BASELINE PESTICIDE DATA FOR SEMI-PERMANENT WETLANDS IN THE ASPEN PARKLAND OF ALBERTA

Alberta NAWMP Partnership
ALBERTA RESEARCH COUNCIL
Alberta Environment

Baseline Pesticide Data For Semi-Permanent Wetlands In The Aspen Parkland of Alberta

Prepared for:

Alberta Environment Water Research User Group
Alberta Environment Ecosystem User Group
and
Alberta North American Waterfowl Management Plan Partnership

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SUMMARY

Semi-permanent wetlands in the Aspen Parkland eco-region are important habitat for migratory waterfowl and offer valuable habitat for pairing and brood rearing. A water quality study was conducted to establish pesticide baseline data for these wetlands. A second objective of this study was to evaluate, at a scoping level, the potential importance of atmospheric loading of pesticides to these wetlands. The literature documents the importance of overland runoff as a pathway of pesticide movement to surface waters, but increasing evidence also points to the importance of atmospheric deposition.

Sixty semi-permanent wetlands with a surface area of approximately 5 ha, a depth less than 1 m and surrounded by well established emergent vegetation and by annually cultivated fields were selected by Ducks Unlimited Canada staff because of their value as waterfowl habitat. All wetlands were sampled for pesticide residues, total phosphorus, conductivity, pH, chlorophyll-*a* and fecal coliform bacteria in July 2000. Twenty-five of these wetlands were sampled in June 2000 and seven were sampled monthly from April to October 2000. Pesticides were also analysed in surface film and plankton samples collected from the seven wetlands. Precipitation samples were obtained at the Alberta Research Council site in Vegreville from May to August 2000. All samples were analysed for a suite of 40 pesticide residues, including 19 of the 30 top-selling herbicides in the Aspen Parkland of Alberta. Additionally, glyphosate and AMPA were analysed in monthly samples from the seven wetlands and in precipitation samples.

Pesticide residues occurred at measurable concentrations in 92% of the wetlands. Out of the 42 compounds analysed in this study, 16 were detected at least once in wetland water, and five were detected in precipitation and plankton tissue, respectively. No pesticides were detected in surface film samples.

2,4-D and MCPA were encountered most frequently in water (58 and 46% of samples, respectively), but other compounds such as glyphosate and picloram occurred at higher concentrations. In contrast, 2,4-D, MCPA and glyphosate were encountered frequently in precipitation samples (65%, 53% and 57% of the samples, respectively) and at higher concentrations than most other pesticides.

The detection of glyphosate in wetland water and rain is noteworthy. The presence of relatively high glyphosate concentrations in all seven wetlands where this compound was analysed suggests that glyphosate may have been a common contaminant of surface waters under the dry and windy conditions that prevailed in spring 2000. It is speculated that the major pathway for glyphosate contamination of wetlands was dry deposition of the chemical adsorbed to dust particles.

Seasonal trends were apparent in the number and type of pesticides detected and in the total pesticide concentration. Pesticide diversity was significantly higher in May and June with as many as six pesticides detected in one sample. Total pesticide concentrations were highest in May because of consistently high detections of glyphosate. Some pesticides such as 2,4-D, MCPA, clopyralid, picloram and imazamethabenz were detected in nearly every month; others such as glyphosate and MCPP had a much narrower temporal distribution.

The diversity, the total concentration and the loading of pesticides in precipitation samples was highest in May and June and 2,4-D, MCPA and glyphosate contributed most to the total concentration and loading in these months. Mass balance results suggest that atmospheric deposition may account for a substantial portion of concentrations detected in wetlands for some pesticides (i.e., 2,4-D and MCPA: >90%; glyphosate: 40% and lindane: 30%). This is supported by the fairly even distribution pattern and relatively narrow concentration range in wetland water of 2,4-D and MCPA. Some compounds such as picloram and imazamethabenz were not detected in precipitation and their presence in wetlands is more likely the result of local runoff or direct contact.

The substantial pesticide database assembled by Environment Canada for Saskatchewan prairie wetlands offers a basis for comparison for our results. While there are broad similarities in pesticide contamination patterns between Saskatchewan and Alberta wetlands, concentrations recorded in this study tend to be lower than in Saskatchewan. Consequently, compliance with surface water quality guidelines for the protection of aquatic life is much higher in Alberta. In Alberta less than 1% of the wetlands had lindane concentrations that exceeded guidelines, whereas in Saskatchewan up to 26% of the wetlands had at least one of several compounds exceeding such guidelines.

Although findings in Alberta suggest a lesser level of contamination and perhaps a lesser risk to the ecological integrity of wetlands, it is important to emphasise that our study was of short duration (less than one year) compared to that in Saskatchewan (over five years with an emphasis on capturing rain events). Our study was carried out in a particularly dry year where the risk for contamination during runoff events was very low; consequently it probably underestimates the actual level of ambient contamination.

The implications of the presence of chronic, low levels of multiple pesticide residues in air, precipitation, water and aquatic food organisms on waterfowl feeding habits, health and reproductive success need to be better understood.

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ACKNOWLEDGEMENTS

This study was funded by several agencies, including the North American Waterfowl Management Plan Partnership and Ducks Unlimited Canada (DUC); Alberta Environment's Water Research and Sustainable Ecosystem Research User Groups and the Pesticide Management Program.

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ABBREVIATIONS

AENV	Alberta Environment
ARC	Alberta Research Council
ASWQG	Alberta Surface Water Quality Guideline
CCME	Canadian Council of Ministers of the Environment
CWQG	Canadian Water Quality Guideline
DUC	Ducks Unlimited Canada
WRUG	Water Research User Group
SERUG	Sustainable Ecosystem Research User Group
ha	hectares
m	metres
mg/L	milligrams per litre
µg/L	micrograms per litre

1.0 INTRODUCTION

Wetlands in the Aspen Parkland eco-region of Alberta are important habitat for migratory waterfowl and semi-permanent wetlands, in particular, offer valuable habitat for pairing and brood rearing.

Agricultural pesticides are believed to present a threat to the ecological integrity of northern prairie wetlands (Donald et al. 1999). In intensively farmed areas of southern Saskatchewan, nine to 24% of wetlands have pesticide concentrations that exceed guidelines for the protection of aquatic life. Under such conditions, pesticide levels may be affecting critical life-cycle functions of sensitive aquatic species.

Pesticides are detected frequently in streams and small lakes of intensively farmed areas of the Alberta Aspen Parkland eco-region although concentrations in excess of surface water quality guidelines for the protection of aquatic life have only been reported on occasion (Anderson et al. 1998; AENV data). Pesticide data for wetlands in this area were unavailable and in light of findings in Saskatchewan, there was a need to establish baseline data.

In spring 2000, Alberta Environment (AENV), in partnership with North American Waterfowl Management Plan and Ducks Unlimited Canada (NAWAMP/DUC) and the Alberta Research Council (ARC), Vegreville, initiated a pesticide sampling program on a selection of 60 wetlands in the Aspen Parkland of Alberta.

The prime objectives of this study were to:

- obtain baseline pesticide residue data for water from semi-permanent wetlands in the Aspen Parkland of Alberta.

- evaluate, at a scoping level, the potential importance of atmospheric loading of pesticides to wetlands waters.

2.0 METHODS

2.1 Program Design

2.1.1 Site Selection

The intent of this program was to describe the level of contamination by agricultural pesticides of wetlands in the Aspen Parkland. Consequently, an attempt was made to select wetlands which were at high risk of contamination because they are located in the middle of annually cultivated fields where pesticide use is the norm.

To allow meaningful comparisons among wetlands and among different landscapes an attempt was made to standardize wetlands with respect to size, depth and surrounding vegetation. Selection criteria in this sampling program required semi-permanent wetlands (Type 4, Stewart and Kantrud 1971) having a surface area no greater than 5 ha and a depth less than 1 m, and surrounded by well-established emergent vegetation (cattails or bulrush) and by annually cultivated land.

Ducks Unlimited Canada staff took a leading role in selecting 60 wetlands which were valuable for waterfowl breeding and brood rearing, and conformed to the specified physical and land use characteristics. DUC staff obtained permission from landowners to sample the water bodies on their land; they also supplied air photos and land descriptions, so that wetlands could be identified easily.

Selected wetlands are shown in Figure 1, wetlands were assigned sequential numbers to facilitate their referencing without compromising the anonymity of the landowners (Table 1).

2.1.2 Sampling Design

2.1.2.1 Wetland Sampling Schedule

Wetlands were sampled for pesticides and a selection of other water quality attributes as described below.

2.1.2.1.1 Pesticide Sampling Program

Pesticide Analysed

All pesticide samples were analysed for the 40 compounds listed in Table 2. These compounds are commonly used in Alberta (Cotton and Byrtus 1995) and are routinely analysed in surface waters by AENV.

In spring 2000, ARC adapted analytical methods for glyphosate in water samples thereby making it possible to incorporate the analysis of glyphosate and its metabolite AMPA (Aminomethylphosphonic acid) at a scoping level in this program.

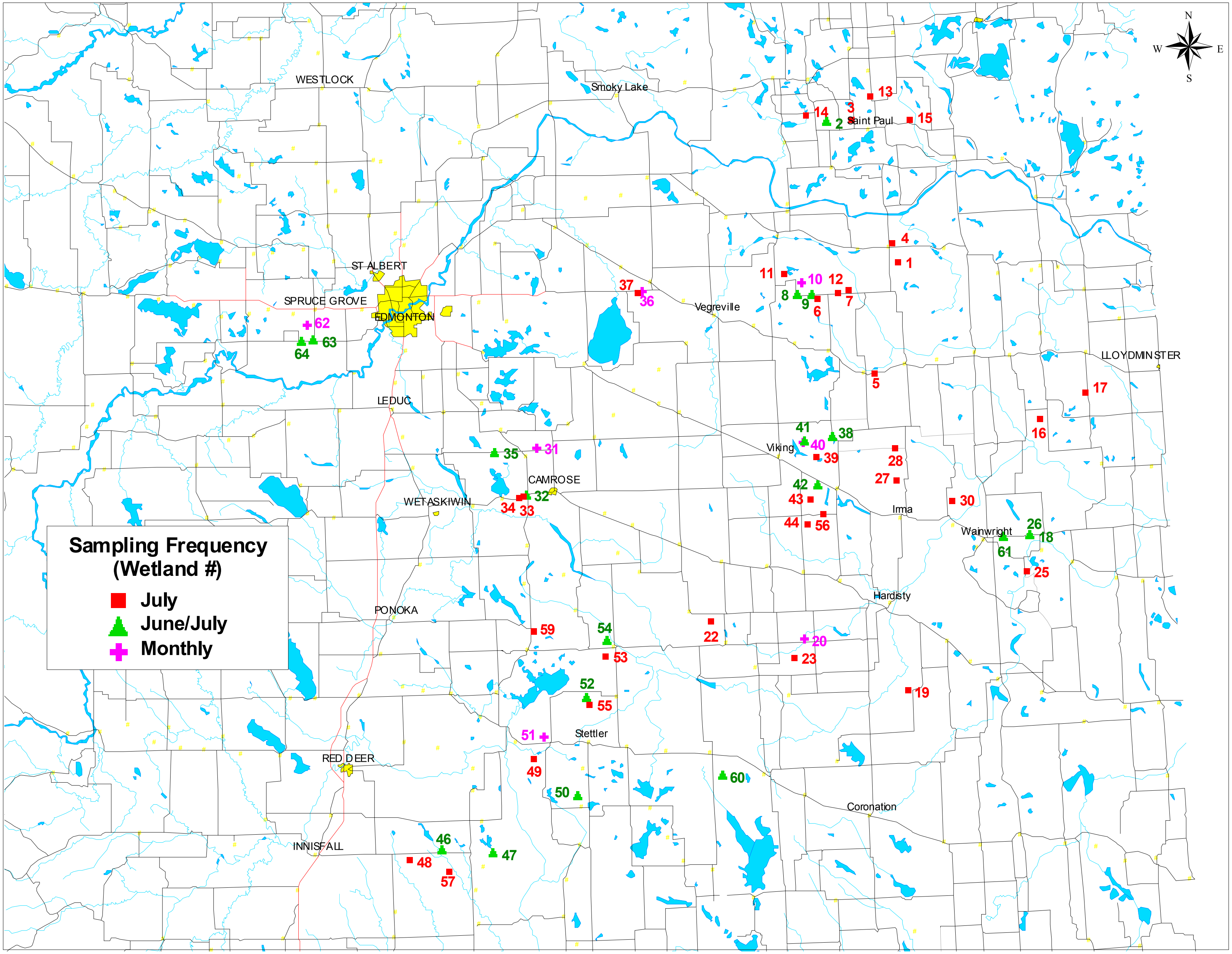


Figure 1 Location of wetlands sampled during summer, 2000

Table 1 List of wetlands showing assigned number, latitude/longitude and sampling frequency

