# MISSISQUOI NATIONAL WILDLIFE REFUGE

## SWANTON, VERMONT

## ANNUAL WATER MANAGEMENT PROGRAM

## 1990

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Prepared by: John B. Gallegos, Assistant Refuge Manager — Date: 6/19/90

Submitted by: Robert A. Zelley, Refuge Manager — Date: 6/20/90 ~~6/20/90~~

APPROVED
~~Reviewed~~ by: Don Frickie, Associate Director — Date: 9-17-90

~~Approved~~ by: ~~Don Young, Assistant Regional Director~~ — Date: 8-20-90
REVIEWED GEORGE GAVUTIS; SUPERVISORY REG. BIOLOGIST

MISSISQUOI NATIONAL WILDLIFE REFUGE
RD2-RT 78
PO BOX 163
SWANTON, VT 05488

I. A. Annual Water Management Program Outline

Refuge: MISSISQUOI Water Unit Name or Number: #2 - CRANBERRY POOL

Maximum elevation permissible: Approximately 99.25' MSL

Flowline elevation of lowest drain structure: 93.00' MSL

Elevation of general pool bottom (not borrow pit bottom): Approximately 95.50'MSL

A.1. Water Surface Elevations and Salinity for Fast Year

| Date | Water Surface Elevations | *Salinity (% of Sea Water) |
|---|---|---|
| Jan. 1 | 97.84' MSL | |
| 15 | 97.81' MSL | |
| Feb. 1 | 97.80' MSL | |
| 15 | 97.75' MSL | |
| Mar. 1 | 97.73' MSL | |
| 15 | 97.33' MSL | |
| Apr. 1 | 99.79' MSL | |
| 15 | 98.80' MSL | |
| May 1 | 98.33' MSL | |
| 15 | 98.22' MSL | |
| June 1 | 98.10' MSL | |
| 15 | 97.59' MSL | |
| July 1 | 97.20' MSL | |
| 15 | 97.10' MSL | |
| Aug. 1 | 96.80' MSL | |
| 15 | 96.90' MSL | |
| Sept.1 | 96.90' MSL | |
| 15 | 96.85' MSL | |
| Oct. 1 | 97.00' MSL | |
| 15 | 96.90' MSL | |
| Nov. 1 | 97.10' MSL | |
| 15 | 97.10' MSL | |
| Dec. 1 | Not Available | |
| 15 | 96.50' MSL | |
| 31 | Not Available | |

B.2. Planned Elevation and Salinity for Program Year

| Water Surface Elevation | *Salinity Objective |
|---|---|
| 97.20' MSL | |
| Draw pool down gradually - 3/1/90 | |
| 96.80' MSL | |
| 96.00' MSL | |
| Ice-out expected 3/25 & flooding by river. | |
| 98.00' MSL (due to flooding) | |
| 97.75' MSL (drawdown) | |
| 97.50' MSL (draw-down if needed) | |
| 97.20' MSL | |
| 97.20' MSL (Draw-down) | |
| 96.00' MSL | |

*To be used for pools approved for brackish water management.

## I.B. EFFECTS OF THE PAST YEAR'S WATER LEVELS ON THE ECOLOGY OF WATER MANAGEMENT UNIT #2

### 1. Water Supply and Use During 1989

As during the past three years, low April precipitation levels resulted in a brief ice-out and flooding this year. The floodwaters of the Missisquoi River and Dead Creek crested at 99.60' mean sea level (MSL) during 3/28 and 4/7. The Cranberry Pool (water management unit), read slightly higher (99.79' MSL) during that time, since the monitoring station is located in the southeastern corner of the pool, opposite from the western side where the Missisquoi River overtops its banks and floods the pool. Prevailing northerly winds, when combined with the floodwater's pressures, create this annually. This high pool level was somewhat of a disappointment, since Refuge staff had chopped through foot-thick ice on 3/1 to open two bays of the Cranberry Pool water control structure (WCS) and dropped pool levels down to the 96.00' MSL objective by 3/9. Subsequent rising pool levels from melting snow and ice raised the pool level back up to 97.33' MSL by 3/15. Attempts to drop the pool level back down to 96.00' MSL on 3/15 were thwarted when ice-out of the Missisquoi River and Dead Creek appeared imminent on 3/17. The pool level had only dropped to 97.20' MSL when it was closed on 3/17, to protect it from ice damage. An ice break-up occurred on 3/18 - 3/19, however, the river refroze again, so that the feared ice-out never occurred. No further attempts to lower the pool level were attempted. The actual ice-out commenced on 3/27, with ice jamming further north than normal, at the Highway 78 bend and down to the Louie's Landing boat launch.

