Appendix 1A
Water management to minimize pesticide inputs in cranberry production
Supplemental data: Specific project results
Objective 1: insects

DEVELOPMENT OF IMPROVED IPM RECOMMENDATIONS FOR LW BEDS

Background. Cranberry fruitworm is a perennial key pest that is responsible for the majority of insecticide applied in MA cranberry. It must be managed with at least a single insecticide application/year aimed at eggs. Currently, growers make early season spray decisions based on crop phenology. On some bogs and in some years, there is a later season, second emergence of moths that trigger the need for additional sprays; growers detect this event using fruitworm egg counts in berry samples (which is very laborious and imprecise). Identification of the sex pheromone was completed in 1993.

I. Development of protocols for sex pheromone trapping. Trap catches may vary enormously:

A.) by location on a bed.
When traps were placed at three sites on the same LW bed (3.7 acre), we found high variation in counts, shown in Table 1.

Table 1. Trap catches for 3 sex pheromone traps placed on the same bed.

	Moth captures		
Date	Site 1	Site 2	Site 3
6/27	29	3	0
7/05	113	1	0
7/11	25	1	2
7/18	2	0	2
7/24	30	7	0

B.) by height of trap.
Traps were placed 1 meter above the cranberry vine and at vine level at 20 sites. Treatments were separated by 20m. In all but a single case, catches were 10-200 times higher in the traps placed 1 m above the vine. Examples of the HI/LO catches are given in Figure 1.

Conclusion: Additional work is required to standardize trapping protocols. Behavioral observations of evening flights by moths may enhance this process.

II. For early season spray applications, monitoring populations of cranberry fruitworm with sex pheromone traps is not proving to be a precise method for:

A.) timing fruitworm spray applications (appearance of infestation).
Eight sites were monitored for trap catch and berries were inspected for egglaying. Examination of actual infestation (sampling of berries for eggs) showed that the traditional IPM technique for the timing of spray applications by crop phenology (7-9) days after 50% out of bloom) was far less risky than using pheromone trap numbers (i.e. peak catch). Figure 2 shows two of the eight sites.

B.) light trap captures were pursued.
Light trap captures were compared to sex pheromone trap captures at 3 sites. Light traps allow both male and female moths to be collected. See Fig. 3.

C.) determining necessity of management measures (severity of infestation).
Early in the season, we found a poor relationship between trap catch numbers and levels of egglaying (See Fig. 2). When trapping protocols (height and placement on a bed) are improved, we may see an improvement in the relationship between trap catch and egg infestation.

Conclusion: To date, for early water beds, we recommend determination of an early season spray using crop phenology. For LW beds, where fruitworm populations are typically strongly suppressed, for early season assessment, fruit should be sampled for eggs in the interval around peak moth flight to determine level of suppression.

III. For determining the necessity of late-season spray applications, pheromone trapping may be valuable.

Later in the season, there was a better relationship between trap captures and egglaying when trap data were used to determine presence/absence of a second, summer emergence of moths (See Fig. 2). This could eliminate laborious inspections of berries for eggs in cases where moth captures are not observed.

Conclusion: Trapping to eliminate late season fruit sampling as well as unnecessary late season sprays should be a key focus next year.

IV. On beds where cranberry fruitworm populations have been eliminated or suppressed by LW, we showed that moths could invade from external population reservoirs such as:

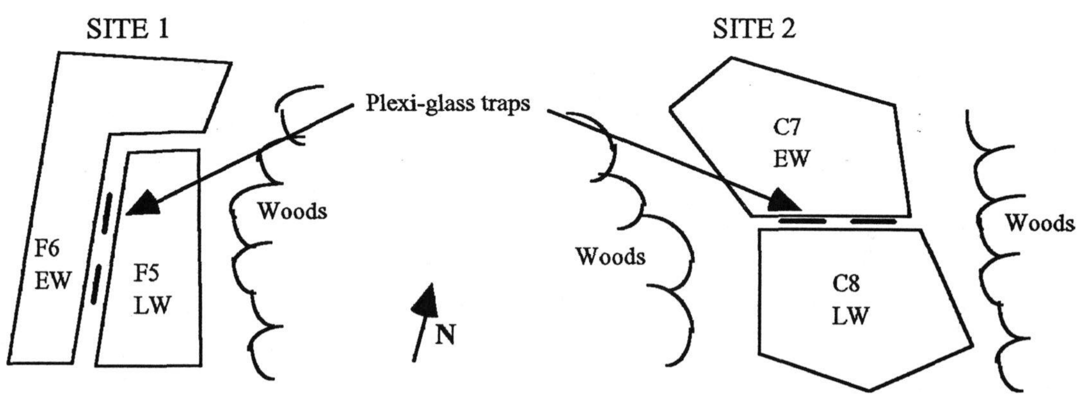
A.) surrounding upland habitats with alternative host plants (wild blueberry).
Pheromone traps placed in the uplands at 3 commercial sites showed a very early flight at two sites and a small flight that coincided with cranberry activity at a third site (See Fig. 4). Moths could move to cranberry from these upland reservoirs as fruits ripen on the commercial beds.

B.) adjacent early water beds harboring fruitworm populations.
We studied sites where the LW bed had adjacent EW beds and attempted to document moth flight by placing experimental sticky passive plexi-glass traps between the beds (See figure below). We did document that moths move. While there appeared to be a trend of movement from EW to LW at Site 2, this was reversed at Site 1, for no clear reason. Unfortunately, numbers captured were extremely small and the moths were too damaged by sticky to be identified to sex.

Figure. Study of moth movement between early water (EW) and LW beds using sticky, plexi-glass traps placed between the 2 bog treatments.

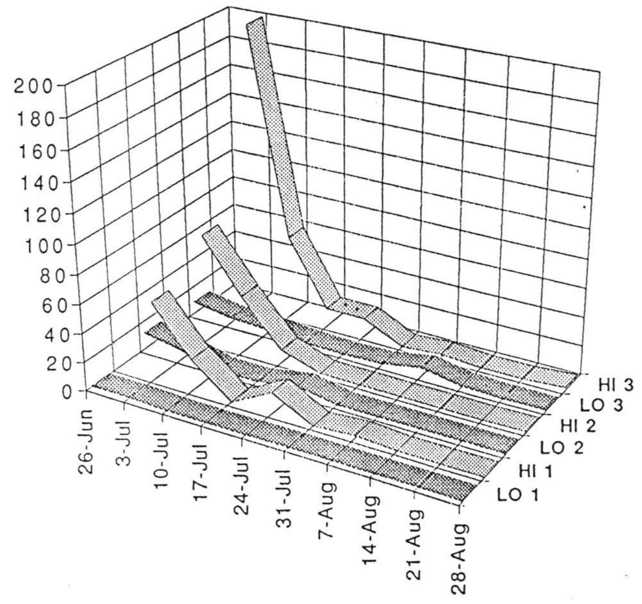
Total number of moths captured

	LW >>> Early Water	Early Water >>> LW
Site 1	9	0
Site 2	2	12



Conclusion: Moth populations are abundant in both the uplands and in beds surrounding a LW bed and movement of moths into a LW bed is a possibility. Thus, growers should not assume that cranberry fruitworm pressure has been eliminated by a LW treatment of a bed. Sampling is recommended throughout the season.