STATION NAME	STATION NUMBER	LONGITUDE			LATITUDE			SAMPLING FREQUENCY		
		Deg	Min	Sec	Deg	Min	Sec	Monthly	June and July	July
Wetland #1	AB05ED1410	111	11	19.1	53	37	11.4			x
Wetland #2	AB05ED1420	111	29	35.4	54	1	4.9		x	
Wetland #3	AB05ED1430	111	22	21.8	54	1	4.9			x
Wetland #4	AB05ED1440	111	12	54.5	53	40	19.4			x
Wetland #5	AB05EE1080	111	19	40.9	53	18	42.2			x
Wetland #6	AB05EE1090	111	34	30	53	31	42.2			x
Wetland #7	AB05EE2000	111	25	46.4	53	32	58.4			x
Wetland #8	AB05EE2010	111	40	5.4	53	32	37.3		x	
Wetland #9	AB05EE2020	111	35	57	53	32	34		x	
Wetland #10	AB05EE0005	111	38	54.8	53	34	26.7	x		
Wetland #11	AB05EE2030	111	43	35.4	53	36	3.2			x
Wetland #12	AB05EE2040	111	28	38.2	53	32	25.9			x
Wetland #13	AB05ED1415	111	16	43.6	54	4	56.8			x
Wetland #14	AB05ED1450	111	35	8.2	54	2	9.7			x
Wetland #15	AB05ED1460	111	5	51.8	54	0	38.9			x
Wetland #16	AB05FE0480	110	34	30	53	9	42.2			x
Wetland #17	AB05FE0490	110	21	21.8	53	13	43.8			x
Wetland #18	AB05FB0681	110	39	5	52	50	36		x	
Wetland #19	AB05FC1020	111	14	54.5	52	25	55.1			x
Wetland #20	AB05FB0015	111	42	29.2	52	35	13.2	x		
Wetland #22	AB05FB0701	112	8	5.4	52	38	50.3			x
Wetland #23	AB05FB0711	111	45	22	52	32	14			x
Wetland #25	AB05FD0360	110	40	35.4	52	44	38.1			x
Wetland #26	AB05FE0500	110	39	16.4	52	50	32.4		x	
Wetland # 27	AB05FE0510	111	14	53.2	53	0	53.5			x
Wetland #28	AB05FE0520	111	14	49.1	53	6	6.5			x
Wetland #30	AB05FE0540	111	0	2.7	52	56	52.7			x
Wetland #31	AB05FA0015	112	54	8.1	53	8	41.6	x		
Wetland #32	AB05FA1930	112	57	38.1	53	0	58.4		x	
Wetland #33	AB05FA1970	112	58	11	53	0	34			x
Wetland #34	AB05FA1940	112	59	38.2	53	0	21.1			x
Wetland #35	AB05FA1950	113	5	57.3	53	8	11.4		x	
Wetland #36	AB05EB0025	112	23	37	53	34	4.7	x		
Wetland #37	AB05EC1060	112	24	54.5	53	34	1.6			x
Wetland #38	AB05FB0611	111	32	16.4	53	8	45.4		x	
Wetland #39	AB05FB0621	111	36	51.8	53	5	25.9			x
Wetland #40	AB05FB0005	111	40	16.4	53	7	50.8	x		
Wetland #41	AB05FB0631	111	40	10.9	53	8	16		x	

Table 1 List of wetlands (continued)

STATION NAME	STATION NUMBER	LONGITUDE			LATITUDE			SAMPLING FREQUENCY		
		Deg	Min	Sec	Deg	Min	Sec	Monthly	June and July	July
Wetland #42	AB05FB0641	111	36	51.8	53	0	42.2		x	
Wetland #43	AB05FB0651	111	39	19.1	52	58	27.5			x
Wetland #44	AB05FB0661	111	40	10.9	52	54	17.8			x
Wetland #46	AB05CE2310	113	23	0	52	2	8.1		x	
Wetland #48	AB05CE2320	113	31	49.1	52	0	38.9			x
Wetland #50	AB05FC1030	112	46	2.7	52	10	40.5		x	
Wetland #51	AB05CD0005	112	54	21.2	52	20	32.5	x		
Wetland #53	AB05FC1040	112	36	54.5	52	33	43.8			x
Wetland #54	AB05FC1050	112	36	43.6	52	36	14.6		x	
Wetland #56	AB05FB0671	111	35	49.1	52	55	55.1			x
Wetland #59	AB05FA1960	112	56	38.2	52	38	11.4			x
Wetland #61	AB05CF0230	110	46	37.6	52	50	35.5		x	
Wetland #62	AB05EA0005	113	57	24	53	30	3	x		
Wetland #63	AB05EA1700	113	55	45.6	53	27	30.3		x	
Wetland #64	AB05EA1710	113	58	58	53	27	17		x	
Wetland # 47	AB05CD2210	113	9	13.6	52	1	27.5		x	
Wetland # 49	AB05CD2220	112	57	35.4	52	17	3.2			x
Wetland # 52	AB05CD2230	112	42	32.7	52	27	3.2		x	
Wetland # 55	AB05CD2240	112	41	43.6	52	25	45.4			x
Wetland # 57	AB05CE2330	113	21	8.2	51	58	38.9			x
Wetland # 60	AB05CF0220	112	6	32.7	52	13	6.5		x	
Vegreville Atmospheric Deposition Site	AB05EE1070	112	5	33.2	53	30	18.9	Event Sampling		

Table 2 List of pesticides analyzed in 60 wetlands in 2000

Variable	Variable Code	Detection Limit in Wetlands Water and Rain (DL)	Detection Limit in Tissue Samples (DL)
HERBICIDES			
AMPA	103453	L1	not analyzed
Atrazine	100674	L0.005	0.050
Bromacil	100675	L0.03	0.300
Bromoxynil	100676	L0.005	0.050
Clopyralid (Lontrel)	100688	L0.02	0.200
Cyanazine	100678	L0.05	0.500
Desethyl Atrazine	102609	L0.05	0.500
Desisopropyl Atrazine	102610	L0.05	0.500
Dicamba	100680	L0.02	0.200
Dichlorprop	100669	L0.005	0.050
Diclofop-Methyl	100681	L0.02	2.250
Diuron	100683	L0.2	2.000
Ethalfluralin	100685	L0.005	0.050
Fenoxaprop-P-Ethyl	102613	L0.04	0.400
Glyphosate	103452	L0.2	not analyzed
Imazamethabenz	102088	L0.05	0.500
Imazamox	103141	L0.02	0.050
Imazethapyr	102612	L0.02	0.500
MCPA	100690	L0.005	0.050
MCPB	100691	L0.02	0.200
MCPP (Mecoprop)	100692	L0.005	0.050
Picloram	100693	L0.005	0.050
Quinclorac	102611	L0.005	not analyzed
Triallate	100696	L0.005	0.050
Trifluralin	100697	L0.005	0.050
2,4-D	100667	L0.005	0.050
2,4-DB	100668	L0.005	0.050
INSECTICIDES			
Alpha-Benzenehexachloride	100670	L0.005	
Alpha-Endosulfan	100671	L0.005	0.050
Chlorpyrifos	100684	L0.005	0.050
Diazinon	100679	L0.005	0.050
Dimethoate	102618	L0.05	0.500
Disulfoton	100682	L0.2	2.000
Ethion	100686	L0.1	1.000
Gamma-benzenehexachloride (Lindane)	100672	L0.005	0.050
Guthion (Azinophos-methyl)	100687	L0.2	2.000
Malathion	100689	L0.05	0.500
Methoxychlor	100673	L0.03	0.300
Phorate	100694	L0.005	0.050
Pyridaben	102614	L0.02	0.200
Terbufos	100695	L0.03	0.300
FUNGICIDES			
Carbathiin	100677	L0.1	1.000

Glyphosate, one of the most commonly used herbicides in Alberta, is used on "tolerant crops" (e.g., canola), for pre-harvest weed control and in "chem-fallow" as an alternative to weed control by repeated cultivation.

Pesticide sales records indicate that 3,000,000 kg of active ingredient were sold in 1998 in the Aspen Parkland of Alberta (Byrtus 2000). This represents 30% of the total provincial sales and the largest sale volume by eco-region, even though other eco-regions with intensive agriculture are much larger than the Aspen Parkland of Alberta. Table 3 shows that 19 of the 31 top-selling pesticides were analysed in this study. It is important to keep in mind that survey results may under estimate actual pesticide contamination because pesticides that were not analysed may be present.

Monthly Sampling

Seven wetlands (Figure 1, Table 2), distributed over the study area, were sampled monthly from April to and including October to describe seasonal changes in pesticide contamination. All water samples were analyzed for 40 pesticides.

Additional samples were collected from these wetlands to explore specific aspects of pesticide contamination.

- From May to September water samples were collected for the analysis of glyphosate and its metabolite AMPA.

- Tissue samples (bulk plankton samples) were collected in June and July to provide an indication of the level of contamination in planktonic organisms which may be a food source for waterfowl.

- Pesticides in surface film can differ in concentration and variety from pesticides found in the water column (Waite et al. 2000). Surface film samples were collected in June with the intent of comparing pesticide levels in surface film and water column. Results may also provide a better understanding of exposure to pesticides for birds that skim food organisms off the water surface.

June Sampling

In addition to the seven wetlands sampled monthly, 18 wetlands were sampled in June for the routine screen of pesticides. These 25 wetlands (Figure 1, Table 2) allow for a comparison of pesticide contamination in June and July, and contribute to our understanding of temporal and spatial variability in contaminant levels.

July Sampling

Most pesticide applications in central Alberta occur in June - early July. Based on the historical AENV pesticide data base, July is the month which couples highest concentrations and greatest

Table 3 List of top selling active ingredients of pesticides in the Parkland Region for 1998 compared with pesticides monitored in wetlands in 2000

Active Ingredient (ai)	Sales in Kg ai [1]	Pesticides Analyzed in Wetlands [2]
Glyphosate	1009111	in seven wetlands
MCPA	347070	yes
Triallate	258353	yes
Ethalfluralin	161844	yes
2,4-D	154541	yes
Trifluralin	102234	yes
Imazamethabenz	71215	yes
Bromoxynil	50590	yes
Carbathiin	39699	yes
Chlorpyrifos	39005	yes
Tralkoxydim	34982	no
Fenoxaprop-p-ethyl	23050	yes
Clopyralid	23022	yes
Sethoxydim	21714	no
Dicamba	18927	yes
Lindane	18347	yes
Trichlorfon	18302	no
Dichlorprop	16949	yes
Fluroxypyr	15500	no
Vinclozolin	13145	no
Clodinafop-propargyl	13145	no
Quizalofop-ethyl	9512	no
Mecoprop (MCPP)	9192	yes
Thiram	8529	no
Benomyl	7611	no
Chlorothalonil	5939	no
Imazethapyr	5764	yes
Thifensulfuron methyl	5747	no
2.4-DB	5360	yes
Fluazifop-p-butyl	5319	no
Picloram	36	yes

(1) Byrtus (2000)

(2) refer to Table 2 for a complete list of pesticides

variety of pesticides in surface waters. Therefore, all 60 wetlands were sampled in July (Figure 1, Table 2). An attempt was made to carry out the sampling after a period of heavy rain under the premise that atmospheric deposition of pesticides would be greater and that runoff would move contaminants from land to water. Such a situation could be a worst-case scenario in terms of concentrations and variety of pesticides. The data provide a general indication of spatial variability of pesticide contamination in the Aspen Parkland of Alberta.

2.1.2.1.2 Other Water Quality Attributes

Total phosphorus, chlorophyll-*a*, conductivity and pH were analysed in all wetlands sampled in July. Bacterial samples (fecal coliform bacteria and *E. coli*) were collected from a selection of wetlands.

These baseline data provide a general indication of the range in trophic status indicators and salinity of the wetlands and allow for the exploration of relationships between pesticide contamination and chlorophyll-*a*, an indicator of algal biomass.

2.1.2.1.3 Precipitation (wet and dry) Samples

Precipitation samples (wet and dry – collected as a total sample) were collected at the Vegreville, ARC site. Samples were analysed for the routine suite of 40 compounds as well as for glyphosate and AMPA. Sample analysis results and precipitation data provide an indication of the relative importance of atmospheric deposition to wetland contamination.

2.2 Sampling Methods

2.2.1 Field Sampling and Sample Handling Methods

Sampling efforts were shared between staff from Monitoring Branch (AENV) and DUC staff. AENV collected samples from the seven wetlands visited monthly and from the 18 additional wetlands sampled in June; DUC staff collected the majority of samples taken in July. AENV staff provided on-site training sessions to DUC staff, instructing them in appropriate sampling and sample handling methods. Precipitation samples were collected by ARC staff at Vegreville.

2.2.1.1 Water Samples

Water samples are composites of several samples taken from five or more different locations in an open water area of the wetland. Such composite samples integrate spatial (vertical and horizontal) variability across the wetland and are believed to be more representative of water quality in the wetland than a single sample would be.

Samples were kept in a dark and cool place (i.e., cooler with ice packs) and sent to the lab the same day. If samples could not be sent in the same day, they were refrigerated until the next day.

Pesticide Samples

Certified clean pesticide containers, meeting trace organic standards, were supplied by ARC. One litre amber glass bottles were used for the 40 compound screen; 125 ml plastic bottles were used for glyphosate. Care was taken not to touch the inside of the lids or bottles. Bottles were completely filled with no headspace.

Depending on water depth and ability of the sampler to wade into the water, samples were taken in two ways:

1. A capped bottle was inserted elbow-deep in the water; the cap was removed and the bottle was lifted up gradually as it filled. The procedure was repeated at four or more locations until the bottle was completely full. Care was taken not to stir bottom sediments while wading in the water.