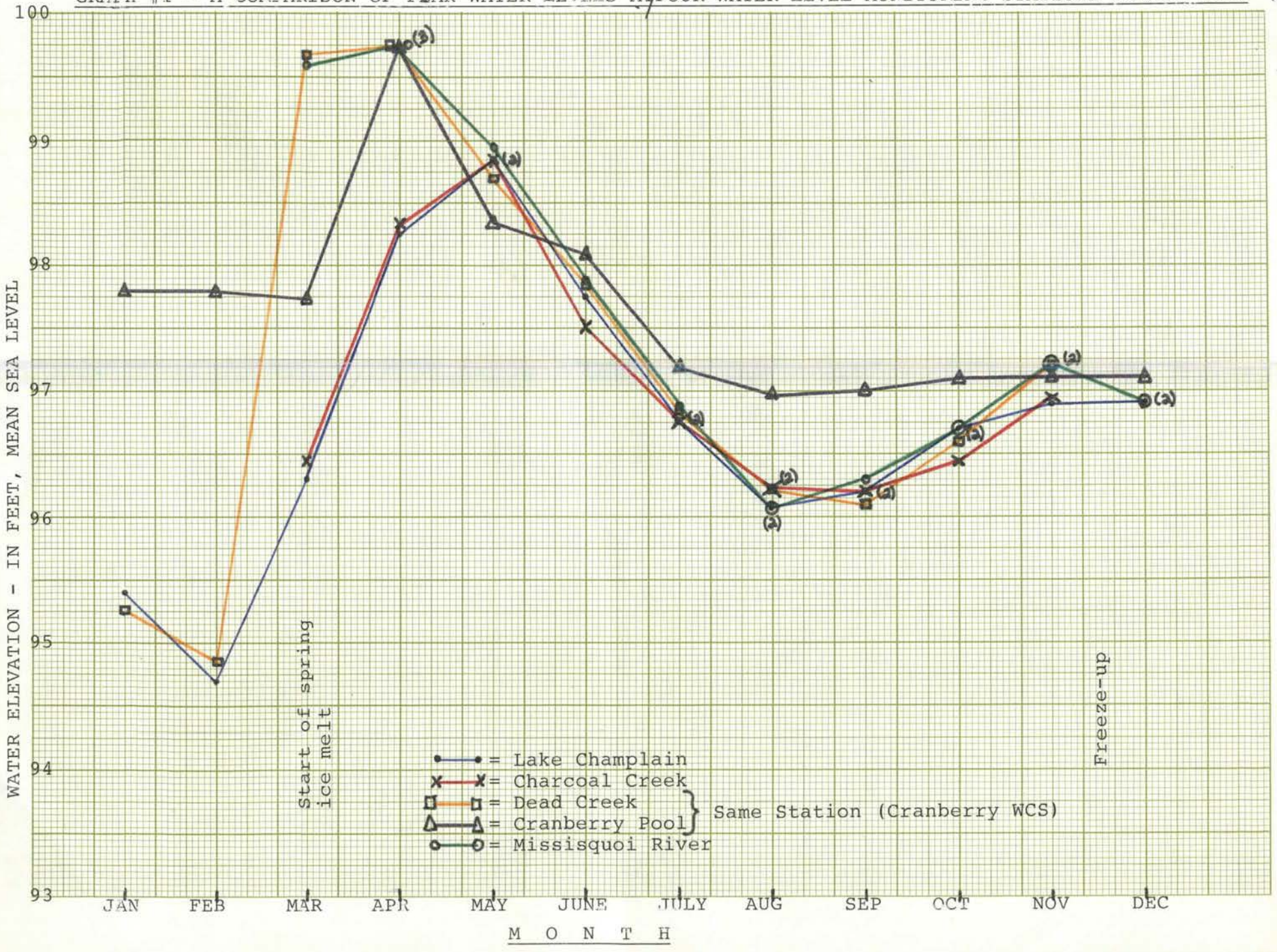
The 1989 Annual Water Management Program had called for lowering Water Management Unit (WMU) #2's level to 96.00' MSL during early March, to try to rescue the negative impacts (loss of ground-nesting habitat to arriving waterfowl) of the spring flooding. This could not be accomplished. The flooding raised this unit's levels to the usual flood levels, well beyond the 97.50' MSL level projected for April 15, in the annual program. The pool level was dropped to 99.33' MSL during 4/4 - 4/6. Rising water levels in Dead Creek forced staff to close the WCS on 4/6, to prevent water entry, through the structure, from Dead Creek. On 4/10, the WCS was reopened, until 4/19, when the pool level reached the level of Dead Creek (approximately 98.40' MSL). The WCS was closed on 4/19 and left closed until the Assistant Manager returned from Law Enforcement Refresher training, on 5/1. On 5/1, the