Figure 1.



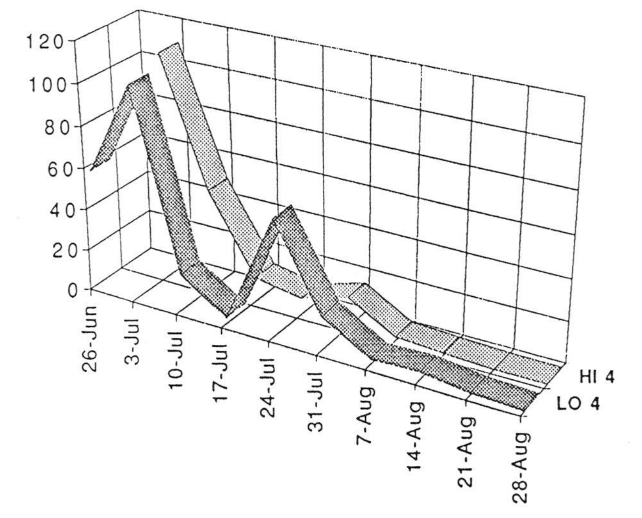
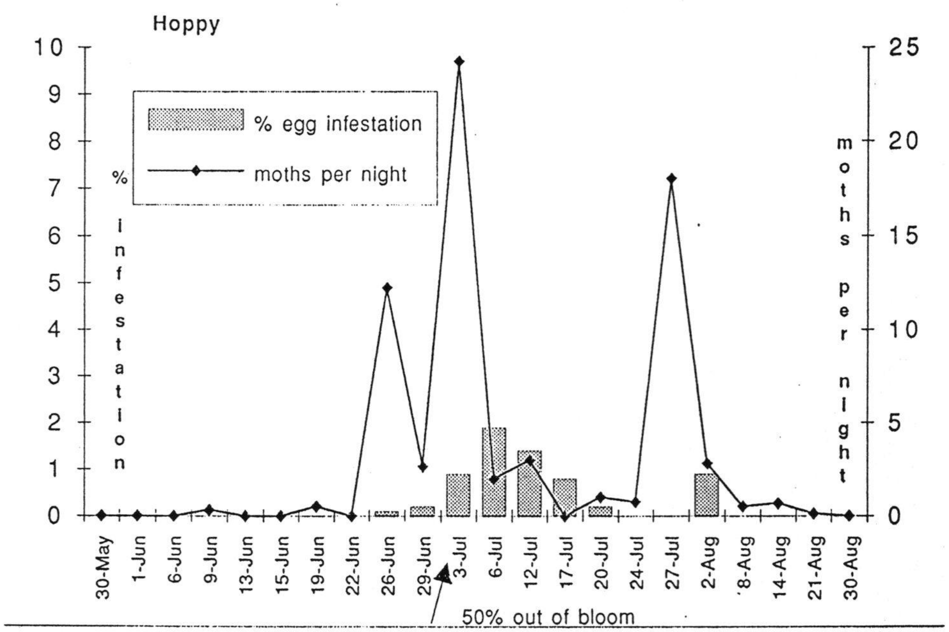


Figure 2.