2. A stainless steel pitcher, mounted on a pole, was used to collect the samples from several sites in wetlands where wading was not practical. Sub-samples were combined in a stainless steel pail. The composite sample was stirred vigorously with a stainless steel spatula before pouring the water into sample bottles. All stainless steel equipment was rinsed in hexane acetone before the sampling of a wetland.

3. The approximate location of the sampling sites was recorded on the field notes. Pesticide bottles were not rinsed.

Blanks, replicates and split samples were included as part of a QA/QC program. Results are presented and discussed in Appendix 4.

2.2.1.2 Bulk Plankton Samples

Biological tissue samples (i.e., bulk plankton samples containing invertebrates and algae) were collected by moving a large plankton net (30 by 50 cm opening and 40 cm deep, net mesh-size: 0.210 um) back and forth in the water, carefully avoiding stirring sediments up. Water was allowed to drain out of the net and plankton was scooped up with a clean stainless steel spoon into a glass jar meeting trace organic clean standards. An attempt was made to collect 100 g wet-weight plankton (about 100 mL). Samples were frozen on dry ice, immediately after collection.

A sub-sample was preserved in 10% formaldehyde and archived for eventual taxonomic analysis.

2.2.1.3 Surface Film Samples

Methods used for surface film sampling followed Muir et al. (1991) and Waite et al. (2000). In June, a glass plate (20 x 20 cm glass plate, with a handle mounted one plane), previously rinsed with DCM (dichloromethane) was touched, horizontally onto the surface of the water. The plate was lifted and held vertically with one corner over a Teflon funnel placed in a one litre amber glass bottle. The plate was rinsed with DCM. The procedure was repeated five times at different locations across the wetland.

2.2.1.4 Other Water Quality Attributes

Samples for the determination of total phosphorus (TP), Chlorophyll-*a*, bacteria (fecal coliforms and *E. coli*), pH, and conductivity were collected from most wetlands.

Individual samples were collected in a similar manner as pesticide samples and pooled into a clean carboy that had been tripled-rinsed with wetland water. The carboy was agitated vigorously before pouring water into the sample bottles that had been triple-rinsed with sample water.

Bacteria samples were collected from a single location from wetlands sampled monthly by AENV staff and from the 18 additional wetlands sampled by AENV in June.

Conductivity and pH measurements were made with a Hydro-Lab at sites sampled by AENV, or else measurements were made upon arrival of the sample at the analytical lab.

2.2.1.5 Field Notes

Additional information, such as apparent size and depth of the wetland, presence and type of submerged and emergent vegetation in and surrounding the wetlands, type of crops, size of buffer zone between crops and wetland, and indications that spraying had occurred, were recorded on-site on specially designed field note sheets (Appendix 1).

2.2.1.6 Precipitation Samples

ARC staff at the Vegreville site collected precipitation samples with equipment supplied by Dr. Bernie Hill and following methods described in Hill et al. (1999). The equipment consisted of a 25-cm stainless steel funnel installed 60 cm above ground over a 4 litre amber bottle. Samples were retrieved at approximately weekly intervals or after a major rainfall event from May to August. Funnels were rinsed with 250 mL distilled water prior to the retrieval of each sample, consequently, results represent pesticide concentrations in both wet and dry deposition.

2.3 Analytical Methods for Pesticides

All pesticide analyses were carried out at the Pesticides and Trace Organics Laboratory under supervision of Dr. Dean Smillie.

2.3.1 Pesticides in Water

One litre unfiltered water samples were extracted with dichloromethane (DCM) at a pH below 2 (acidified with phosphoric acid) and with the addition of sodium chloride in a separatory funnel. Sample bottles were rinsed with DCM. Deuterated surrogates were added prior to the extraction to monitor sample handling procedures and to minimize the possibility of false negative results.

The organic extract was dried with acidified sodium sulphate, concentrated with nitrogen and derivatized with diazomethane. Internal standards were added to the extract immediately prior to analysis by Gas Chromatography/Mass Spectrometry/Iontrap. Qualitative analysis was performed using the relative retention time and relative abundances of two or more characteristic ions. Quantitative analysis was performed using a multi-internal standards technique and extracted areas of characteristic ions.

Water samples were analysed in batches of 12 with one sample being a distilled water/reagent blank that includes all steps applied to samples including addition of surrogates.

Mass spectrometer calibration was checked against decafluorotriphenylphosphine (DFTPP). Method was calibrated with a four point calibration curve using certified standards. Ions used for pesticide quantification and qualification were selected from individual standards that represent each compound and are free of matrix interferences. List of ions used are given in ARC methods manual. Gas chromatograph and mass spectrometer conditions are also given in method manual.

The percent recoveries of the deuterated surrogate compounds (2,4-D, dicamba, atrazine, lindane) within each batch were evaluated to determine if they were within method specifications.

Results are not adjusted for recoveries. Results are expressed in μg active ingredient per litre. Method detection limits are listed in Table 2.

2.3.1.1 Pesticides in Water: Glyphosate

The analysis of Glyphosate and AMPA relied on in-situ derivatization in water followed by analysis by gas chromatography/mass spectrometry/Iontrap.

Water samples were analysed in batches of nine with one sample being a distilled water/reagent blank that includes all steps applied to samples.

Mass spectrometer calibration was checked against decafluorotriphenylphosphine (DFTPP). The method was calibrated with a three-point calibration curve. Ions used for pesticide qualification and quantification were selected from individual standards that represent each standard and are free of matrix interferences. The list of ions used is given in ARC methods manual. Gas chromatograph and mass spectrometer conditions are also given in method manual.

Results are not adjusted for recoveries. Results are expressed in μg active ingredient per litre. Method detection limits are listed in Table 2.

2.3.2 Pesticides in Tissue Samples

Frozen samples were thawed, filtered to remove excess water and weighed. Whole samples were extracted with DCM by 14 hour soxhlet extraction. The extract was concentrated and derivatized following similar procedures to those described for water samples.

Results are expressed in terms of active ingredient concentrations per filtered (wet) weight. Results are not adjusted for recoveries. Method detection limits are dependant upon the amount of sample received. Due to the increased matrix interferences, the on-column detection limits are ten times for tissue samples than for water samples (Table 2).

2.3.3 Pesticides in Surface Film

Dichloromethane/water washings were combined with 1 litre distilled water and extracted as per normal water samples. Results are expressed in terms of active ingredient concentration per surface area (i.e., ug/m^2).

2.4 Analytical Methods for Inorganics and Bacteria

2.4.1 Total Phosphorus

Analyses were carried out at the Inorganics Laboratory at ARC, Vegreville under the supervision of Dr. Dean Smillie. The method used for phosphorus analysis is described in Dieken et al. (1996) and consists of two steps:

- Samples were digested in a block digestor with sulphuric acid containing potassium sulphate and a mercuric oxide catalyst to convert organic and condensed phosphates to orthophosphate during a multi-stage heating cycle (120 to 360^{o}C).

- The orthophosphate then reacts with ammonium molybdate and potassium antimony tartrate to form a phosphomolybdate antimony complex which is reduced by ascorbic acid to a blue coloured complex which is measured colorimetrically at 880 nm.

2.4.2 Chlorophyll-a

Analyses were carried out at the McIntyre Laboratory, Monitoring Branch under supervision of Morna Hussey following methods outlined in Yensh and Mentzel (1963), Holm-Hansen et al. (1965) and Strickland and Parson (1965). Known sample volume is filtered through a 0.8 um membrane filter. The residue is extracted with acetone-water mixture (9 to 1 volume), then centrifuged. Fluorescence intensities are measured on a pre-calibrated fluorometer, equipped with a Wratten 47B for the excitation light and a Corning CS.2-64 filter for the emitted light.

2.4.3 Bacterial Analyses

Analyses were carried out at the Provincial Health Laboratory in Edmonton.

Fecal coliform and *E. coli* counts were obtained by the membrane filter procedure (Millipore 0.45 um pore size filters). For *E. coli*, the well shaken sample is filtered and the membrane filter is placed on membrane Lactose Glucuronide Agar medium (indicator 5-bromo-4chloro-3indolyl-B-D-glucuronic acid cyclohexylammonium salt) and incubated in a humid chamber at 44.5^{o}C for 24 hours. Green and blue colonies are counted with the aid of a stereoscopic microscope. Questionable colonies are confirmed with methyl red (acid production from glucose fermentation), growth using citrate as a sole source of carbon, indole production from tryptophase, and absence of cytochrome oxidase.

2.4.4 Conductivity

Conductivity was measured using an electronic meter with a six-electrode (nickel) cell and automatic temperature compensation to 25^{o}C.

2.5 Pesticide Data Analysis

Pesticide concentrations, pesticide detection frequency and total pesticide concentration were used to describe spatial and temporal trends in the data set.

- *Pesticide concentration* is the actual concentration reported by the analytical laboratory for individual compounds. Concentrations reported as less than the detection limit were not included in calculations of percentiles, detection frequency, number of pesticides per sample or total pesticide concentration. However, in statistical analyses numbers reported as less than the detection limit were replaced by 1/10th of the detection limit (e.g., Donald et al. 2001).

- *Pesticide detection frequency* is the number of samples with at least one pesticide detection per sample, divided by the number of samples analysed. Pesticide detection frequency was used to represent the frequency of detection of individual compounds as well as the frequency of pesticide detection (i.e., occurrence of samples with at least one detection).

- *Total pesticide concentration* per sample is the sum of concentrations reported for individual compounds in that sample.

- *Number of detections per sample* is the number of individual pesticides per sample, for which a measurable concentration is reported.

Comparisons with Canadian Ambient Guidelines (CCME 1999, 1987) for the protection of aquatic life (PAL) for irrigation (IRR) for drinking water (Drink) and for livestock watering (Live) provided a basis to evaluate the significance of reported concentrations. The application of guidelines does not imply that water bodies which were sampled in this project provide water for irrigation, human consumption or livestock watering. Concentrations which were above the guideline were said to be non-compliant; those at or below the guidelines were said to be compliant.

Statistical analyses include analyses of variance (ANOVA) and t-test.

- ANOVA (Sokal and Rohlf, 1969) were carried out to determine the significance of differences in the means of various data groups (e.g., differences among monthly data sets), the Bonferoni test was applied to determine which pairs of samples were significantly different.

- t-tests (Sokal and Rohlf, 1969) were used to determine the significance of differences between paired data sets (e.g., June- July).

3.0 RESULTS

3.1 Overview of Results

3.1.1 Wetland Characteristics

The location of wetlands sampled in this project is shown in Figure 1.

A review of field notes compiled in July (Appendix 2) indicates that the most common crops or land uses observed in the wetlands' drainage areas consisted of cereals (39% of the wetlands), canola (18%), bush and trees (20%), fallow (2%), hay (1%), pasture (1%) and flax (<1%). While two or more of these land uses often occurred in the watershed of most wetlands, some watersheds were dominated by single uses (i.e., cereal crops: 18 wetlands; canola: 11; hay: 4; pasture: 2; and flax: 1).

The average distance between cropland and the water's edge was most commonly between 5 and 20 m (45% of wetlands) and between 20 and 50 m (23%). However, while the buffer strip between cultivated land and water was much wider in some wetlands (50- 100 m: 7% and >100 m: 12%) in 13% of the wetlands, cultivation was right to the edge of the water (0-5 m).

50% of the wetlands ranged in surface area between 0.4 and 2 ha (25th to 75th percentile, respectively) with a median of 0.8 ha. The size of the smallest wetlands was estimated at 0.02 ha and the largest one at 46 ha.

In 50% of the wetlands water depth ranged between 0.35 m and 0.75 m with a median of 0.55 m. The deepest wetland was 2.2 m and the shallowest one was 0.04 m. Overall, wetlands sampled in this study were much shallower than anticipated; this situation is a direct result of very low snow pack and rainfall in preceding years.

Most wetlands had emergent vegetation consisting of *Typha* (cattails) and *Scirpus* (bulrushes). *Carex* (sedge) and *Beckmannia* (slough grass) were also reported. However, some wetlands were not surrounded by emergent vegetation.

Many (37%) of the wetlands had very little submerged vegetation (0 to 20% substrate cover), while others (28%) were nearly completely clogged (>80% substrate cover). *Myriophyllum (*milfoil*), Ceratophyllum (*coontail*), Potamogeton spp. (*pondweed*) Utricularia (*bladderwort*), Lemna spp. (*duckweed), *Ranunculus (*buttercup) and filamentous green algae were reported most frequently. *Aphanizomenon (Cyanobacteria)* was observed in one wetland.

3.1.2 Overview of Pesticide Samples

From April to October 2000, 124 water samples, seven surface film samples and 13 bulk plankton tissue samples, collected from wetlands in the Aspen Parkland Natural Region of Alberta and 17 precipitation samples, collected at the Alberta Research Station in Vegreville were analysed for pesticides. Detailed pesticide data are presented in Appendix 3a (water), 3b (tissue), 3c (rain), 3d (surface film).

3.1.3 Detection Frequency

A summary of pesticide detections, presented in Figure 2, indicates that out of the 42 compounds analysed in this study, 16 were detected at least once (i.e., MCPA, 2,4-D, clopyralid, picloram, glyphosate, imazamethabenz, lindane, bromoxynil, MCPP, AMPA, dichlorprop, dicamba, triallate, carbathiin, desethyl atrazine and desisopropyl atrazine). Detection frequency varied substantially among pesticides and among sample matrices.