WCS was reopened and the pool drained down to 98.21' MSL, until rising waters in Dead Creek once again forced closure of the WCS, on 5/3. The outside higher water level of Dead Creek kept the WCS closed until 5/30, when the outside levels dropped to 97.91' MSL, below the pool level of 98.33' MSL. The WCS was left open throughout June, so that the pool would subside with the gradually dropping level of Dead Creek. On 6/28 the pool level reached the objective level of 97.20' MSL, and the WCS was closed.

WMU #2's level gradually subsided thereafter, to 96.80' MSL during early August. Rainfall raised the water level up to 96.95' MSL by 8/23, after which it dropped back down to 96.85' MSL by mid-September. Similar fluctuations, between 96.85' MSL and 97.10' MSL occurred during September and October. On 11/2, the Cranberry WCS was reopened, in an attempt to bring pool levels down to the 1988 Program objective of 96.00' MSL, for November. High outside (Dead Creek) water levels kept this from occurring, however, by 11/8, the pool level had only been lowered to 96.58' MSL and water began flowing into the pool from Dead Creek. Rather than close the WCS, a decision was made to leave it open during the winter, until the level dropped to 96.00' MSL. The Cranberry Pool froze over during the third week of November. The water had dropped to 96.50' MSL by mid-December, where it stayed for the rest of the month. The ice-formation around the WCS was only 1½" to 3" thick due to the water flow, and allowed easy penetration with an ice chisel for water level readings.

A comparison of the peak high water levels for each of the four water monitoring stations located on Missisquoi NWR are shown on Graph #1. The Cranberry WCS water monitoring station provides readings for both the Cranberry Pool, on one side of the stoplogs, and Dead Creek, on the other side. The graph shows a definite correlation between the water levels of Dead Creek with the Missisquoi River, and Charcoal Creek with Lake Champlain, as would be expected. It also shows a definite contrast between the levels of Lake Champlain and the Missisquoi River - Dead Creek system. In most cases, the Lake Champlain level never reaches the level of the two waterways.