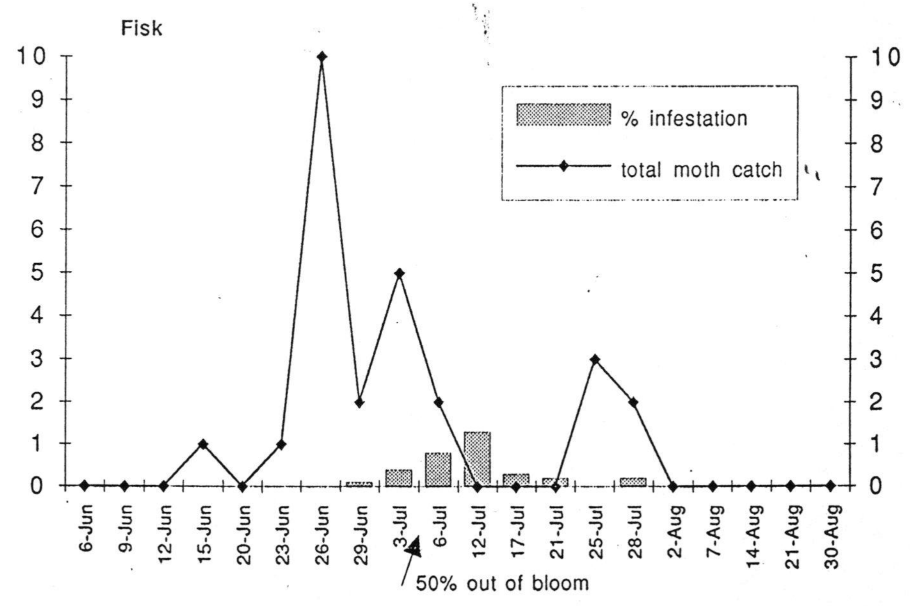


Figure 3.	Light trap captures compared to sex pheromone trap captures at 3 sites

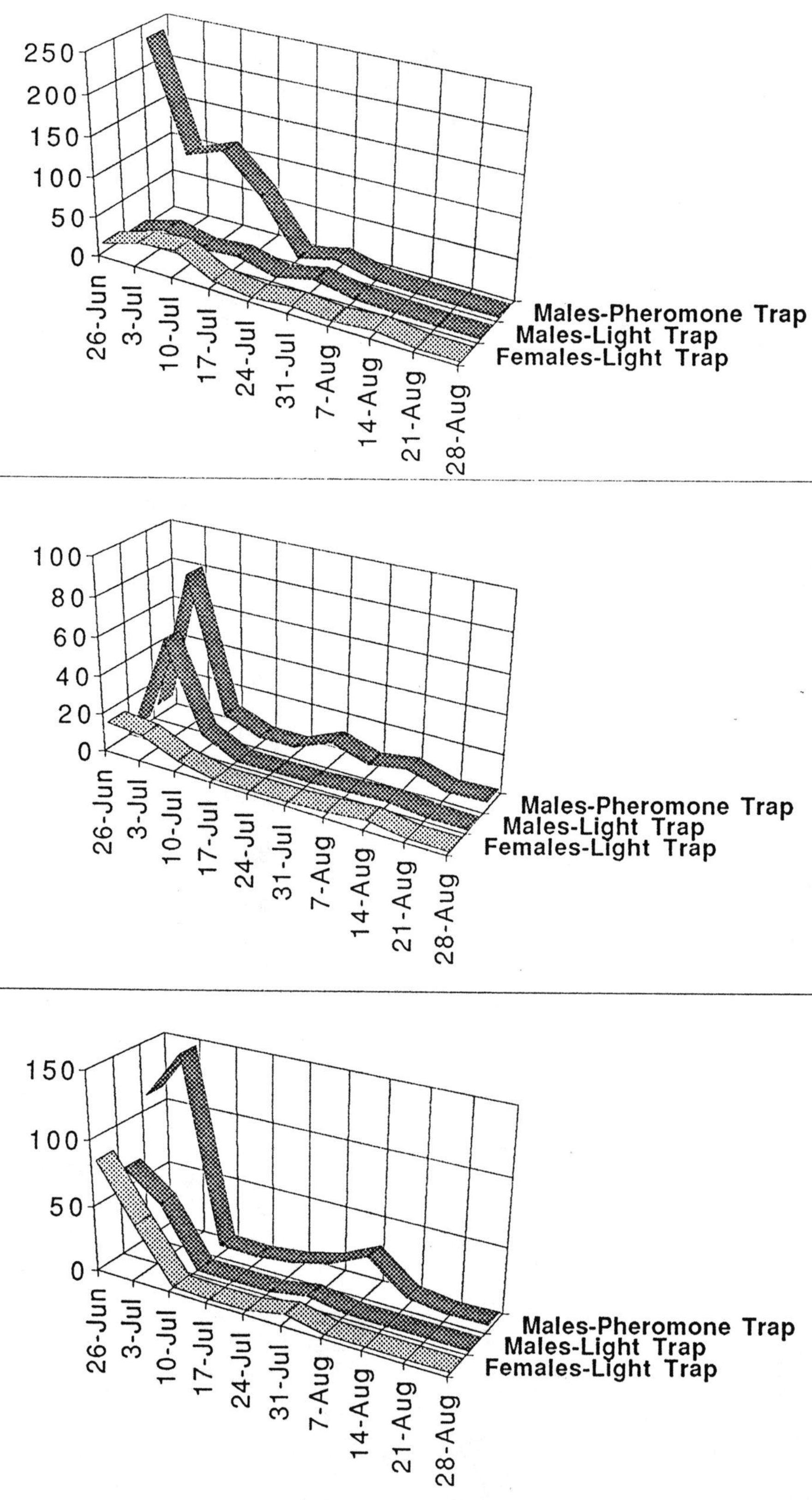
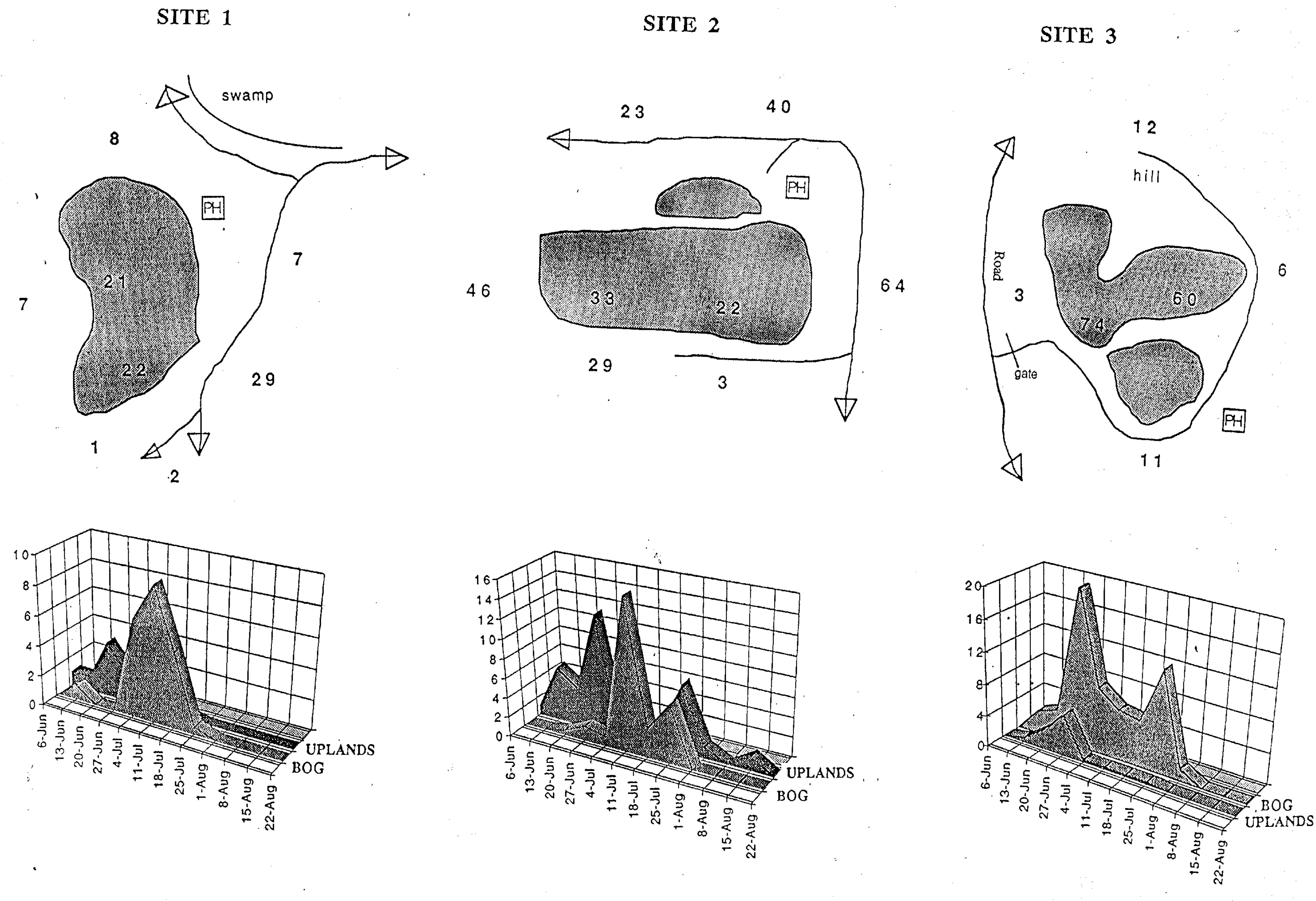


Figure 4.