- All 16 compounds, except triallate, desethyl atrazine and desisopropyl atrazine) were found in water. MCPA and 2,4-D were encountered most frequently (58 and 46% of the samples, respectively). Glyphosate, clopyralid, AMPA, and imazamethabenz were encountered in less than 5% of the samples.

- 2,4-D was detected most frequently in rain (65%), followed by glyphosate (57%), and MCPA (53%). Lindane, bromoxynil, MCPP, triallate and clopyralid were detected in more than 5% of the samples.

- Only five compounds were detected in tissue samples (2,4-D, clopyralid, imazamethabenz, desethyl atrazine, and desisopropyl atrazine).

- No pesticides were detected in surface film samples.

It is worth noting that picloram, which occurs fairly commonly in water, was not detected in rain, and that lindane, bromoxynil and triallate were encountered more commonly in rain than in water.

Differences in detection frequency among compounds and matrices may indicate the actual (ambient) level of contamination in each matrix (Table 2), or differences in characteristics of the active ingredients (e.g., K_{OC}, solubility, volatility). They may also be a function of differences in the number of samples analysed, the geographical distribution of the samples, and the detection limits that could be achieved for each matrix.

3.1.4 Concentrations

Concentrations of the pesticides detected in the three matrices are summarised in Figure 3.

- In water, median concentrations of glyphosate and AMPA were higher than those of other compounds. Picloram reached the highest peak concentration (11.916 µg/L on July 12, 2000 in wetlands #12). Although MCPA and 2,4-D were encountered frequently, their median concentration was lower than that of most other compounds detected in water.

- In rain, compounds with the highest median concentration (2,4-D, MCPA and glyphosate) were also those with the highest detection frequency.

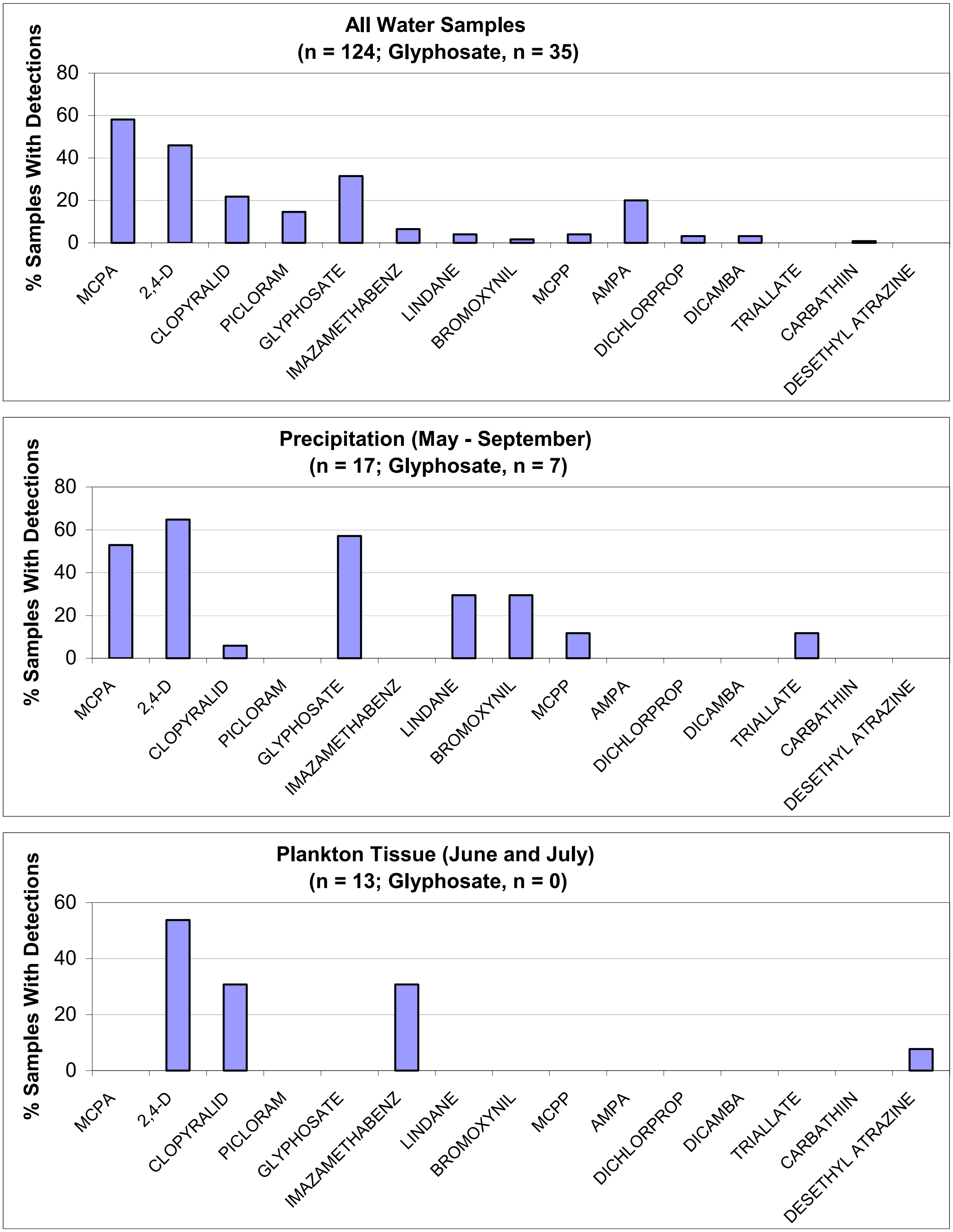


Figure 2 **Pesticide detection frequency in wetlands, precipitation and plankton from the Aspen Parkland, 2000**

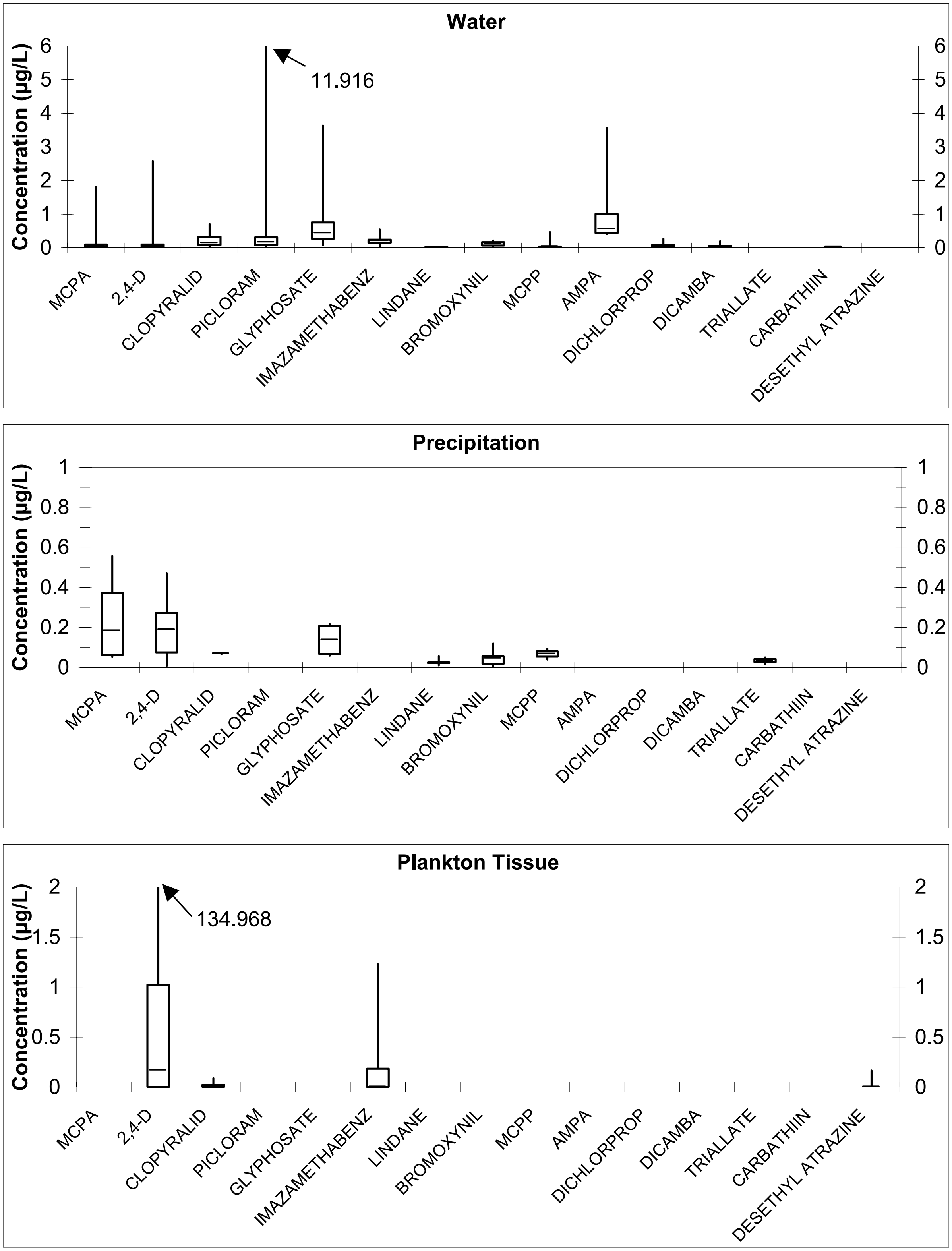


Figure 3 Pesticide concentrations detected in wetlands, precipitation and plankton from the Aspen Parkland, 2000

- While only traces of clopyralid, desethyl atrazine and desisopropyl atrazine were detected in plankton tissue, concentrations of imazamethabenz and especially 2,4-D were much higher.

3.1.5 Compliance with Guidelines

Pesticide concentrations detected in water and rain were evaluated against water quality guidelines for the protection of aquatic life, irrigation and drinking water for livestock and humans (CCME 1989, 1999). Results of this evaluation are summarised in Table 4.

A safety factor is built into CCME guidelines. Guidelines for the protection of aquatic life usually have a safety factor of 0.1 (i.e., guideline is 10 times lower than the lowest NOEL [no observable effects level] recorded on the most sensitive Canadian species tested). The safety factor for irrigation may vary.

Of the compounds that were detected in this study, dicamba and bromoxynil are the only two that have a full set of guidelines. A partial set of guidelines exists for 2,4-D, picloram, glyphosate and lindane. No guidelines have been set for imazamethabenz, clopyralid, MCPP, AMPA, dichlorprop, and carbathiin. When guidelines for specific uses are not available, the significance of pesticide detections on these uses cannot be evaluated.

Pesticides analysed in this study have no tissue guidelines that could be used to evaluate the safety of a food source for higher trophic levels. Consequently, the implications of detecting pesticide residues in plankton tissue cannot be evaluated.

3.1.5.1 Drinking Water for Humans and Livestock

Pesticide concentrations for 2,4-D, picloram, dicamba, lindane and triallate, which were recorded in water and precipitation, complied with guidelines for human and livestock drinking water.

3.1.5.2 Guidelines for the Protection of Aquatic Life

All pesticides, which have guidelines for the protection of aquatic life, occurred at concentrations that complied with these guidelines with the exception of lindane. Four detections of lindane in water and in precipitation were non-compliant. The concentrations of lindane measured in wetlands were within the safety factor of 0.1 that is usually built into guidelines for the protection of aquatic life.

3.1.5.3 Guidelines for Irrigation

MCPA and dicamba have irrigation guidelines for crops of different sensitivity.

MCPA guidelines for irrigation of crops were exceeded in 53 water samples, and in nine precipitation samples, respectively. In water five samples exceeded guidelines by more than a factor of 10. In precipitation three samples exceeded the guideline by a factor of 10.