GRAPH #1 - A COMPARISON OF PEAK WATER LEVELS AT FOUR WATER LEVEL MONITORING STATIONS DURING 1989

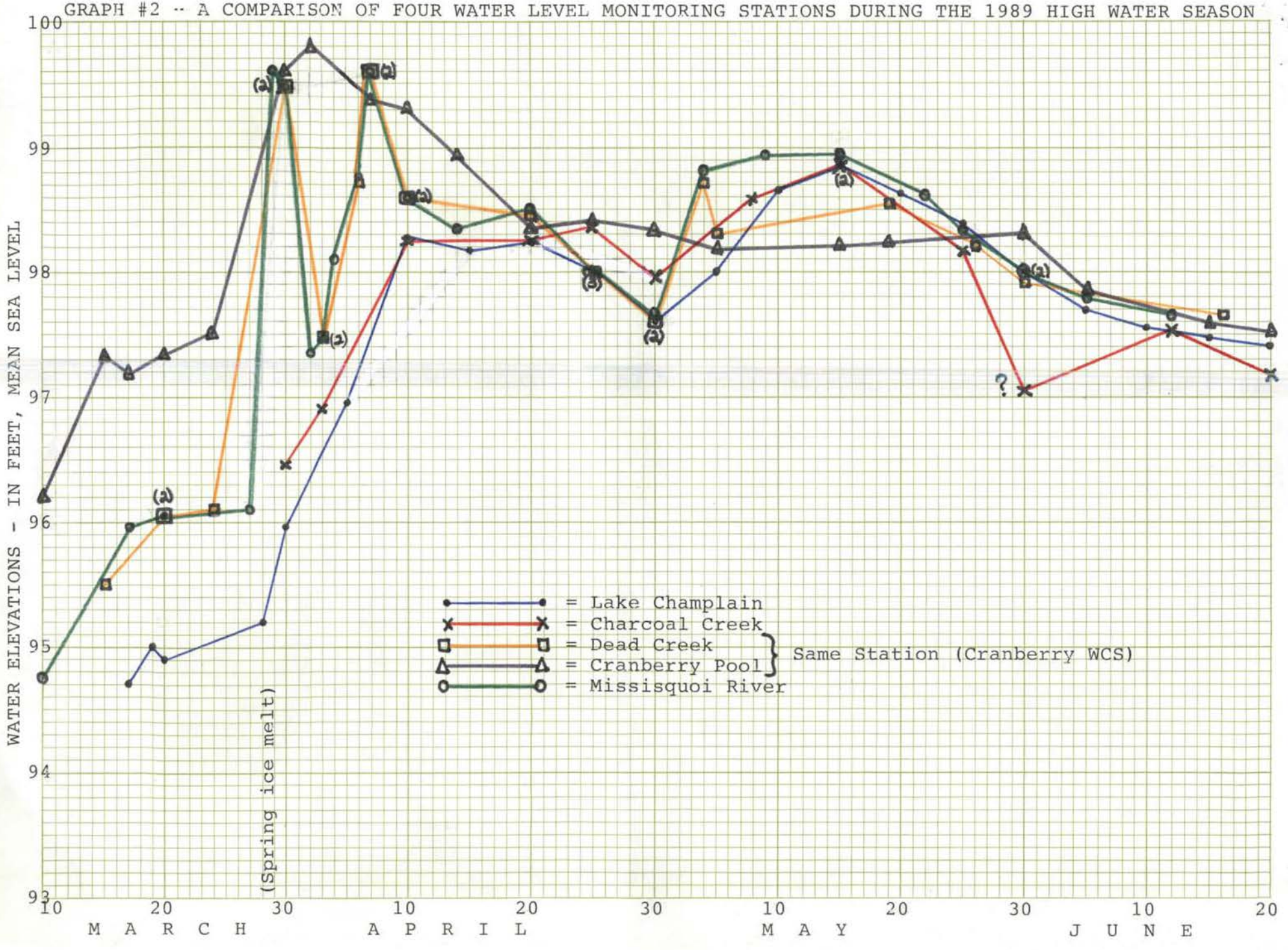


During 1989, Dead Creek water level readings were consistently slightly lower - by 0.10' or less than the Missisquoi River; unlike last year, when Dead Creek levels were slightly higher.

Graph #2 examines more specifically the readings from the four Refuge water monitoring stations during the 1989 spring flooding period. This graph displays the differences in trends between the more dynamic Missisquoi River - Dead Creek system that feeds into Lake Champlain; the Lake Champlain - Charcoal Creek system, that reflects water level changes much more gradually; and the impounded Cranberry Pool (WMU #2). On 4/7, both the Missisquoi River and Dead Creek reached a peak annual high level of 99.60' MSL. The peak 1989 high water period for these two waterways ran from 3/28 - 3/29, to 4/1, and from 4/6 to 4/12. Between these two peak periods, both waterways dropped briefly more than 2', illustrating their tendency to suddenly change levels at that time of year, unlike the Lake Champlain and Charcoal Creek systems. Graph #1 also emphasizes this point. Staff tried to capitalize on the sudden drop in Dead Creek levels by opening the Cranberry Pool's WCS on 4/4. Levels dropped 0.46', before rising waters forced the closure of the WCS on 4/6.

The peak high-water period for Lake Champlain and Charcoal Creek occurred during mid-May, well after the Missisquoi River - Dead Creek peak periods of late March and early April. This mid-May peak was 98.86' MSL, below the Missisquoi River - Dead Creek peak of 99.60' MSL. The Cranberry Pool reflected the highest peak of the three systems being monitored. During the first few days of April, the Cranberry Pool's water level rose to 99.79' MSL - 0.19' above the Missisquoi River - Dead Creek peak of 99.60' MSL. The combination of flooding of the pool, over the banks of the Missisquoi River along the pool's western side, combined with the ice/snow melt within the pool, to create this effect. The Cranberry Pool is flooded when the Missisquoi River reaches the approximate elevation of 99.25' MSL at several points along its western and northwestern side.