SITE 1
swamp
8
PH
7
21
7
22
29
1
2
SITE 2
23
40
PH
46
33
22
64
29
3
SITE 3
12
hill
Road
3
60
6
74
gate
PH
11
UPLANDS
BOG
6-Jun
13-Jun
20-Jun
27-Jun
4-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug

Appendix 1B
Water management to minimize pesticide inputs in cranberry production
Supplemental data: Specific project results
Objective 1: diseases

COMPARISON OF FUNGI IN BERRIES SAMPLED FROM EARLY WATER AND LATE WATER BEDS - 1995

The following pairs of early water and late water beds were utilized:

(1) Mattapoisett #6 (E) and Mattapoisett #1 (L) - Early Black
(2) Waterville D2 (E) and Waterville D14 (L) - Early Black
(3) Eagle Holt - Railroad North (E) and Eagle Holt - Little Mary Pina (L) - Howes
(4) South Carver C2 (E) and South Carver C8 (L) - Early Black

Beginning on July 27 and at weekly intervals thereafter, fifty symptomless berries were sampled from three areas in each bed. Berries were halved, surface sterilized in 10% Clorox, blotted dry on sterile paper towels, and plated on acidified cornmeal agar. Plates were incubated at 24°C for three weeks. Fungi were identified to genus and species (where necessary). Sampling was begun one week later at the South Carver pair due to a Guthion application; consequently, sampling was extended one week to accommodate the same number of samples. Sampling of the other three pairs was ceased on September 14.

The data from the four pairs are found on the following pages (** are major pathogens, * are minor pathogens causing fruit rot; unasterisked are non-pathogens).

The isolation data in 1995 were not as clear-cut as the isolation data compiled from different early water/late water pairs in 1994. The pathogenic fungi which were detected at higher levels in early water beds were *Allantophomopsis*, *Coleophoma*, *Glomerella*, and *Godronia* (the latter two were significantly different). The pathogenic fungi which were detected at higher levels in late water beds were *Phomopsis*, *Phyllosticta elongata*, *Phyllosticta vaccinii*, and *Physalospora* (the 2nd and 4th were significantly different). The results for *Phomopsis* and *Phyllosticta vaccinii* conflicted with the findings in 1994, and the differences were not nearly as striking as for some of the other fungi as in 1994 (i.e. *Glomerella*, *Physalospora*). A third year of comparisons will be necessary to see whether there are true differences in the fruit rot fungi between the two management practices.

Mattapoisett #6 (E)

Percent isolation

Fungus	Jul27	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14
Allantophomopsis**	0	2	0	12	0	6	8	8
Alternaria	0	0	0	0	0	0	0	0
Aspergillus	2	0	0	0	2	2	0	0
Aureobasidium*	2	0	6	0	4	2	6	0
Botrytis*	0	0	2	0	2	0	0	0
Cladosporium	0	0	2	6	2	2	2	2
Coleophoma**	0	0	0	0	0	2	0	0
Curvularia	0	2	0	0	0	0	0	0
Epicoccum	0	6	8	2	0	0	0	0
Glomerella**	0	0	0	0	4	2	0	6
Godronia**	2	6	0	0	4	2	2	6
Penicillium #1*	0	4	6	4	0	10	6	2
Penicillium #2*	0	0	2	0	0	0	2	0
Penicillium #3*	0	0	2	2	6	0	0	0
Pestalotia*	0	0	0	0	0	0	0	0
Phomopsis**	2	10	10	2	10	12	10	6
P. elongata**	0	0	0	2	0	0	6	0
P. vaccinii**	0	0	0	0	0	0	4	0
Physalospora**	49	56	52	68	72	58	72	76
Sphaeropsis	0	0	0	2	0	0	0	0
Unidentified	0	0	6	2	8	8	2	6
Sterile	56	18	18	16	10	10	6	6

Mattapoisett #1 (L)

Percent isolation

Fungus	Jul27	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14
Allantophomopsis**	0	0	0	4	0	6	2	16
Alternaria	6	0	8	0	0	0	0	0
Aspergillus	0	0	2	2	2	2	4	0
Aureobasidium*	0	0	6	0	0	0	6	0
Botrytis*	0	0	0	2	0	0	0	0
Cladosporium	4	0	8	6	4	0	2	4
Coleophoma**	0	0	0	0	0	0	0	0
Curvularia	2	0	0	0	0	0	0	0
Epicoccum	2	0	8	4	0	0	0	0
Glomerella**	0	2	2	6	0	0	0	2
Godronia**	4	0	2	2	4	2	6	2
Penicillium #1*	4	2	18	6	6	4	12	4
Penicillium #2*	2	0	2	0	0	0	0	0
Penicillium #3*	0	0	2	0	0	0	2	0
Pestalotia*	0	0	4	2	0	0	0	0
Phomopsis**	10	12	6	12	14	12	12	16
P. elongata**	4	0	0	0	2	0	2	0
P. vaccinii**	0	0	0	0	0	0	0	0
Physalospora**	0	6	10	20	12	6	8	34
Sphaeropsis	0	2	0	6	0	0	0	0
Unidentified	6	4	4	12	12	10	0	10
Sterile	56	72	30	24	50	58	50	26

Waterville D2 (E)

Percent isolation

Fungus	Jul27	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14
Allantophomopsis**	2	0	14	7	8	12	4	6
Alternaria	2	0	0	0	0	0	0	0
Aspergillus	0	6	0	2	2	0	0	0
Aureobasidium*	2	6	2	2	0	0	16	10
Botrytis*	0	0	0	0	0	0	0	0
Cladosporium	0	2	10	11	0	4	0	0
Curvularia	0	0	4	0	0	0	0	0
Coleophoma**	0	0	0	0	0	0	0	2
Epicoccum	2	0	4	2	0	0	0	0
Glomerella**	2	6	4	4	10	4	6	6
Godronia**	2	2	0	2	4	0	0	0
Penicillium #1*	4	8	14	4	8	4	12	10
Penicillium #2*	4	0	0	0	0	0	0	0
Penicillium #3*	0	2	0	2	0	0	0	0
Pestalotia*	0	0	0	0	0	0	0	0
Phomopsis**	2	6	0	7	8	8	6	8
P. elongata**	0	4	2	2	4	2	2	4
P. vaccinii**	0	0	0	0	0	0	0	4
Physalospora**	0	10	12	24	26	10	36	26
Sphaeropsis	0	0	2	0	0	0	0	0
Unidentified	0	4	4	4	2	6	0	4
Sterile	78	44	40	38	36	58	34	30

Waterville D14 (L)

Percent isolation

Fungus	Jul27	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14
Allantophomopsis**	0	2	2	8	0	4	12	4
Alternaria	2	0	6	0	0	0	0	0
Aspergillus	0	2	0	0	0	2	0	2
Aureobasidium*	4	6	12	14	12	22	6	2
Botrytis*	0	4	0	0	0	0	0	0
Cladosporium	8	8	10	10	6	0	4	0
Coleophoma**	0	0	0	0	0	0	0	0
Curvularia	0	0	2	4	0	0	0	0
Epicoccum	4	2	10	4	2	0	0	0
Glomerella**	2	4	20	4	6	6	8	10
Godronia**	6	2	0	0	0	2	4	2
Penicillium #1*	4	2	12	16	8	4	4	2
Penicillium #2*	0	0	2	0	0	0	2	2
Penicillium #3*	2	4	0	2	8	0	2	2
Pestalotia*	0	2	2	4	0	0	0	0
Phomopsis**	8	18	6	8	16	16	14	24
P. elongata**	0	2	0	6	4	10	12	4
P. vaccinii**	2	0	0	0	0	0	0	0
Physalospora**	14	12	42	38	36	26	48	60
Sphaeropsis	0	0	0	0	0	0	0	0
Unidentified	0	2	4	4	12	10	4	8
Sterile	52	36	6	8	14	14	10	4