Table 4 Comparison of pesticide concentrations detected in wetland water and in precipitation with CCME guidelines

Pesticides Detected in Wetlands	CCME (1999) Guidelines in µg/L				WETLAND WATER SAMPLES							
									# of Samples Exceeding Guidelines			
	Drinking	Irrigation	Livestock	FAL	# Detections (# Samples)	% Detection	Median Detected Conc. (µg/L)	Maximum Conc. (µg/L)	Drinking	Irrigation	Livestock	FAL
AMPA	-	-	-	-	7(35)	20	0.552	3.568	-	-	-	-
Bromoxynil	5	0.33	11	5	2(124)	1.6	0.112	0.216	0	-	0	0
Carbathiin	-	-	-	-	1(124)	0.8	0.025	0.025	-	-	-	-
Clopyralid	-	-	-	-	27(124)	21.8	0.133	0.714	-	-	-	-
Dicamba	120	0.006	122	10	4(124)	3.2	0.012	0.195	0	3(1)[2]	0	0
Dichlorprop	-	-	-	-	4(124)	3.2	0.028	0.272	-	-	-	-
Glyphosate		-	280	65	11(35)	8.9	0.429	3.633		-	0	0
Imazamethabenz	-	-	-	-	8(124)	6.5	0.197	0.547	-	-	-	-
Lindane	4	-	4	0.01	5(124)	4	0.013	0.021	0	-	-	4(0)
MCPA	-	0.025	25	2.6	72(124)	58.1	0.045	1.812	-	53(5)	0	0
MCPP	-	-	-	-	5(124)	4	0.032	0.472	-	-	-	-
Picloram	190	-	190	29	18(124)	14.5	0.162	11.196	0	-	0	0
Triallate	-	-	230	0.24	0(124)	0	nd[1]	nd	-	-	0	0
2,4-D	100	-	100	4	57(124)	46	0.053	2.572	0	-	-	0

Pesticides Detected in Rain	CCME (1999) Guidelines in µg/L				RAIN SAMPLES						
									# of Samples Exceeding Guidelines		
	Drinking	Irrigation	Livestock	FAL	# Detections (# Samples)	% Detection	Median Detected Conc. (µg/L)	Maximum Conc. (µg/L)	Irrigation	Livestock	FAL
AMPA	-	-	-	-	0(7)	0	nd	nd	-	-	-
Bromoxynil	5	0.33	11	5	5(17)	29.4	0.048	0.119	-	0	0
Carbathiin	-	-	-	-	0(17)	0	nd	nd	-	-	-
Clopyralid	-	-	-	-	1(17)	5.9	0.068	0.068	-	-	-
Dicamba	120	0.006	122	10	0(17)	0	nd	nd	0	0	0
Dichlorprop	-	-	-	-	0(17)	0	nd	nd	-	-	-
Glyphosate		-	280	65	4(7)	23.5	0.137	0.216	-	0	0
Imazamethabenz	-	-	-	-	0(17)	0	nd	nd	-	-	-
Lindane	4	-	4	0.01	5(17)	29.4	0.023	0.056	-	-	4 (0)
MCPA	-	0.025	25	2.6	9(17)	52.9	0.182	0.47	9 (3)	0	0
MCPP	-	-	-	-	2(17)	11.8	0.067	0.094	-	-	-
Picloram	190	-	190	29	0(17)	0	nd	nd	-	0	0
Triallate	-	-	230	0.24	2(17)	11.8	0.034	0.05	-	0	0
2,4-D	100	-	100	4	11(17)	64.7	0.187	0.068	-	-	0

[1] nd = not detected - = no guidelines have been established FAL = Freshwater Aquatic Life

[2] Numbers in brackets indicate the number of samples that exceed the guideline by an order of magnitude

Three dicamba detections in water exceeded the irrigation guideline, one of these by a factor of more than 10. No rain samples exceeded irrigation guidelines for dicamba.

3.1.6 Other Water Quality Variables

Total phosphorus and chlorophyll-*a* are general indicators of trophic conditions in surface waters. Phosphorus is a major plant nutrient and chlorophyll-*a* is an indicator of algal biomass. In general, the higher the nutrient levels the higher the chlorophyll-*a* content. The phosphorus and chlorophyll content has been used to classify lakes according to trophic status. Three broad groups are generally recognised: oligotrophic (<0.01 mg P/L; <2.5 µg Chl-*a*/L), mesotrophic (0.01 to 0.035 mg P/L; 2.5 to 8 µg Chl-*a*/L), eutrophic (0.035 to 0.1 mg P/L; 8 to 25 µg Chl-*a*/L), hypereutrophic (> 0.1 mg P/L; >25 µg Chl-*a*/L).

Based on their phosphorus concentration, more than 75% of the wetlands would be qualified as hyper-eutrophic, but based on the chlorophyll content most wetlands would be classified as oligotrophic or mesotrophic. The difference in classification suggests that phosphorus is not the only factor that regulates algal growth. Many natural factors, including seasonal variability in light and temperature, high turbidity or shading by vegetation, and high salinity influence algal growth. Furthermore, planktonic algae tend to represent a relatively minor component of the primary producers biomass in shallow wetlands. Consequently, macrophytes and associated periphyton may be a better indicator than phytoplankton.

Conductivity, a general indicator of ionic concentrations and salinity is known to influence species composition of characteristic plant associations in wetlands and has been used in wetland classification (Stewart and Kantrud 1971). Wetlands sampled in the Aspen Parkland in 2000 ranged in conductivity from 196 to 12,150 uS/cm. According to Stewart and Kantrud's conductivity-based classification, eight wetlands are 'fresh'(<40 to 500 uS/cm); 27 are 'slightly brackish' (500 - <2000 uS/cm), 18 are 'moderately brackish' (2000 to < 5000 uS/cm) and six are 'brackish' (5000 to <15,000 uS/cm).

Bacterial concentrations in 75% of the wetlands were less than 100 colonies/100 mL (i.e., they complied with the Canadian Water Quality Guideline for irrigation). These counts are quite low compared to other water bodies in agricultural areas (e.g., Anderson et al. 1998, Anderson 2000, Donahue 2000). Wetland #50 is the only wetland where very high fecal coliform levels were reported in a sample collected on September 21, 2000 (i.e., maxima reported in Table 5).

Table 5 Summary of water quality measurements conducted on wetland water

Variable	Units	Minimum	25th Percentile	Median	75th Percentile	Maximum
Escherichia coli	no./100 mL	10	20	38	98	11000
Fecal Coliforms	no./100 mL	10	10	30	91	12000
pH	pH units	6.89	8.04	8.55	9.11	10.12
Specific Conductance	uS/cm	196	1190	2010	3550	12150
Total Phosphorus (P)	mg/L	0.041	0.308	0.650	1.195	3.570
Chlorophyll-*a*	µg/L	0.6	1.9	3.8	8.3	233.1

3.2 Pesticides

3.2.1 Water Samples

The survey of wetlands carried out in July 2000, combined with sampling carried out in other months, provide a broad description of spatial variability in pesticide contamination of wetlands in the Aspen Parkland. The subset of seven wetlands sampled monthly from April to October depicts seasonal fluctuations in pesticide concentration and types. Data from twenty five wetlands sampled once in June and a second time in July strengthens the understanding of seasonal trends for a time window where the likelihood of pesticide contamination is greatest.

An ANOVA was performed to compare July samples from all wetlands, July samples from wetlands that were sampled in June and July, and July samples from wetlands that were sampled monthly. The test revealed no significant difference in the means and variances of these three groups for the number of compounds detected per sample, the total concentration per sample or the concentration of individual compounds (ANOVA, df 2, 96, $p>0.05$). Imazamethabenz was the only exception: its mean concentration in the subset of seven wetlands was significantly higher than in all wetlands sampled in July (ANOVA, df 2, 96; $p<0.05$). Test results suggests that overall, there is no significant difference in pesticide contamination among the three sample groups; hence, except for imazamethabenz, it is assumed that seasonal trends described for subsets of wetlands may be considered representative of all wetlands.

3.2.1.1 Temporal Trends

<u>*3.2.1.1.1 Monthly Results*</u>

Pesticide data for the seven wetlands sampled monthly are summarised in Figures 4 to 6. ANOVA's followed by the Bonferoni range test were performed to evaluate the significance of differences among monthly means for pesticide concentrations and derived variables.

The mean number of pesticides detected per sample (Figure 4) was significantly higher in May and June than in any other month (ANOVA, F:3.175; df: 6, 44, $P<0.05$; Bonferroni, $P<0.05$). The largest variety of pesticides was encountered in a May sample from wetland # 51 which contained residues of six different compounds. In May and June all wetland samples contained residues of at least one pesticide, in other months some samples had no detectable residues.

The total pesticide concentration measured in the seven wetlands ranged between 0 and 7.257 µg/L (Figure 4) and varied significantly among months (ANOVA, F-ratio: 7.607, df: 6,44; $p<0.05$). Mean concentrations in May were significantly higher than in any other month (Bonferroni, $P<0.05$), mainly because of the relatively high concentrations of glyphosate and AMPA that were detected in all seven wetlands in that month.

Some pesticides were detected in nearly every month, but more frequently and at higher concentration in May (clopyralid), June (2,4-D, MCPA), and July (imazamethabenz, picloram) (Figures 5 and 6). Other pesticides had a much narrower temporal distribution. Glyphosate and AMPA, for instance, were found in all May samples at relatively high concentrations compared

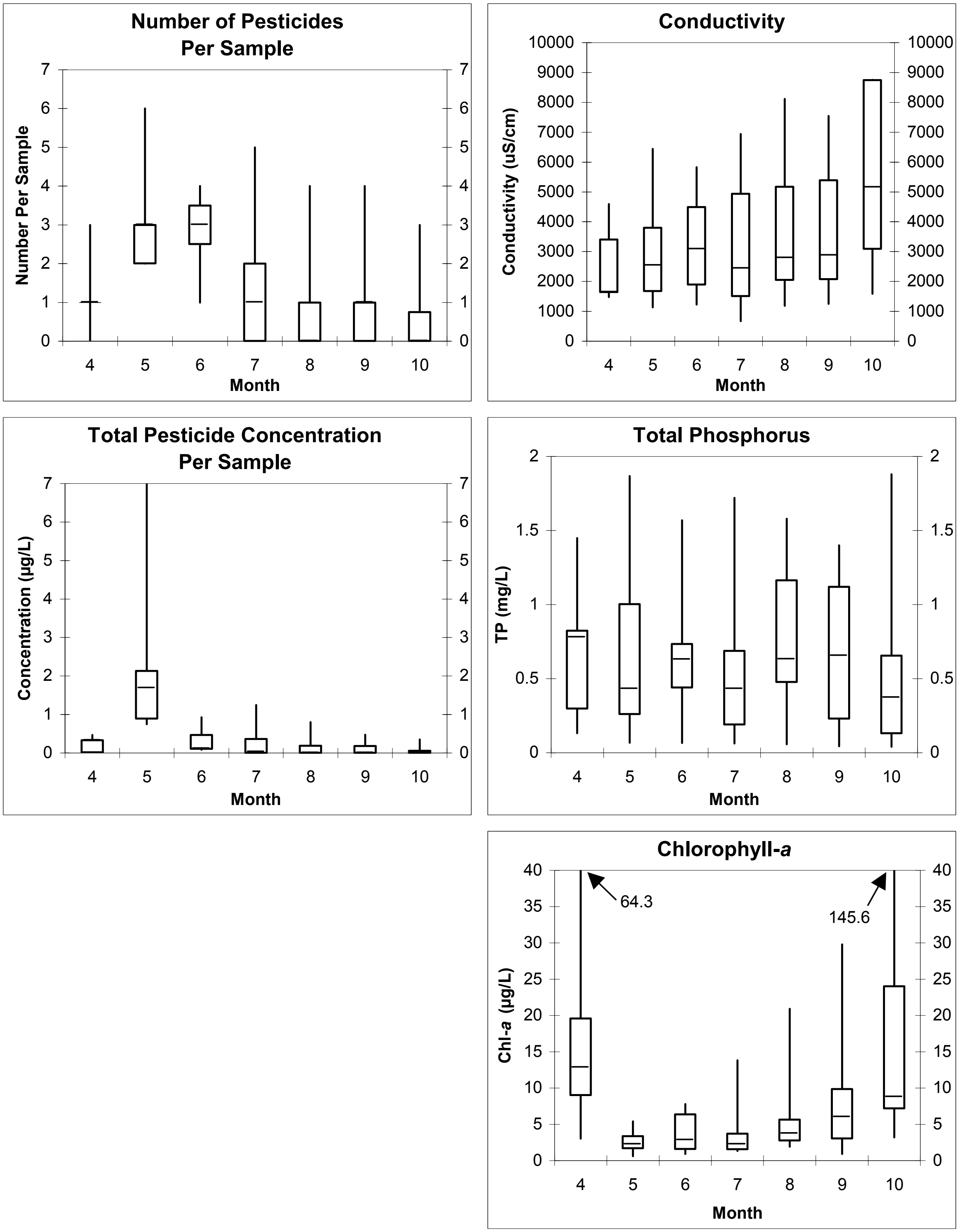


Figure 4 Seasonal trends in pesticide detections and total concentrations in seven wetlands from the Aspen Parkland sampled monthly in 2000