Throughout the spring flooding period, WMU #2 appeared to operate independently of the other three more natural water systems of the Refuge. Graph #2 displays this fact. Heavy rains during August kept water levels higher than normal in all five water systems being monitored. Rainfall during September, October and early November


GRAPH #2 -- A COMPARISON OF FOUR WATER LEVEL MONITORING STATIONS DURING THE 1989 HIGH WATER SEASON
WATER ELEVATIONS - IN FEET, MEAN SEA LEVEL
100
99
98
97
96
95
94
93
10
20
30
10
20
30
10
20
30
10
20
M A R C H
A P R I L
M A Y
J U N E
(Spring ice melt)
= Lake Champlain
= Charcoal Creek
= Dead Creek
= Cranberry Pool
Same Station (Cranberry WCS)
= Missisquoi River

were adequate to keep those systems' water levels above normal into the winter. September water levels were 1'-1½' higher than those of the past five years. In conclusion, the 1989 goals of Section IA (Annual Water Management Program Outline) were as follows:

a. Draw WMU #2 down to 96.00' MSL by 3/15/89. This was accomplished.

b. After spring flooding, draw WMU #2 down to 97.20' MSL by 5/15/90. This was not accomplished due to the flooding of the pool up to its usual flood levels (well above 99.00' MSL), despite the earlier drop in water level. Outside water levels remained high until June, preventing the draining of the pool down to the objective until then.

c. Draw WMU #2 down to 96.00' MSL by 11/15/90. This was not accomplished, due to the higher levels of the Dead Creek - Missisquoi River system, that the pool drains into, throughout the winter.

2. Related Biological Conditions and Wildlife Use

The current water management policy for the Cranberry Pool (WMU #2) continues to be one of getting the spring (or early summer) water level down to 97.20' MSL as soon as possible and holding the water levels there throughout the rest of the year. This policy has been shown to meet the objectives of the station "Water Management Plan" best, in that waterfowl, food and cover plants, mammals and wading birds respond favorably to such a program.

1989 was no exception to that policy; however, the second peak high-water period of early May (Ref. Graph #2) made draining this WMU below 98.20' MSL impossible, without the aid of pumps - which we do not have. The pool was able to maintain its 98.20' - 98.30' MSL water level throughout this 5/2 - 5/26 high-water period, despite the fact that outside levels were from 0.4' - 0.7' higher during that period. Following the 5/26 drop in outside water levels, the WMU was able to be gradually lowered to the objective, but not until the end of June because of high outside levels.

The sudden 5/1 - 5/4 rise in water levels of all the systems that comprise this area's hydrology, spelled disaster for ground-nesting birds on-refuge. Refuge staff encountered submergent duck nests (mallard or black) on two occasions.

This area's waters rose 1.20' over a four day time period, with the exception of the Cranberry Pool. However, even the waters in the Cranberry Pool were 1.20' - 1.30' above the intended objective level for that time, so that only a limited amount of above-water, nesting substrate was available for ground-nesting waterfowl throughout their peak nesting period here. These impacts combined to provide poor production this year for Refuge mallards, black ducks and teal, as in most past years. Completion of the Cranberry Dike along the Missisquoi River should eliminate the spring flooding problem for this WMU - unless other unknown hydrological impacts occur - and is encouraged. The original intent of this unit has not yet been achieved, despite the costs already invested, due to the incomplete dike along the northwestern periphery of the pool - where the Missisquoi River overtops its banks and floods the pool each spring. The flooding lasts for only 7-10 days; yet it renders the pool unusable for black duck, mallard and teal nesting until after the duck-nesting season is essentially over in late May or June. This pool's potential ground-nesting duck production has never been realized, nor will it be, until the original development plans are completed.

Cavity-nesting duck production was very good this year in WMU #2. Their production is unaffected by high-water levels, since they usually nest well above the high-waters of spring in Refuge nestboxes or natural tree cavities.

General waterfowl use of WMU #2 was on a level with past years, as was waterfowl food and cover plant distribution and availability.

During 1989, wading birds consistently utilized the interior of this water management unit, particularly the great blue, black-crowned night and green-backed herons. The continuous presence of these waders in Cranberry Pool indicates the presence of a viable fish and frog population that probably supports the large, great blue herony on Shad Island, approximately three miles to the north.

Raptors such as the marsh hawk and red-tailed hawk were also frequent visitors to this WMU during 1988. Muskrat and beaver populations increased. Muskrat and beaver trapping harvests, beaver house surveys, and a lack of negative impacts to wetland habitats, reflect viable populations of these mammals.