Eagle Holt - Little Mary Pina (E)

Percent isolation

Fungus	Jul27	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14
Allantophomopsis**	0	0	4	12	2	16	14	8
Alternaria	2	0	4	0	0	0	0	0
Aspergillus	0	0	4	0	0	0	2	0
Aureobasidium*	12	10	10	10	14	26	10	12
Botrytis*	2	0	2	0	0	0	0	0
Cladosporium	6	10	16	24	16	8	6	0
Coleophoma**	0	0	0	0	0	2	0	4
Curvularia	2	0	2	2	0	0	0	0
Epicoccum	2	2	10	10	2	0	0	0
Glomerella**	6	2	0	8	10	4	16	6
Godronia**	12	14	6	4	18	14	20	6
Penicillium #1*	0	4	18	12	2	4	2	14
Penicillium #2*	0	0	0	0	0	0	0	0
Penicillium #3*	0	0	4	0	0	0	0	2
Pestalotia*	0	0	2	0	0	0	0	0
Phomopsis**	20	24	14	4	24	16	10	18
P. elongata**	4	0	0	2	0	0	0	0
P. vaccinii**	0	0	0	0	0	0	0	0
Physalospora**	6	18	24	24	14	28	22	30
Sphaeropsis	0	2	0	0	0	0	0	0
Unidentified	0	2	2	0	6	4	2	0
Sterile	26	22	14	12	10	8	6	14

Eagle Holt - Railroad North (L)

Percent isolation

Fungus	Jul27	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14
Allantophomopsis**	0	0	2	16	8	8	6	6
Alternaria	4	2	6	0	0	0	0	0
Aspergillus	0	0	4	2	0	0	0	0
Aureobasidium*	8	32	12	26	30	14	22	26
Botrytis*	2	0	2	0	2	2	0	0
Cladosporium	14	20	16	26	16	8	4	0
Coleophoma**	0	0	0	0	0	0	0	0
Curvularia	0	2	0	0	2	0	0	0
Epicoccum	20	2	10	8	2	0	0	0
Glomerella**	0	2	0	2	2	2	2	2
Godronia**	4	0	2	0	4	10	2	2
Penicillium #1*	6	0	10	10	0	4	6	6
Penicillium #2*	2	0	0	2	0	0	0	0
Penicillium #3*	0	0	2	2	4	2	4	0
Pestalotia*	0	0	0	0	0	0	0	0
Phomopsis**	16	12	6	10	20	26	14	16
P. elongata**	4	6	0	4	8	8	8	12
P. vaccinii**	0	0	0	2	0	0	0	0
Physalospora**	0	8	28	24	12	22	44	52
Sphaeropsis	0	0	0	0	0	0	0	0
Unidentified	0	4	12	10	14	16	12	8
Sterile	30	22	12	4	6	4	2	2

South Carver C2 (E)

Percent isolation

Fungus	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14	Sep21
Allantophomopsis**	2	14	14	10	14	14	16	8
Alternaria	8	6	0	0	0	0	0	0
Aspergillus	4	0	2	0	0	0	0	0
Aureobasidium*	0	38	8	8	6	10	6	2
Cladosporium	2	6	10	8	2	0	0	2
Coleophoma**	0	0	0	0	0	0	0	0
Curvularia	2	2	0	0	0	0	0	0
Epicoccum	0	6	4	0	0	0	0	0
Glomerella**	2	8	4	2	14	2	6	16
Godronia**	0	0	2	6	4	10	8	4
Penicillium #1*	6	6	6	6	16	2	12	6
Penicillium #2*	0	0	0	0	0	0	0	0
Penicillium #3*	0	0	0	0	0	2	0	2
Pestalotia*	0	0	0	0	0	2	0	0
Phomopsis**	6	10	8	20	8	18	14	10
P. elongata**	2	0	6	12	2	18	4	12
P. vaccinii**	2	0	0	0	4	4	4	6
Physalospora**	8	6	24	22	12	26	16	30
Sphaeropsis	0	2	6	0	0	0	0	0
Unidentified	12	6	0	8	8	0	8	8
Sterile	44	18	18	26	24	14	22	16

South Carver C8 (L)

Percent isolation

Fungus	Aug3	Aug10	Aug17	Aug24	Aug31	Sep7	Sep14	Sep21
Allantophomopsis**	0	2	4	4	6	6	6	2
Alternaria	0	4	4	0	0	0	0	0
Aspergillus	4	2	2	0	2	0	0	0
Aureobasidium*	4	4	20	14	20	8	22	22
Cladosporium	2	20	14	12	2	0	2	0
Coleophoma**	0	0	0	0	0	2	0	0
Curvularia	0	2	2	2	0	0	0	0
Epicoccum	4	18	4	0	0	0	0	0
Glomerella**	2	16	4	4	0	4	2	0
Godronia**	2	2	0	0	0	0	2	2
Penicillium #1*	6	4	8	4	8	4	6	6
Penicillium #2*	2	0	2	0	0	0	0	0
Penicillium #3*	0	0	0	2	0	0	4	2
Pestalotia*	0	0	0	0	0	0	0	4
Phomopsis**	8	12	14	24	6	14	10	10
P. elongata**	0	0	2	4	0	10	6	0
P. vaccinii**	0	0	14	4	16	28	12	2
Physalospora**	2	4	38	38	30	48	36	66
Sphaeropsis	2	2	0	0	0	0	0	0
Unidentified	8	10	2	0	12	4	6	0
Sterile	54	14	4	10	16	6	8	6

UPRIGHT DIEBACK INCIDENCE IN THE YEAR AFTER LATE WATER - 1995

Four pairs of early/water beds utilized in 1994 were visited in early July to assess the incidence of upright dieback disease and to determine whether the LW practice itself or the fungicide schedule employed in 1994 had any positive or negative effect on the disease occurrence. The pairs were:

(1) Tom Coyne (E) and Felix Coyne (L) - Howes
(2) Mattapoisett #1 (E) and Mattapoisett #12 (L) - Early Black
(3) Middle Starr (E) and Upper Starr (L) - Early Black
(4) Barn (E) and West Branch (L) - Early Black

For each bed, a square meter was randomly dropped at five interior and five exterior locations widespread throughout the bed. Uprights were excised within the m^2 area and the ten samples per bed were processed. The total number of uprights was counted as well as the total number of uprights which had dieback. The data are as follows:

Bed	Water	Total uprights	Uprights with dieback	Percent dieback
Tom Coyne	E	955	3	0.31
Felix Coyne	L	1042	0	0.00
Mattapoisett #1	E	1485	1	0.07
Mattapoisett #12	L	1569	2	0.13
Middle Starr	E	1831	2	0.11
Upper Starr	L	1666	0	0.00
Barn	E	1163	1	0.09
West Branch	L	1694	3	0.18

