw-down during the waterfowl nesting season. It is assumed that with more nesting habitat available, waterfowl production should benefit. Obviously, completion of Cranberry Dike along the northwestern and western low areas of Cranberry Pool would eliminate spring flood-waters. A WCS should be included in this diking for added flushing and quicker dewatering capabililties.

B. Water depth(9)

This is directly related to the problem presented in the above constraint, "Drainage Capabilities". The suggested solutions there are also applicable in this case.

C. Protection of dikes and WCS (8)

Additional maintenance and some rehabilitation of dikes and WCS's are needed. The Big Marsh Slough WCS has been inoperative for years; the Goose Bay Pool dike's slopes are much too step; and, the Cranberry Pool WCS leaks. Although there are probably no keys in the dikes, seepage is not a problem. Burrowing by woodchucks in the upper half of dikes and muskrats at water level or below has the potential of creating weakened areas susceptible to localized collapse and/or washouts.

Repair or replacement of the Big Marsh Slough WCS and completion of all peripheral diking are necessary for achieving full control of water levels in this Unit. Obviously, this would be very expensive and have to be planned and budgeted for well in advance. The Goose Bay Pool's dike slopes are reaching the point that the structure's integrity may soon be threatened. An engineer should examine this dike and also the leak at the Cranberry Pool WCS to ascertain potential problems and suggest repairs. This should be done as soon as possible. Woodchuck and muskrat burrows in the dikes can be maintained at tolerable levels through gassing (woodchucks) and trapping (muskrats). Current funding will allow the staff to effectively control these animals on and near the dikes.

D. Public use conflicts(7)

This refers to staff time administering hunting and fishing on the refuge. Such efforts detract from more closely achieving the major refuge objectives. Until sufficient staff time is available to adequately cover all facets of the station program, it will be necessary to operate on a priority basis determined by refuge objectives.

E. Pest plants (5)

Although purple loosestrife has been observed on the refuge for many years, it has not established itself in extensive, almost monotypic stands as it frequently has elsewhere in New England. Control

efforts, using RODEO, began in 1984 and show promising results although the treatment will probably have to be an annual endeavor with the WMU's receiving priority.

Purple loosestrife is most thickly established along the south boundary of the Maquam Swamp. Control on this area has not occurred due to the higher priority of spraying loosestrife in the managed marsh and the river delta marshes that are the principal areas used by waterfowl.

It will probably be impossible for a five person staff to completely control loosestrife over the entire refuge using single plant applications of RODEO from backpack units.

In 1986, a second well-known pest plant, phragmites, was located along the northern end of the Cranberry Pool dike. This was controlled with RODEO. A stand of 3 + acreas of phramites was found in Big Marsh Slough in the fall of 1986. This stand is too large for current techniques and will have to be aerially sprayed.

The staff will have to be constantly alert for incursions of these pest plants and aggressively work at their control. Aerial searches every other year may be desirable.

F. Water quality (3)

Recently, state personnel have cautioned the public against eating lake trout caught in Lake Champlain because of high PCB levels. It is not known if any refuge fishes are similarly affected. When more information becomes available and if it appears refuge species (especially those in the impoundments) could harbor potentially harmful chemicals, samples should be taken and analyized. No landfills are known to be adjacent to or near the refuge nor is the staff aware of any upriver chemical or heavy metal sources of any significance.

G. Pest animals (2)

Woodchucks and muskrats in pest situations were covered under Number 3- "Protection of dikes and WCS's". Beavers are generally not a serious problem to the dikes.

H. Water supply (2)

The water level in WMU #1 is directly related to that of Lake Champlain until the lake level drops below 96.00' MSL. Thereafter, the water level is only

maintained by rainfall which at times may not be adequate.

Complete peripheral diking with an operable WCS and/or pumping would provide an adequate water source.

VI. Program Evaluation

Water management, though handicapped at Missisquoi NWR, became a reality in the early 1960's with the partial construction of the Goose Bay Pool and Big Marsh Slough dikes which have yet to be completed. In 1970, water management at Cranberry Pool also became feasible although again, full peripheral diking was not and never has been completed. Spring flooding frequently overtops low non-diked areas of the impoundments which is believed to minimize nesting habitat for ground nesting puddle ducks at a crucial time. Because of this, one of the major program objectives- to manage water levels in impoundments to provide optimum habitat for nesting waterfowl- has frequently not been attainable.

At odds with some refuge objectives are the results of studies by Vermont Fish and Game Department biologists in the mid-70's which showed excellent success of black ducks and mallards that selected nest sites in flooded wooded swamps in tree stumps, upturned roots, and deadfalls. It was felt these birds had been imprinted to do this, "knowing" that the greatest flood waters might come after the site was chosen. The average height of 17 nests (black ducks-8; mallards-9) was 4.5' above the high water (101.55' MSL). None of the nests were lost to flooding and about 60 percent of the total first nests were successful. The next year, 38 nests were found and the average height above water was 4.8'. Again, there was no loss of nests to high water.

Other black ducks and mallards nest in brush and fields on the refuge and adjacent to it. What percentage of these birds do so is not known. In fact, nesting data for these species on the refuge is skimpy at best, so it is impossible to project reliable estimates of nesting and success in flooded timber vs. brush and fields, and to compare the results from years of high and low water levels.