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## I.C. STATEMENT OF OBJECTIVES FOR THE PROPOSED LEVELS

During 1988, a great deal of discussion and consultation took place between management staff and Dick Quinn of the Regional Office's engineering division, that involved understanding the hydrology of the Cranberry Pool and surrounding area. These discussions focused on the feasibility of WMU #2 maintaining a lower water level than the exterior water levels (of Dead Creek, the Missisquoi River and Lake Champlain) during the spring ice melt and subsequent flooding. If feasible, then completion of the Cranberry Pool dike system along the low-lying areas of the Missisquoi River on the western side of the pool would also be feasible. The outcome of those discussions remains yet to be seen. However, the following water management changes for 1989 and subsequent years are being initiated in an attempt to improve upon the current situation in this unit, and as a result of some of those discussions, in the event the diking remains incomplete. Section IV.B.2. of the station "Water Management Plan" was revised in 1989 (pps. 24 and 25) to incorporate these changes. They are:

1. During March and November, gradually draw down the pool level to 96.00' MSL, to allow for the usual spring flooding of this unit. Should the unit fail to flood, then the WCS can be opened to permit pool levels to rise to the objective.

2. Start monitoring the water level of Dead Creek inside the WCS, at the same benchmark used for monitoring the pool level, with the aid of a long level.

3. Continue to monitor the two water levels at the WCS through the ice during winter, with the aid of an ice chisel.

4. Arrive at the summer and fall seasons' objective as soon as possible in April, in order that as much nesting substrate as possible be available for such ground-nesting waterfowl as the black duck, mallard and both teals. (In the Lake Champlain area, mallards and black ducks start nesting during the first week of April).

The proposed water levels should benefit ground-nesting waterfowl production by providing increased nesting substrates earlier in the duck-nesting season.

The proposed winter draw-down will provide a one foot water level "buffer," so that the spring flooding will fill, rather than flood, the pool. Although this was not possible during 1989, because of the high water levels throughout the winter, the concept still merits testing. Prolonged flooding of the

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MISSISQUOI NATIONAL WILDLIFE REFUGE
RD2-RT 78
PO BOX 163
SWANTON, VT 05488

II.A. Annual Water Management Program Outline

Refuge: Missisquoi Water Unit Name or Number: Unit #1 & Rest of Refuge

Maximum elevation permissible: Approximately 96.25' mean sea level (MSL)

Flowline elevation of lowest drain structure: N/A (formerly 92.00'MSL)

Elevation of general pool bottom (not borrow pit bottom): Approx. 95.00'MSL

| A.1. Water Surface Elevations and Salinity for Fast Year | | | B.2. Planned Elevation and Salinity for Program Year | |
|---|---|---|---|---|
| Date | Water Surface Elevations | *Salinity (% of Sea Water) | Water Surface Elevation | *Salinity Objective |
| Jan. 1 | No water level readings were taken during 1988 due to an absence of benchmark and water gauge. | | Since water levels cannot be controlled, future planning is not practical. | |
| 15 | | | | |
| Feb. 1 | | | | |
| 15 | | | | |
| Mar. 1 | | | | |
| 15 | | | | |
| Apr. 1 | | | | |
| 15 | | | | |
| May 1 | | | | |
| 15 | | | | |
| June 1 | | | | |
| 15 | | | | |
| July 1 | | | | |
| 15 | | | | |
| Aug. 1 | | | | |
| 15 | | | | |
| Sept.1 | | | | |
| 15 | | | | |
| Oct. 1 | | | | |
| 15 | | | | |
| Nov. 1 | | | | |
| 15 | | | | |
| Dec. 1 | | | | |
| 15 | | | | |
| 31 | | | | |

*To be used for pools approved for brackish water management.

pool by the Missisquoi River during the spring melt may defeat the winter draw-down effort in some years, but the attempt must still be made each year, rather than do nothing. The pool's water levels, at 96.00' MSL, may be able to withstand the short-term flooding of 3-4 days, that typify the Missisquoi River's impacts to the Cranberry Pool in most springs. During 1987, the pool level was only raised approximately 0.6' by flooding along the low areas of the Missisquoi River.