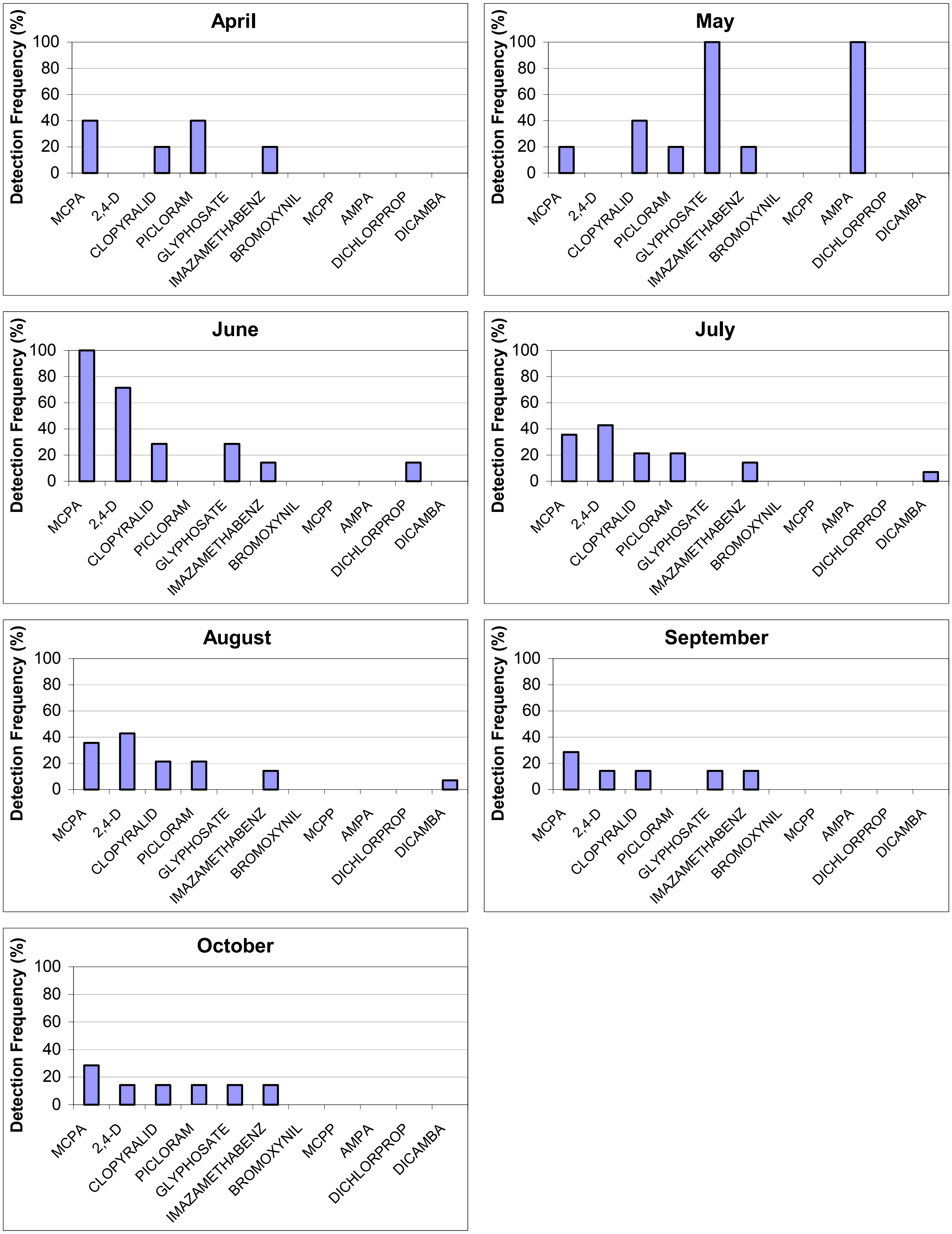


Figure 5 Monthly detection frequency of pesticides detected in water from seven wetlands sampled in the Aspen Parkland in 2000

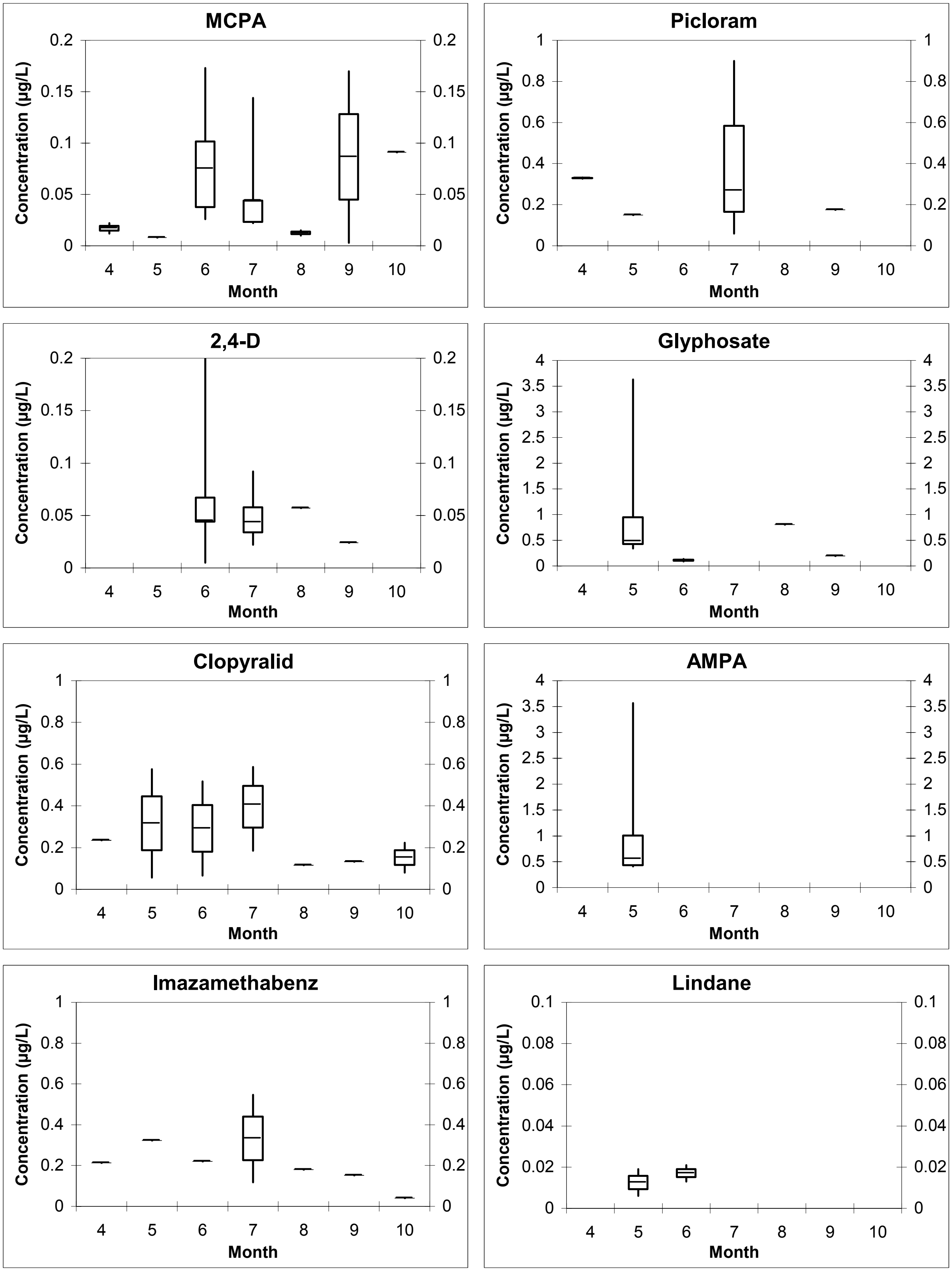


Figure 6 **Seasonal trends in concentrations of pesticides detected in water from seven wetlands sampled in the Aspen Parkland in 2000**

to other pesticides, but were detected in few samples (glyphosate) or not at all (AMPA) later on. Lindane was detected only in May and June samples. Picloram and imazamethabenz were found most frequently and at higher concentration in July.

Some pesticides such as dicamba, dichlorprop, were found too infrequently to evaluate their seasonal distribution. Bromoxynil, and MCPP were not found in any of the seven wetlands, though they were detected in other wetlands sampled in this study.

Based on the seasonal information obtained from the seven wetlands, it appears that July may not be the month of highest overall pesticide contamination. Highest detection frequency, diversity, total concentrations, and concentration of some pesticides (i.e., 2,4-D, MCPA, clopyralid, and lindane) are encountered in a different month. Hence results of the broad spatial survey conducted in July may underestimate maximum ambient pesticide contamination in water.

3.2.1.1.2 Comparison of June and July Samples

A paired t-test was used to compare pesticide concentrations and derived variables in June and July sample pairs. Concentrations of individual pesticides detected in June were not significantly different from concentrations detected in July, neither was the total pesticide concentration (paired t-test, $P>0.05$); however, the number of pesticides detected per sample was significantly higher in June (paired t-test, $P<0.05$). These results are compatible with the findings derived from seasonal monthly samples.

Differences in pesticide diversity and frequency between June and July are illustrated in Figure 7. There were no detections of glyphosate, lindane, and dichlorprop in July and fewer detections of MCPA and 2,4-D.

3.2.1.2 Spatial Trends

The distribution of pesticide detections across wetlands is summarised in Figures 8a to m. Of the 60 wetlands that were sampled in 2000 all but five (i.e., # 3, 30, 46, 48, and 55) had detectable levels of at least one pesticide.

Detections of individual compounds appear to be distributed randomly across the study area (i.e., no apparent aggregation). MCPA and 2,4-D were encountered in the largest number of wetlands (MCPA detected in 52 and 2,4-D detected in 44 wetlands). Glyphosate and AMPA were only analyzed in seven wetlands and they were detected in each of these. Considering that glyphosate is the most widespread use herbicide in the Aspen Parkland of Alberta it is suspected that its occurrence in wetlands is widespread. Clopyralid and picloram were encountered in 13 wetlands each. Other compounds such as MCPP, dichlorprop, dicamba, lindane and bromoxynil were detected in fewer wetlands (5, 4, 4, 4, and 2 wetlands, respectively). Imazamethabenz and carbathiin were found in a single wetland (#51 and 1, respectively).

Wetlands # 7, 10 and 40 (two samples) had lindane concentrations which exceeded the guidelines for the protection of aquatic life (Table 5).

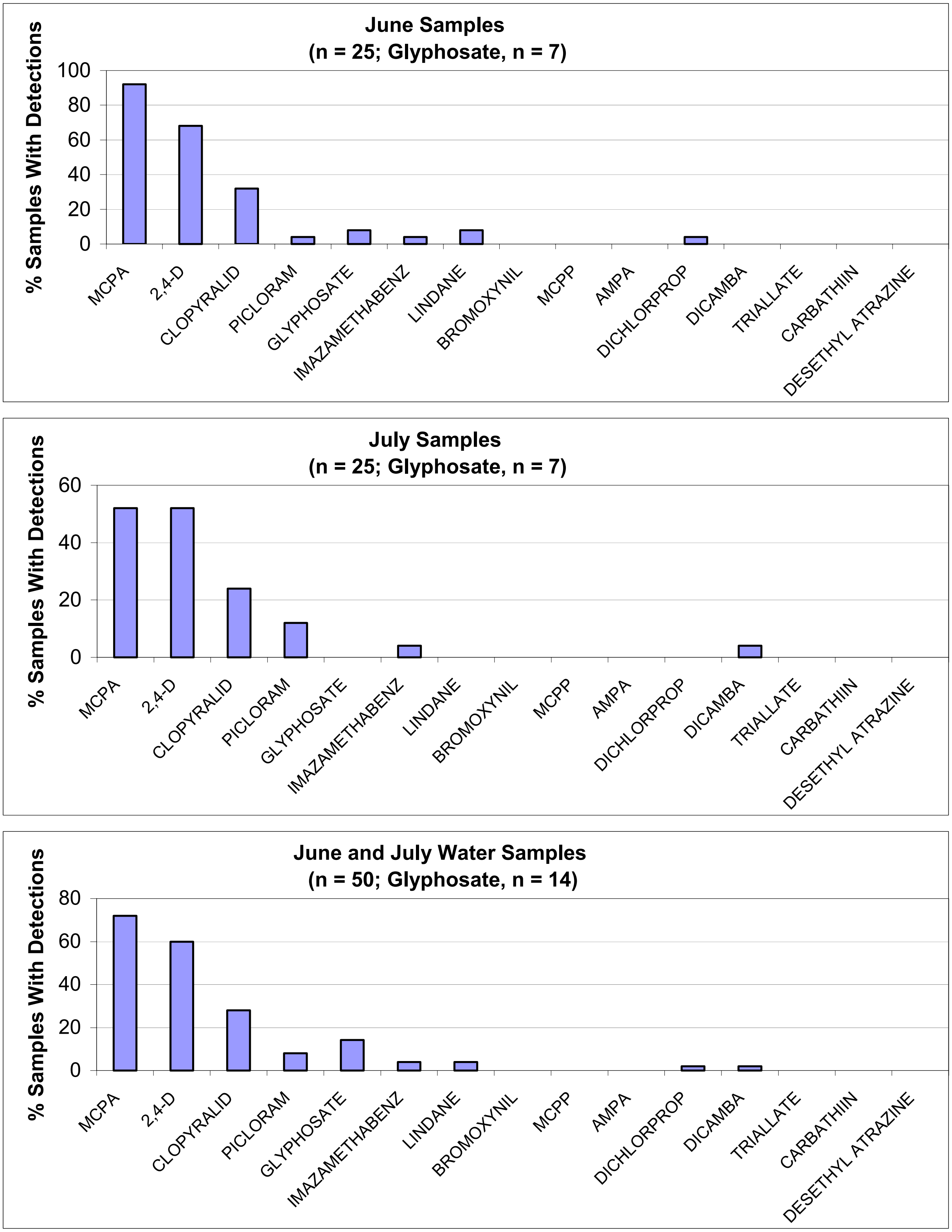


Figure 7 Comparison of pesticides detection frequency in sample pairs (June-July) taken from seven wetlands sampled in the Aspen Parkland in 2000