Maintaining lower levels in impoundments, although creating additional nesting locations, would also decrease water depths, allowing easier access by shoreline mammalian predators, especially raccoons. It is not known what affect this would have on nesting ducks, although the assumption would be that predation would increase and nesting success decrease. The Service should determine which water management regime in the WMU's affords the best nesting success for black ducks and mallards.

The other major nester, the wood duck, begins nesting later, often during the highest stage of lake water but is less affected than the first two species. The "woody", being a hole nester, uses natural cavities and man-made nesting boxes, always nesting well above flood waters. The

blue-winged teal, however, is primarily a grassland nester and on the refuge, although nesting later than blacks and mallards, may well be the species most affected by high water.

Normal for Lake Champlain is its yearly cycle of water level fluctuations which usually differ every year and sometimes markedly every few years. It is these higher highs and lower lows that keep the whole ecosystem in such a vibrant state of vigor, releasing fresh nutrients each time to stimulate change, abundance, food, and pioneering of both fauna and flora. Our management should be aimed at complementing this system with variations that will maximize waterfowl production and waterfowl foods over extended periods. In line with this, spring high waters with their attendant nutrients, should not be completely eliminated from the regime.

There is good interspersion of waterfowl food and cover plants on both WMU's although additional open-water areas would be beneficial, particularly in Unit #1 where dense stands of buttonbush and leatherleaf predominate. Selectively opening up these stands would increase waterfowl usage in areas currently experiencing low to nonexistent use.

Excellant stands of wild rice exist in the impoundments, especially in Unit #2 where they are predominating in some sections almost to the extent of being a monoculture. Although it is a fine waterfowl food source and does provide cover, at some point it may have to be checked in favor of better plant interspersion. Perhaps after a dewatering year, competing species will be more in evidence.

Prior to dike construction (and even now to some extent), there was concern by both state biologists and the public that the dikes would eliminate access of northern pike to large areas of spawning habitat. Brief surveys in the 1960's and 1970's by FWS Fisheries Assistance personnel indicated there were no extensive spawning areas in the impoundments that would significantly add to the annual recruitment of pike. Some of the better spawning habitat is created when sedge and grasses establish themselves on the outter dike faces.

Staff evaluation of the Marsh and Water Management Program is assessed through a synthesis of data collected from:

Waterfowl roost counts
Waterfowl brood surveys
Waterfowl breeding pair surveys
Waterfowl nest box surveys
Weekly waterfowl surveys
Great blue heron nest counts
Beaver and muskrat counts
Aquatic vegetation transects

Under present staffing limitations, just to accomplish the above requires a concerted effort by both staff and volun-

teers.

None of the planned impounding has occurred at Maquam Swamp and it is unlikely that it will because such a proposed major construction project in a federally-owned wetland would stand little chance of approval. Of the three proposed Maquam impoundments, Number 5, however, would probably have the best chance of being constructed because it would create a moist soil area dependent on the spring flood and rain for water.

As much becomes known about Maquam Swamp (actually a bog), the more it appears to be a unique ecosystem,exhibiting plant and wildlife species regarded as threatened or of special concern by the state. Preliminary investigations indicate that the present trophic status and plant community composition are regulated by three interacting processes:

1. Annual flooding by Lake Champlain.
2. Plant successional processes and peat accumulation.
3. The regular occurrence of natural fires.

The plans for impounding the swamp would obviously destroy this ecosystem.

III. SUMMARY

The water management infrastructure at Missisquoi NWR is from 17 to 27 years old and is in need of not only increased maintenance and repairs but also completion of the dikes in Units 1 and 2. The plug dikes in WMU # 1 allow water to be held in the pool but the depth is determined by spring floods as the one WCS is inoperable. There is some water management capability in WMU #2 because the WCS's function, but flood waters cannot be excluded. Although a major objective is to create waterfowl nesting habitat in the impoundments by excluding spring flood waters, it is not known how much nesting currently occurs or how much high water actually tends to prohibit nest access by mammalian predators. Waterfowl food and cover production in the impoundments are good but there is a tendancy towards monotypic stands of wild rice which decreases species and life form interspersion. Some stands of buttonbush receive little waterfowl use except as brood cover.

An effort is being made to control the two most important pest plant species on the refuge: purple loosestrife and phragmites. This relatively recent endeavor appears to be fairly successful for the loosestrife and should be for phragmites as it is very localized.

VIII. RECOMMENDATIONS

A. Bring existing diking at both WMU's up to Service standards.
B. Rehab. WMU #1's WCS or construct a new one.

C. Repair leaks at WMU #2's WCS'S.
D. Complete peripheral diking at WMU #2.
E. Install a WCS in the proposed WMU #2 dike with access to the Missisquoi River.
F. Determine if nesting by puddle ducks in the impoundments' flooded timber is in concert with high water levels. Apply results towards water management regimes.
G. Install water guages to monitor water levels in both WMU's, Dead Creek, Charcoal Creek, and the Missisquoi River.
H. Selectively open up dense buttonbush and leatherleaf stands, especially in WMU #1.
I. Continue annual control efforts directed at purple loosestrife and phragmites.
J. Master plan the refuge before any effort is expended on the Maquam Swamp diking proposal.
K. Develop a method to adequately monitor and evaluate the effects of the station's marsh and water management program. As part of this method, it would be helpful if the pools' aquatic vegetation could be mapped every three years, realizing that staffing constrants might only allow a very general appraisal.
L. Re-evaluate the current marsh and water management objectives.