Should the pool be flooded up to an approximate increase of 1.2', the objective will have been attained without having to drawdown the WMU at all. This would be a first for this station. Should less than 1.2' of floodwaters enter the Pool, then the WCS can be opened to permit additional water entry until the objective is attained. With such a program, the Pool should be at the objective level by the beginning of the duck-nesting season. Under no conditions should pool levels be left below the objective level during April, for any attempts to raise the Pool to 97.20' MSL after the start of the duck-nesting season may result in the flooding and destruction of waterfowl nests on the ground.

The proposed water levels and gradual winter draw-downs will provide a more dynamic management program that should retard eutrophication and not significantly affect other WMU residents (muskrats, otter, beaver, fish, etc.). An adequate water depth will remain in most areas normally permitting their movement beneath the ice.

Water level readings must continue being obtained twice weekly during 1990, at all monitoring stations, when weather and conditions permit. Measuring both the Dead Creek and Cranberry Pool levels at the Cranberry Dike's WCS will allow a more accurate assessment and comparison of water level differences between Dead Creek, the Missisquoi River, Cranberry Pool and Lake Champlain. A better understanding of this station's hydrological dynamics should result in and provide for better management decision-making. Continuing the readings throughout the winter will provide data for a time of year when it had not been obtained in the past and plug the statistical gaps in the annual hydrological cycles of this area on Refuge records.

## II.B. EFFECTS OF THE PAST YEAR'S WATER LEVELS ON THE ECOLOGY OF WATER MANAGEMENT UNIT (WMU) #1 (BIG MARSH SLOUGH AND GOOSE BAY POOL)

### 1. Water Supply and Use During 1989

Big Marsh Slough and Goose Bay Pool continue to be treated as a single Water Management Unit (WMU #1). They were connected by a man-made ditch between the two systems

during the latter 1960s (Ref. Map #2). Incomplete diking around the perimeter of these areas holds water only below the 96.25' - 96.50' MSL elevation.

The stop-logs in the Big Marsh Slough dike were not manipulated during 1989, since the water control structure (WCS) is totally silted in. To our knowledge, that WCS has not been used for 10-15 years, since management has centered around simply retaining as much water as possible for as long as possible. Therefore, the unit operates in accordance with the water levels of Dead Creek and Lake Champlain, until the water levels drop below the approximate perimeter elevation of 96.50' MSL. The connecting ditch between Big Marsh Slough and Goose Bay Pool was dammed up by beavers during 1969, and a decision was made then to allow it to remain, in order that 2"-4" more water be retained within Goose Bay Pool than in Big Marsh Slough. This policy has continued to the present, and will be continued, since the waterfowl habitat in Goose Bay Pool is improved by the higher water levels.

Water levels in WMU #1 are not presently measurable since no known benchmark elevation is located therein that will permit measurements. However, if it is assumed that the levels in Big Marsh Slough are similar to those of Lake Champlain, and that Goose Bay Pool levels are slightly higher than the Lake Champlain - Big Marsh Slough levels, then the 1989 water level trends can be identified from Lake Champlain's water level readings.

Using 1989 data from Refuge files ("Monthly Record of Gauge Findings and Weather"), the WMU #1 water level dropped well below 94.00' MSL (1/25) during January, February and early March. The known winter low was 94.60' MSL, while the high was 95.40' MSL (1/1). Since water levels below 96.25' - 96.50' MSL do not seem to cause a similar subsidence of WMU #1's more confined water levels, it must be assumed that WMU #1 maintained levels of approximately 96.00' - 96.50' MSL throughout this same winter period.

Lake levels rose rapidly, from 94.90' MSL (3/24) to 96.63' MSL (4/1) in response to the ice melt. WMU #1's water levels are assumed to have been also flooded to the 4/1 Lake Champlain level. Thereafter, both systems' water levels continued rising and subsiding synonymously during April and early May to the annual peak of 98.86' MSL of 5/15. A gradual subsidence occurred throughout May, June and July, until 6/17 when the waters dropped below 96.25' MSL, making WMU #1 independent of Lake Champlain. Lake Champlain continued to generally subside from July through

September, to the annual low of 96.50' MSL, on 9/15. It must be assumed that the WMU #1 water level also subsided below 96.00' MSL during this low-water period, due to evapo-transpiration. Thereafter, the water level rose to 96.20' MSL on 9/25 before dropping once again to the annual low (95.60' MSL) on 10/15. Lake levels remained lower than the perimeter elevation (96.25' MSL), and therefore, probably did not enter WMU #1, nor raise its water levels significantly at that time. However, during later October, Lake Champlain levels rose to 96.68' MSL, and stayed above the 96.25' - 96.50' MSL perimeter elevation of WMU #1 through November and until the second week of December. During this period, the Lake Champlain level and the level of WMU #1 were synonymous, to include the November peak of 96.90' MSL (11/25). Lake levels subsided to the 96.00' - 96.20' MSL mark during most of later December, after falling below 96.25' MSL on 12/15. Despite the lower levels outside WMU #1, we must assume that the water levels within the unit maintained a level of approximately 96.20' - 96.25' MSL during the last two weeks of December.