Fungicide schedules for fruit rot control employed in 1994 were as follows:

(1) Tom Coyne (E) - 3 applications; Felix Coyne (L) - 2 applications
(2) Mattapoisett #1 (E) - 3 applications; Mattapoisett #12 (L) - 3 applications
(3) Middle Starr (E) - 4 applications; Upper Starr (L) - 3 applications
(4) Barn (E) - 3 applications; West Branch (L) - 3 applications

The data indicate that there were no differences in the incidence of upright dieback in 1995 in beds subjected to either early or late water in 1994. Late water certainly had no deleterious effect on the disease occurrence. Upright incidence was extremely low in all eight of the beds. In the two pairs (Coyne, Starr) in which one less fungicide application was utilized in the late water bed, upright dieback incidence did not increase the following year due to the reduced fungicide schedule. It would have been nice to do a comparison where 2-3 fewer applications were utilized in the late water bed to see what happened. That situation was unavailable.

Appendix 1C
Water management to minimize pesticide inputs in cranberry production
Supplemental data: Specific project results
Objective 1: crop production, growth, and flowering

CROP YIELD: 6 LATE WATER/EARLY WATER PAIRS

Growers provided records of deliveries of fruit to handlers, including number of barrels for which they received payment. The table below shows a comparison of LW vs. EW companion bogs and vs. previous 5 year production average of the LW bog.

Table. Yields on LW and EW bogs 1995. Yields are reported in bbl/A (bbl=barrel=100 pounds).

Pair	Yield LW	Yield EW	Prev. 5 yr. LW	Compare LW/EW	Compare LW/prev.
1	82	154	89	-47%	-8%
2	143	184	211	-22%	-32%
3	38	147	173	-74%	-80%
4	91	153	127	-41%	-28%
5	88	N/A	109	----	-19%
6	138	229	N/A	-30%	----
Average	97	173	142	-43%	-33%
Early Black				-40%	-24%
Howes				-33%	-25%

Yield was reduced on LW bogs compared to EW bogs in 1995. Yield was also down compared to bog histories. If Bog 3, which appeared to be an outlier, is removed from the comparisons, yield on LW bogs was 35% less than on EW bogs and 22% less than the previous 5 year average of the LW bogs. For the two varieties studied, there seemed to be equally adverse impact of LW in 1995. The LW bogs were poorer in general than the EW bogs (compare previous LW yield to 1995 EW yield), but this did not account for all of the yield difference. ***Yield was not reduced by LW in 1993 or 1994.***

GROWTH AND FLOWERING: 6 LATE WATER/EARLY WATER PAIRS

Vine samples were collected from 6 LW/EW bog pairs in August 1995. Samples consisted of all vines removed from a 6" dia. circular area, 15 replicates per bog. Samples were evaluated for number of flowering or vegetative uprights and number of flowers. Upright length (current season growth) was evaluated by measuring 10 uprights randomly selected from each of the 15 samples from each bog. As summary of the data is presented in the table below.

Table. Vine sample data, 1995. Count are based on 6" dia. area.

Management	Total uprights	Flowers	Uprights Flowering	Flowers/ Upright	Upright length (mm)
			All pairs		
LW	94	75	27%	2.8	65.8
EW	105	110	34%	3.2	63.8
LW vs. EW	*-10%***	*-32%***	*-21%***	*-12%***	*+2%*
			Early Black pairs		
LW	101	78	24.4%	2.9	61.8
EW	114	108	29.8%	3.2	61.9
LW vs. EW	*-11%*	*-28%*	*-18%*	*-9%*	
			Howes pairs		
LW	80	70	32.2%	2.7	73.9
EW	86	113	42.5%	3.1	67.5
LW vs. EW	*-7%*	*-38%*	*-24%*	*-13%*	*+9%*

***highly significant difference*

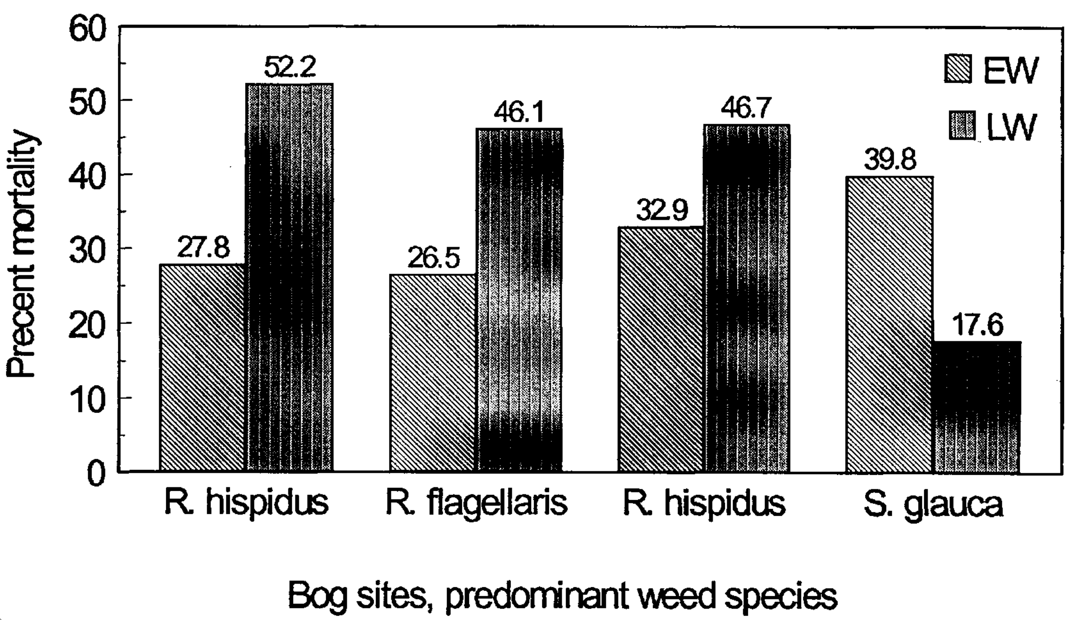
LW bogs had fewer uprights and flowers per unit area then did EW bogs, but upright length was similar. LW bogs had 32% fewer flowers than did EW bogs; this was the result of both fewer uprights that flowered *and* fewer flowers per upright. The trend was the same for both Howes and Early Black but the disparity between EW and LW was greater for Howes. This may have been a contributing factor to the low crops reported for Howes in 1995. Over all samples upright length was similar for LW and EW bogs (likely due to decreased N application on LW bogs offsetting growth promoting effects that had been reported previously). When the variety data were examined separately, we found that Howes uprights were longer on LW bogs than on EW bogs.