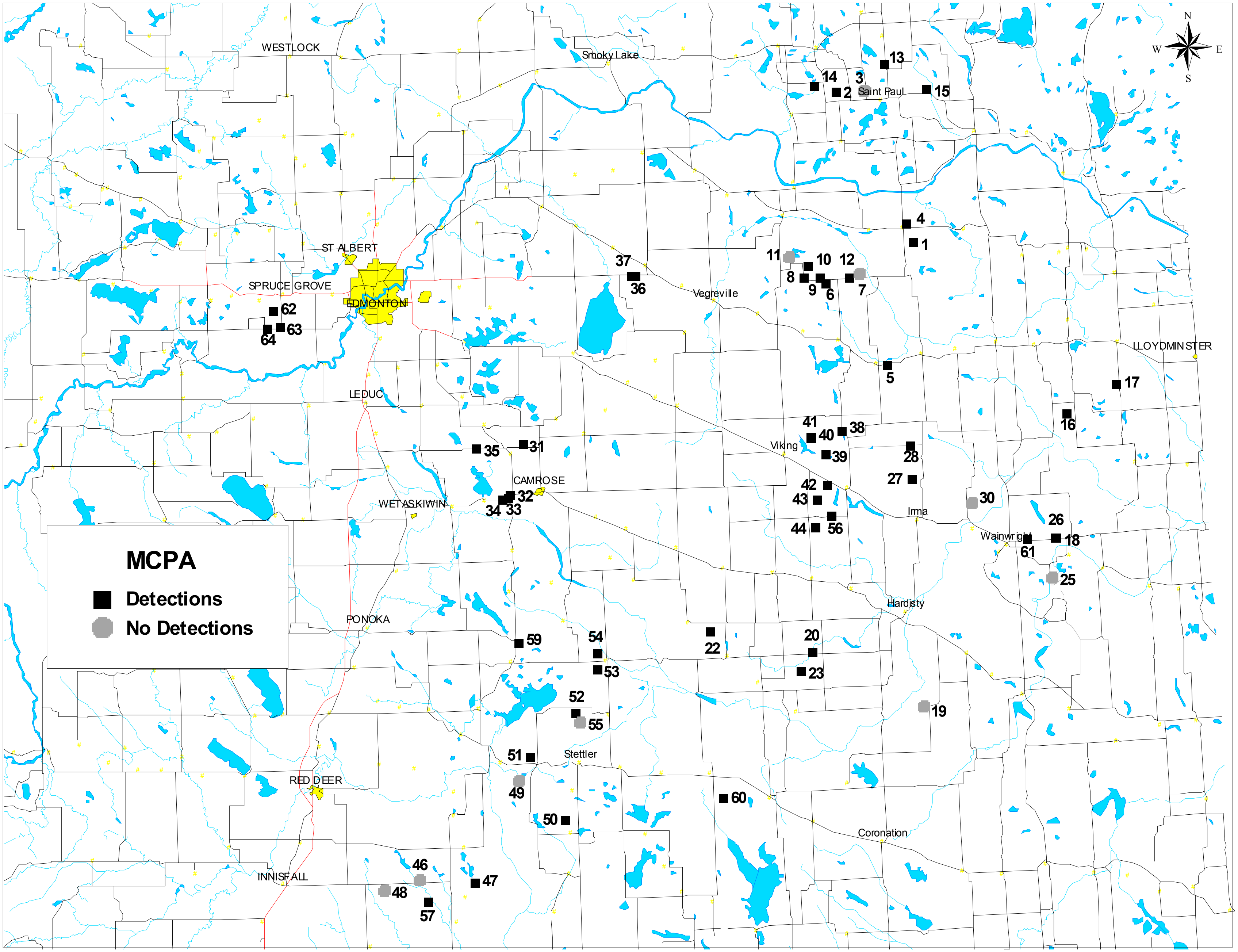


Figure 8a Distribution of MCPA detections in wetlands sampled in 2000

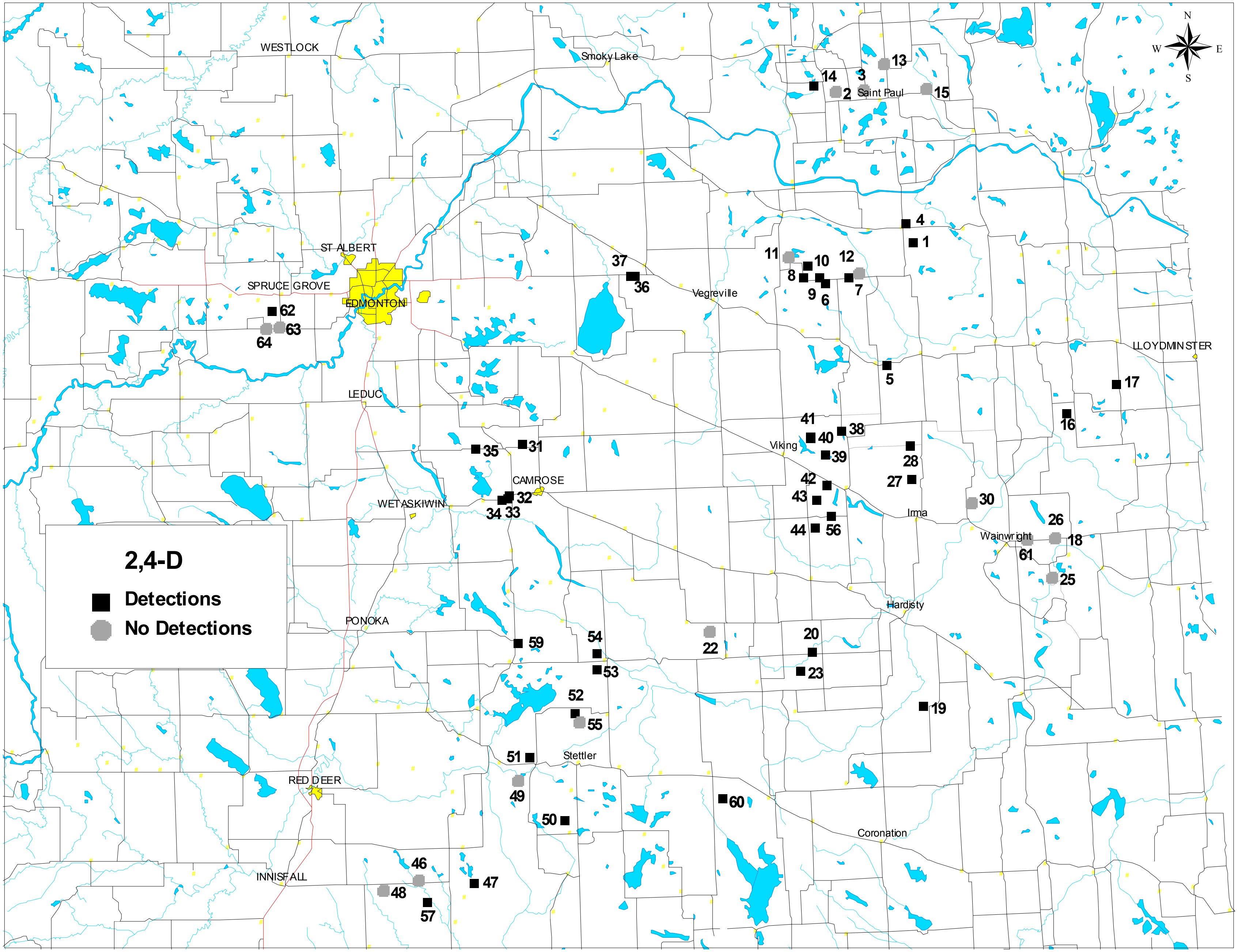


Figure 8b Distribution of 2,4-D detections in wetlands sampled in 2000

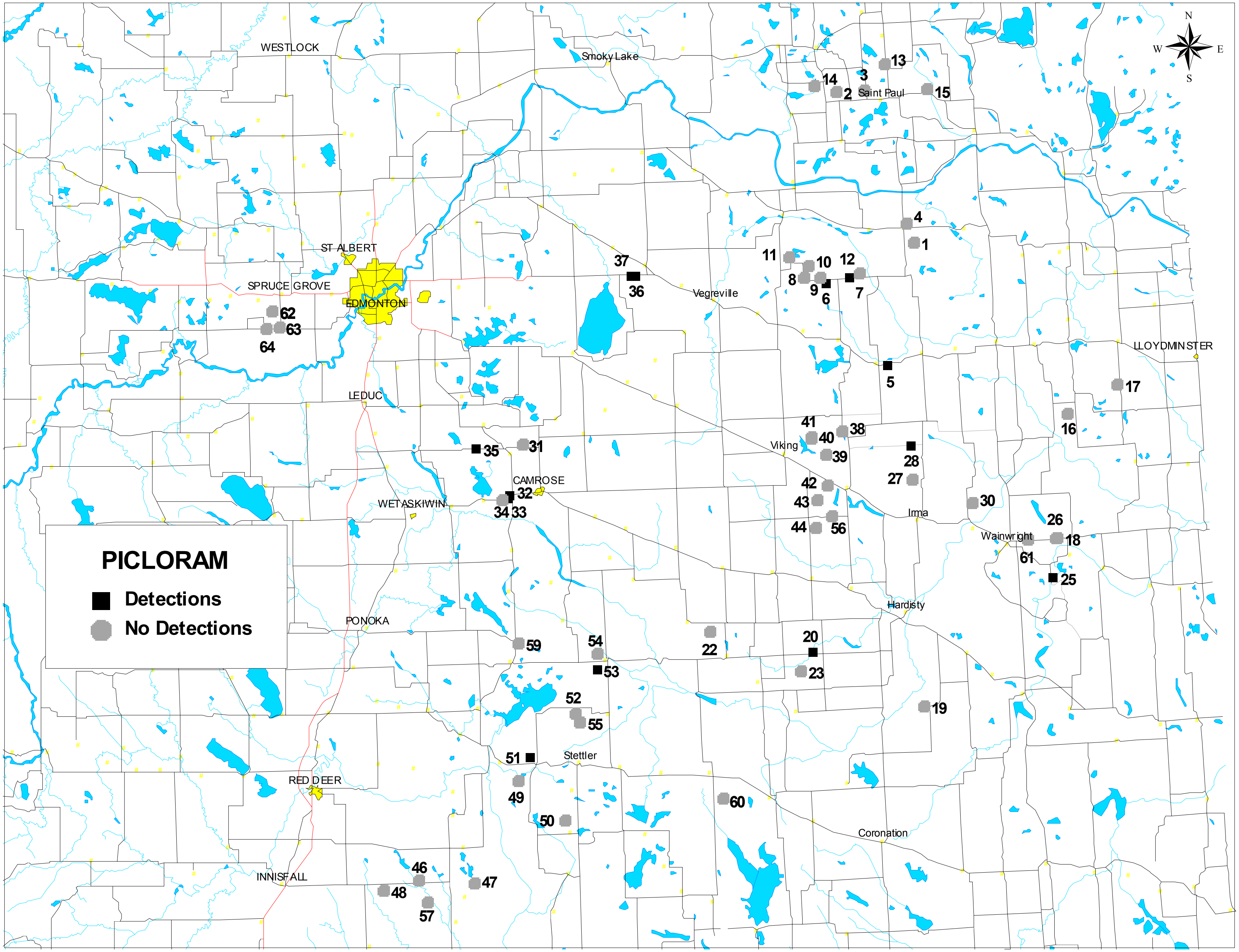


Figure 8c Distribution of picloram detections in wetlands sampled in 2000

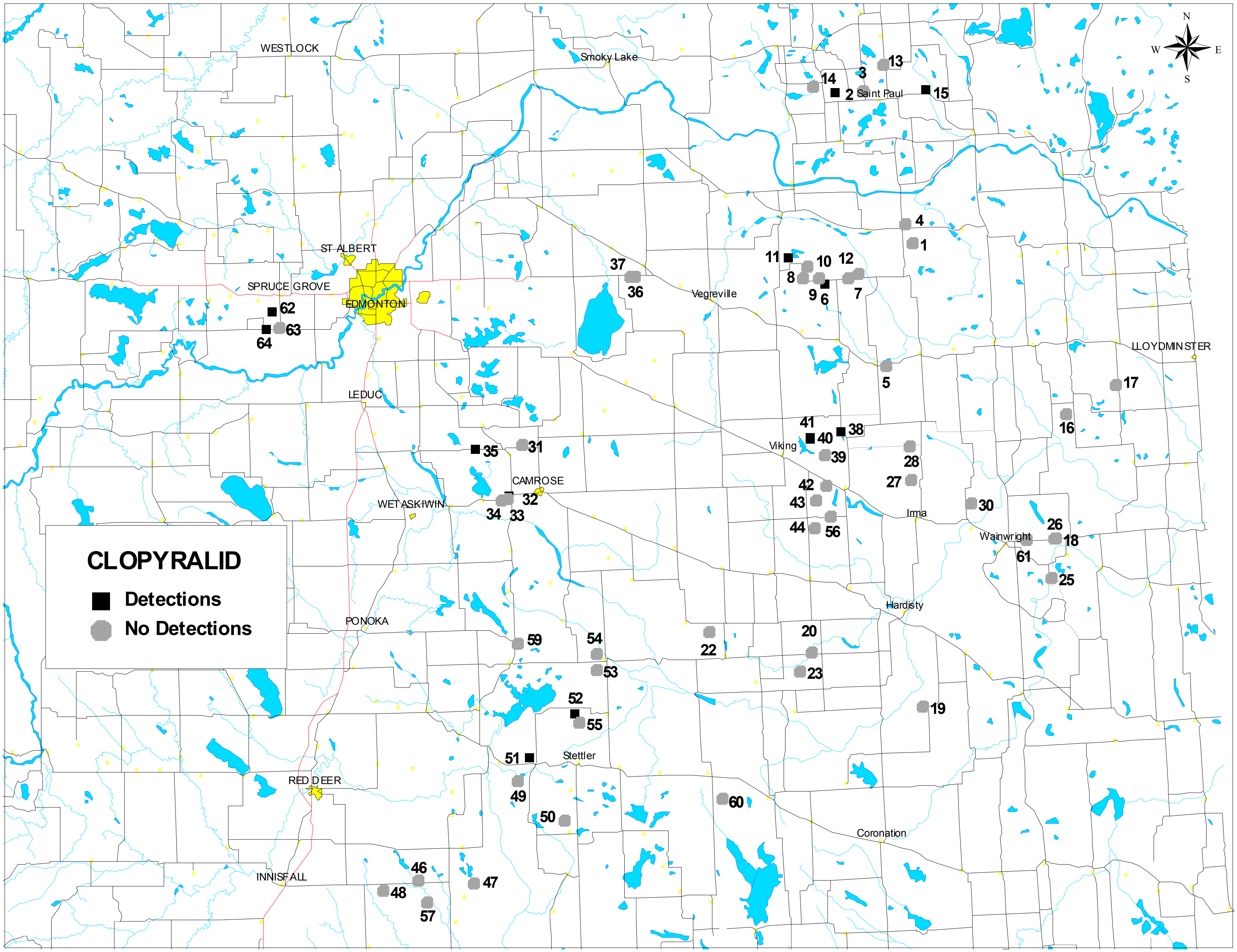


Figure 8d Distribution of clopyralid detections in wetlands sampled in 2000