In summary, WMU #1 maintained water levels that were higher than the levels of 1988, but similar to the levels of 1986 and 1987. The Lake Champlain level was below the WMU #1 perimeter elevation during January, February, March, half of July, August, September, most of October and the last half of December. During the remaining periods of 1989, the lake level was above the WMU #1 perimeter elevation, resulting in that unit operating as an extension of Lake Champlain, and not as an independent system with higher levels than outside.

2. Related Biological Conditions and Wildlife Use

Despite the lack of water control that currently characterizes Water Management Unit #1, the system fared well during 1989. The Lake Champlain - Dead Creek water levels kept this unit with an adequate amount of water surface acreage that provided for an excellent crop of waterfowl food plants. Wild rice stands predominated in shallow waters and along the water's edges throughout the entire Unit, while submergents and emergents, such as pickerelweed, arrowheads, pondweeds, spikerushes and duckweeds provided plenty of food for the 16,900 ducks using Big Marsh Slough and the 550 ducks using Goose Bay Pool during October. The stands of buttonbush did not seem negatively impacted by 1989 water levels. Water lilies, watershield and burreed were also common throughout the unit. Water Management Unit #1 continues to provide the highest concentrations of waterfowl on-refuge, especially ring-necked ducks. No negative impacts attributable to water levels were observed in this Unit during

1989. The four Phragmites reed stands discovered along the eastern side of Big Marsh Slough during November 1987 appeared dead throughout 1989 as a result of the aerial treatment of those stands on 7/28/88. No retreatment was necessary during 1989, since resprouting was not evident.

No die-offs of fish, mammals or ducks were noticed during 1989. Beaver, otter and muskrat populations appeared healthy.

II.C. A STATEMENT OF OBJECTIVES FOR THE PROPOSED LEVELS

Not applicable.

III.A. 1990 ANNUAL WATER MANAGEMENT PROGRAM OUTLINE FOR THE REMAINING REFUGE AREAS

No applicable. (See Section II A.)

B. EFFECTS OF THE PAST YEAR'S WATER LEVELS ON THE ECOLOGY OF THE REMAINING REFUGE AREAS

1. Water Conditions During 1989

Water conditions within the remaining Missisquoi Delta, Lake Champlain shore areas, Charcoal Creek and Maquam Swamp vicinities, are all tied into the water levels of Lake Champlain. Therefore, their conditions were similar, if not identical, to those of Water Management Unit #1. Although the Maquam Swamp area was proposed for dike construction projects during the 1950s, nothing has been done. Because of the uniqueness of the Maquam Bog, development of that area should be discouraged.

2. Effects of 1989 Water Conditions

The effects of the 1989 water conditions were as favorable throughout the rest of the refuge as they were in WMU #1. The water levels provided for abundant waterfowl food plants and frequent use of Metcalfe Island's Pothole, Long Marsh Bay and Creek, Goose Bay and Gander Bay by dabblers and divers alike. The most puddler use (mallards and blacks) took place in Metcalfe Pothole, Long Marsh Channel and Gander Bay. Wild rice production appeared excellent throughout these remaining Refuge areas, as did arrowhead, pickerelweed and submergent waterfowl food plants. Muskrat populations appeared to be healthy, as did beavers. A gradual increase in the beaver population of Metcalfe Island, Long Marsh Bay and the branches of the Missisquoi River is becoming noticeable through the presence of new houses.

III.C. A STATEMENT OF OBJECTIVES FOR THE PROPOSED LEVELS

Not applicable.

IV. LITERATURE CITED

A. Refuge Manager - "Water Management Plan," (1986), unpublished document on file at Missisquoi NWR headquarters.

B. Refuge Manager - "1989 Annual Water Management Program," unpublished document on file at Missisquoi NWR headquarters.

JBG:jib