Flower numbers and upright lengths on LW/EW pairs have been documented in previous studies (1993 and 1994). Flower numbers were lower in 1993 and 1994 (significant difference in 1994) on LW bogs than on EW bogs. In both years the number of flowers per flowering upright was the factor that accounted for the flower number difference. As was the case in 1995, the length of uprights in LW and EW bogs did not differ. In 1993 fertilizer N use was 30% less on LW bogs, in 1994 60% less, and in 1995 70% less than on EW bogs. This is a good indication that if fertilizer use was equal, LW bogs would have much longer uprights (this has been reported in the historic literature).

Appendix 1D
Water management to minimize pesticide inputs in cranberry production
Supplemental data: Specific project results
Objective 1: weeds

LATE WATER EFFECTS ON SPREADING PERENNIAL WEEDS

A preliminary study in 1994 suggested that LW caused partial mortality to populations of three species of spreading perennial weeds of cranberry bogs: prickly dewberry, bristly dewberry, and glaucous greenbrier (*Rubus flagellaris, Rubus hispidus, Smilax glauca*). In the fall of 1994, we initiated a replicated study of this phenomenon. Four pairs of bogs (planned for LW or EW in 1995) were selected in the fall of 1994 and approximately 120 weed crowns were marked on each bog using pin flags. After the LW floods (April to May 1995), crown mortality was assessed in June. Three of the four pairs were infested with dewberries, the fourth with greenbrier.



Mortality of both Rubus species was significantly greater in LW than in EW bogs. Approximately 50% of marked crowns failed to emerge the summer following flooding. These results suggest that LW can be useful as a component in management of these weed, perhaps in combination with intensive glyphosate hand-wiping. By weakening root and rhizome systems, LW may increase the effectiveness of both intensive wiping and hand weeding. We will investigate the combination in 1996, the brambles have already been marked for that study.

In other observations, we have found R. flagellaris to produce as many as six vegetative runners ('daughter plants'). R. hispidus has been observed to produce eight new plants vegetatively in a single season. ***There is some preliminary data that indicate that LW decreased the rate of 'daughter plant' production*** (see Table below). Even assuming more common vegetative reproductive rates of two new plants per plant per year, it is clear that populations of dewberries, if left untreated would return to pre-flood numbers in 1-2 years following LW treatment. A future line of research may be to evaluate using LW in successive years or with one year between for dewberry control.

No control of glaucous greenbrier by LW was found in this study. This was not the case in previous studies.

Table. Rooting of vegetative shoots ('daughter plants') on LW and EW bogs. Evaluation of 50 parent plants at each site.

Location	Treatment	Rooting shoots	non-rooting shoots	total shoots
Benson Pond	EW	169	24	193
	LW	66	36	102
Long Pond	EW	61	22	83
	LW	41	26	67

Appendix 1E
Water management to minimize pesticide inputs in cranberry production
Replicated Experiments and Demonstration sites
Supplemental data: Specific project results
Objective 3: Protocols for LW management

(3) Year after LW fungicide study - 1995

Plots were on an Early Black bog which had LW in 1994. Bravo 720 (chlorothalonil) schedules were evaluated. Randomized complete block design, 5x5 ft plots, evaluate berry weight, field rot, storage rot (8 weeks). **Replicates = 8, Treatments = 7**

Treatment	Bravo Rate	Application dates
Check	0	---
Bravo 4-1X	4 pt/A	6/29 (85% bloom)
Bravo 4-2X	4 pt/A	6/26 (55% bloom), 7/10 (100% bloom, 50% fruit set)
Bravo 4-3X	4 pt/A	6/21 (10% bloom), 7/5 (100% bloom, 20% fruit set), 7/19 (5% remaining bloom, 95% fruit set)
Bravo 7-1X	7 pt/A	6/29 (85% bloom)
Bravo 7-2X	7 pt/A	6/26 (55% bloom), 7/10 (100% bloom, 50% fruit set)
Bravo 7-3X	7 pt/A	6/21 (10% bloom), 7/5 (100% bloom, 20% fruit set), 7/19 (5% remaining bloom, 95% fruit set)

Results:

Treatment/Rate	%Field Rot	%Storage Rot	%Total Rot	Weight/100 berries (g)
Untreated check	5.5 a	1.4 b	6.8 b	85.0 a
Bravo 4-1X	6.8 a	2.0 a	8.6 ab	78.1 b
Bravo 4-2X	7.3 a	1.7 ab	8.9 ab	75.5 b
Bravo 4-3X	7.1 a	1.5 ab	8.5 ab	78.5 b
Bravo 7-1X	6.3 a	1.7 ab	7.8 ab	80.7 ab
Bravo 7-2X	6.8 a	1.8 ab	8.5 ab	81.2 ab
Bravo 7-3X	8.7 a	1.9 ab	10.4 a	77.3 b

The untreated check had very little field rot or storage rot, probably indicating that there was a good carryover of inoculum reduction from the late water year. None of the fungicide schedules improved rot control; in fact, more field rot and storage rot was found in the fungicide treatments, although most were statistically no different from the check. The fungicide treatments also had a deleterious effect on the berry size and weight, although the effects were not drastic. ***These data certainly indicate that neither is there a need for a full fungicide schedule nor should full fungicide rates be used in the year after late water.***

(5) Nitrogen fertilizer reduction with LW.

Completely randomized design, 2x2 m plots, 4 sites (1 LW/EW pair each 'Early Black' and 'Howes', 2 years at the same sites (in Year 2 all sites will be EW), evaluate yield, field rot, tissue nitrogen concentration **Replicates = 5, Treatments = 10**

	Fertilizer N dose (lb/A)	
Treatment	Year 1	Year 2
1	0	0
2	10	10
3	15	15
4	20	20
5	30	30
6	10	20
7	10	30
8	15	20
9	15	30
10	20	30

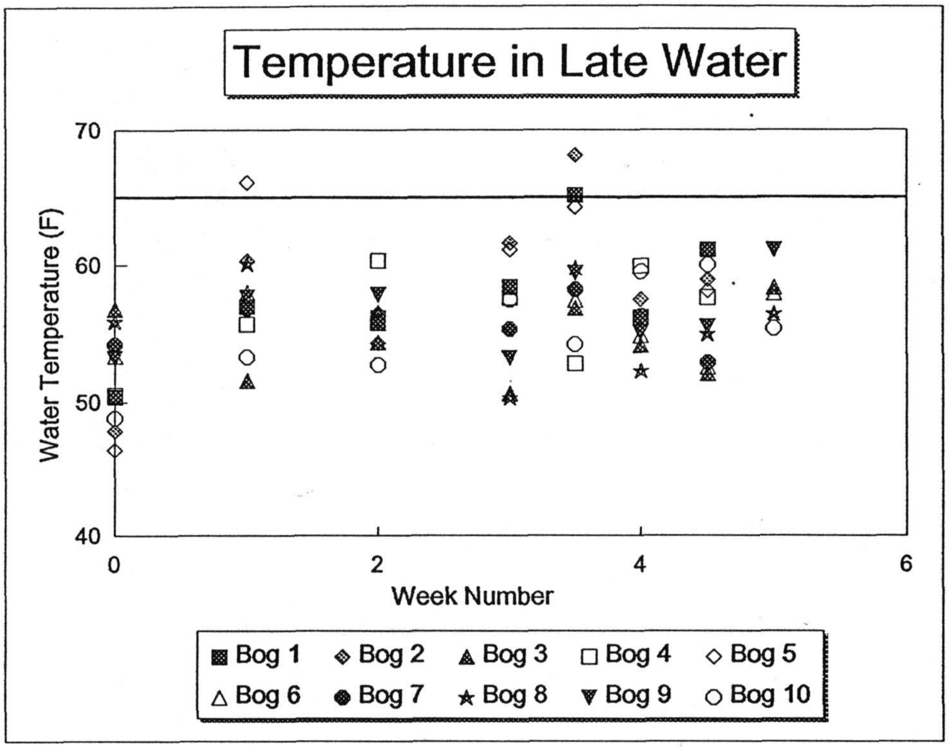
Results after Year 1 (1995)

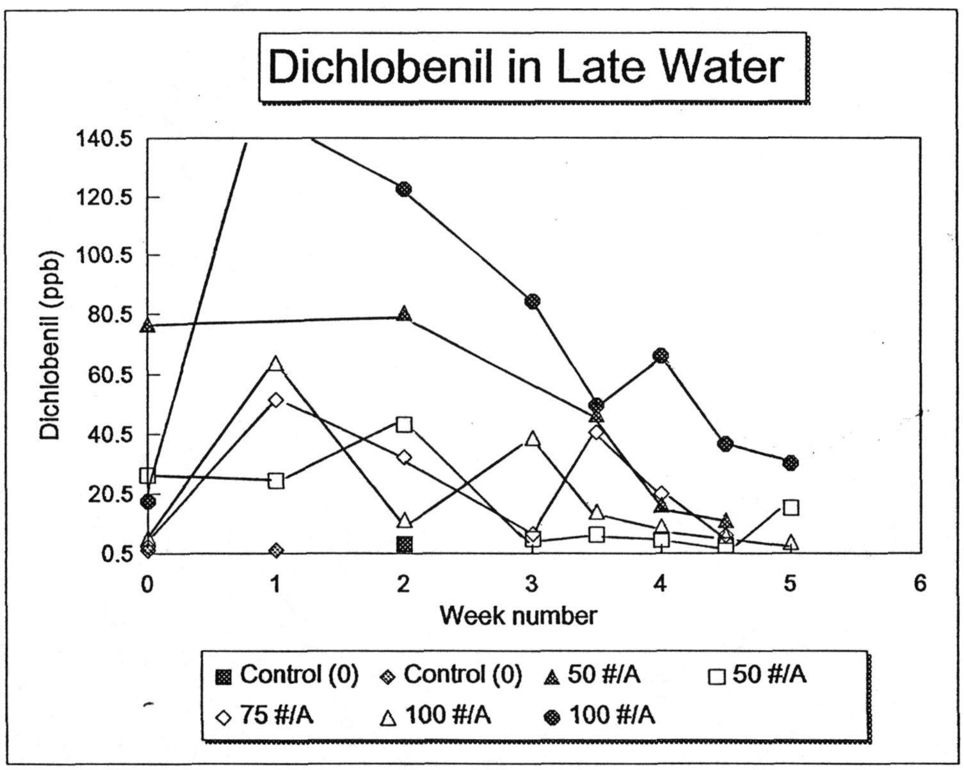
There were no differences among treatments over all locations or within any location for the variables ***yield potential, number of berries per square foot, weight per berry, or percent field rot.*** There were differences by location:

Location	Yield	Berries/ft^2	Weight/berry	% Field rot
		Early Black		
Late Water	102 A	114 A	0.93 C	3.3 A
Early water	91 AB	99 A	0.96 C	2.8 A
		Howes		
Late Water	80 B	70 B	1.20 A	1.2 B
Early Water	81 B	76 B	1.10 B	1.1 B

Most differences were between the varieties rather than between LW and EW. The LW Howes had greater weight per berry than the EW Howes but that was offset by the (non-significant) greater number of berries on EW Howes.

Appendix 1F
Water management to minimize pesticide inputs in cranberry production
Supplemental data: Specific project results
Objective 5: water quality





APPENDIX 3
1994 LATE WATER SURVEY RESPONSES

We received 140 responses to the late water survey sent out as an addendum to the November 1994 Cranberry Station Newsletter. These responses represent approximately 9,000 acres of owned or managed bogs. About 1,500 of those acres have been treated with late water sometime in the last 15 years. Responses to the survey questions are listed below.

Q: Have you used LW in the past 15 years?

A: 46 said yes (33%), 94 said no.
Of those who responded yes, 10 said they use LW on a regular schedule (22%). 36 said they do not.

Q: How often do you use late water on each bog (how many years between 2 consecutive late water years on 1 bog?)

A: Those who use late water on a regular schedule said they use late water every 3-4 years on one piece.

Q: How often do you use late water on *any of your bogs?*

A: 25% responded that they use late water at least 1 of 4 years. The rest of the respondents use late water less often.

Q: Why do you use late water?

A: 37% responded that they use late water to control weeds
29% said they use late water to control insects
15% use late water to control rot
11% use late water to increase vine growth
8% use late water to increase frost tolerance

Q: What would lead you to use late water more often (or not at all)?

A: 39% of respondents would use late water to reduce pests (44% to control weeds, 44% to control insects and 12% to control rot).

6% would use late water to reduce chemical use

13% would use late water to increase the keeping quality of fruit

22% said they had problems which would prevent them from being able to hold late water
Bog gradation 13%
Soil quality (porosity) 9%
Inability to hold water 21%
Lack of water 57%

6% said they had financial restrictions which enabled them from holding late water such as time involved and the quality and price of the fruit.

15% said they needed more information/research to make late water more appealing

Q: List any research questions regarding late water on which you would like us to work?

A: Weeds and herbicides - 24%. "Can perennial weeds be controlled as well as annual weeds?" "What rates and timing should be used for Casoron during LW years?"

Insects and insecticides - 11%. "Is LW effective on controlling grubs and mites?"

Fungi and fungicides - 5%. "Are fungicide rates reduced after LW?" "Is LW effective on fruit rot and phytophthora?"

Fertilizer use - 4%. "Can we fertilize in the water? "What fertilizer rates are used after LW?"

Yield and fruit quality - 25%. "What steps can be taken so a volume yield reduction does not occur?" "What is the average crop difference between LW and early water?"

Sanding - 7%. "Barge sanding and late water - can it be done during the same year?"

Pros and Cons to LW - 20%. "Old timers say the risk of losing a crop would discourage them from using LW." "Provide a survey of current successful results from other growers."

Timing and Dates - 4%. " People differ on the dates for late water. Any ideas?"

It would appear that many of the issues and questions raised are being addressed in this project.