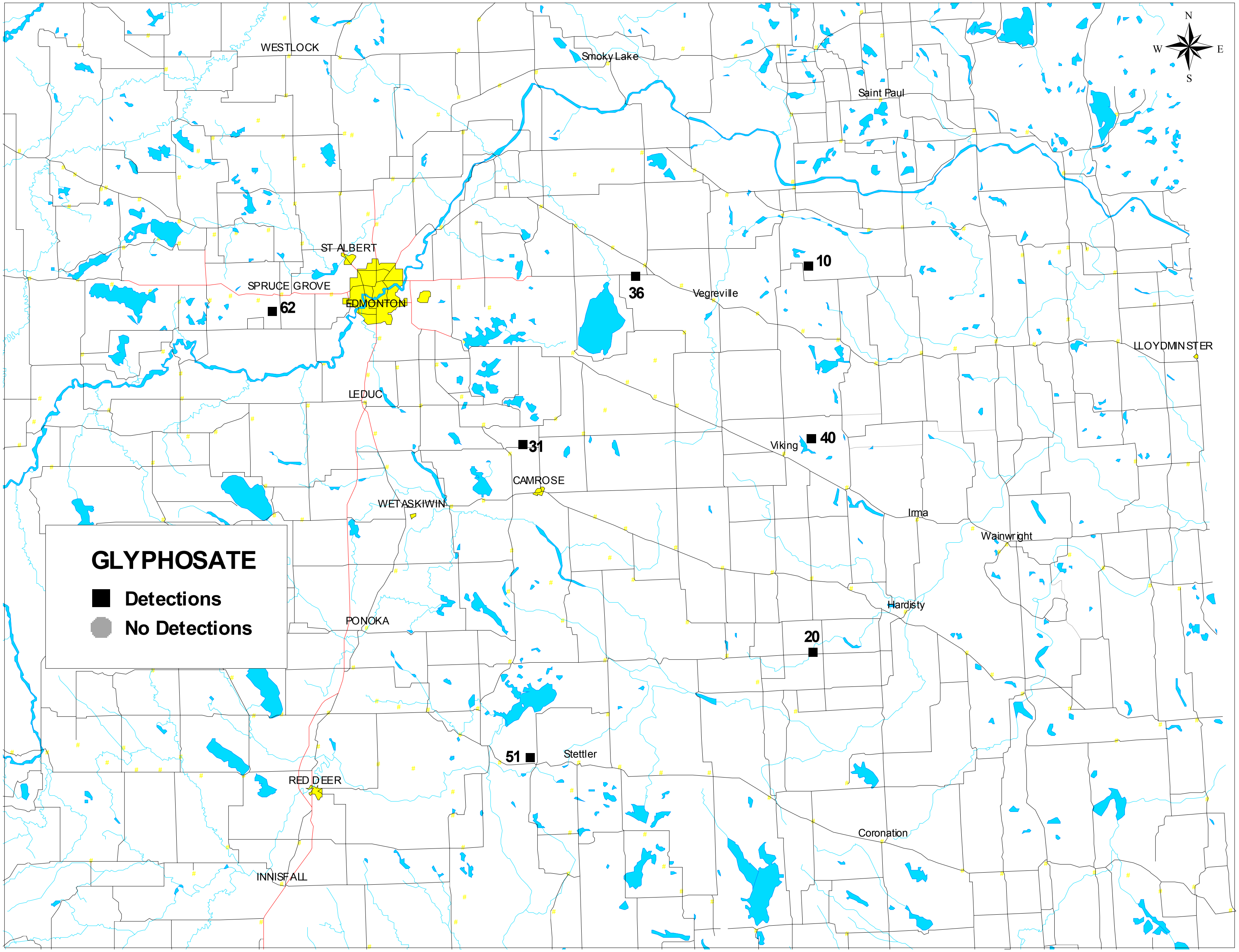


Figure 8e **Distribution of glyphosate detections in wetlands sampled in 2000**
Note: only analyzed (and detected) in seven wetlands

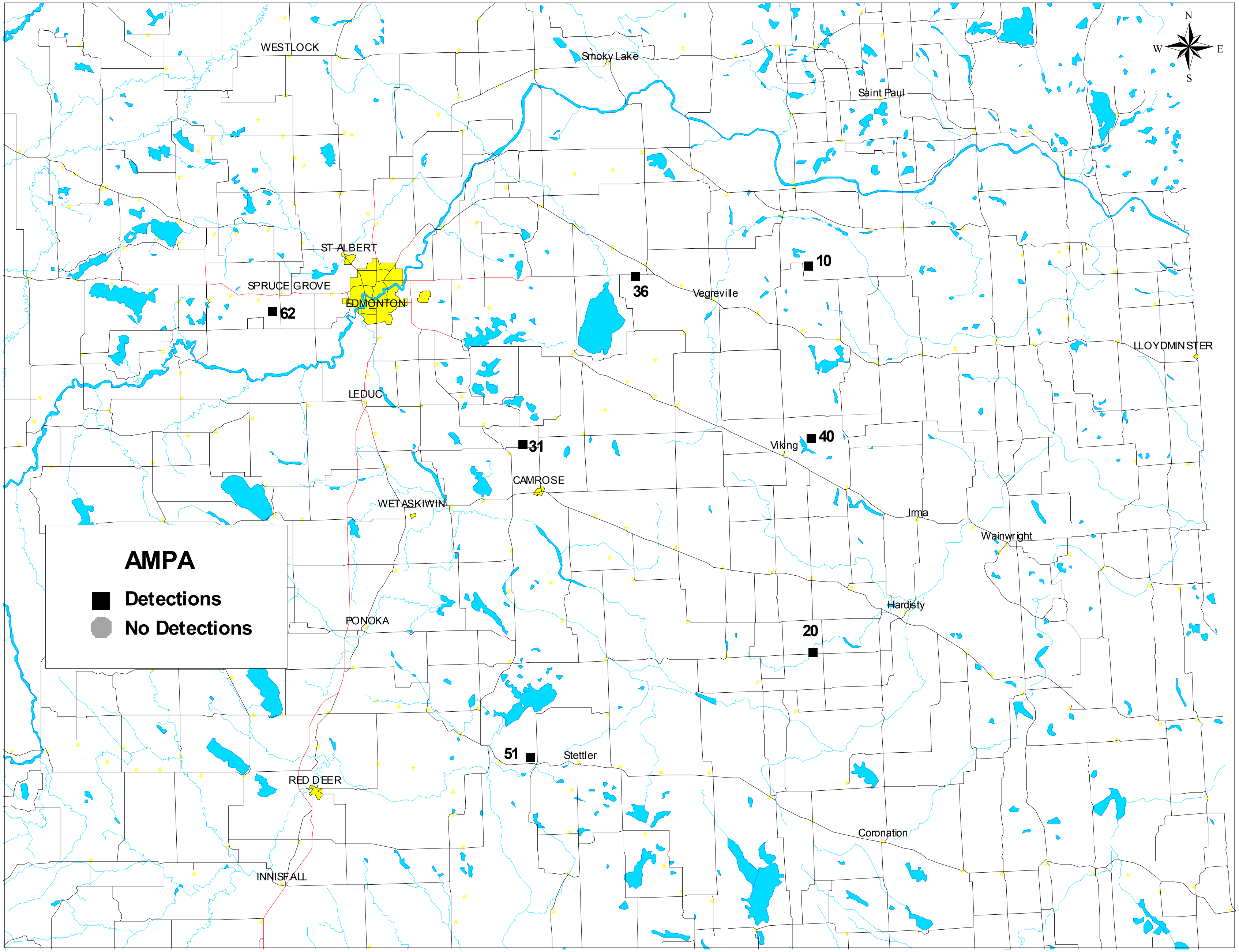


Figure 8f **Distribution of AMPA detections in wetlands sampled in 2000**
Note: only analyzed (and detected) in seven wetlands

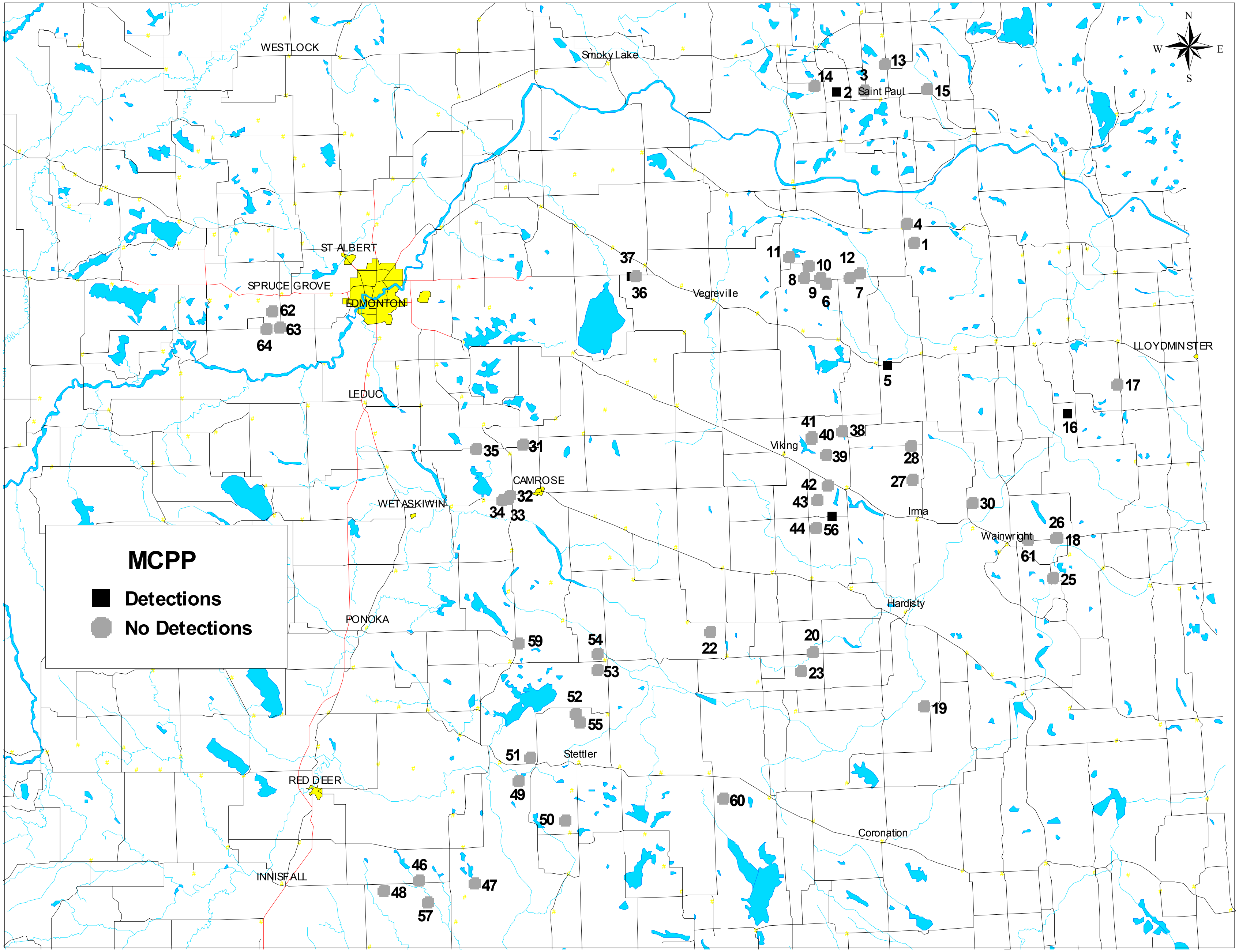


Figure 8g **Distribution of MCPP detections in wetlands sampled in 2000**

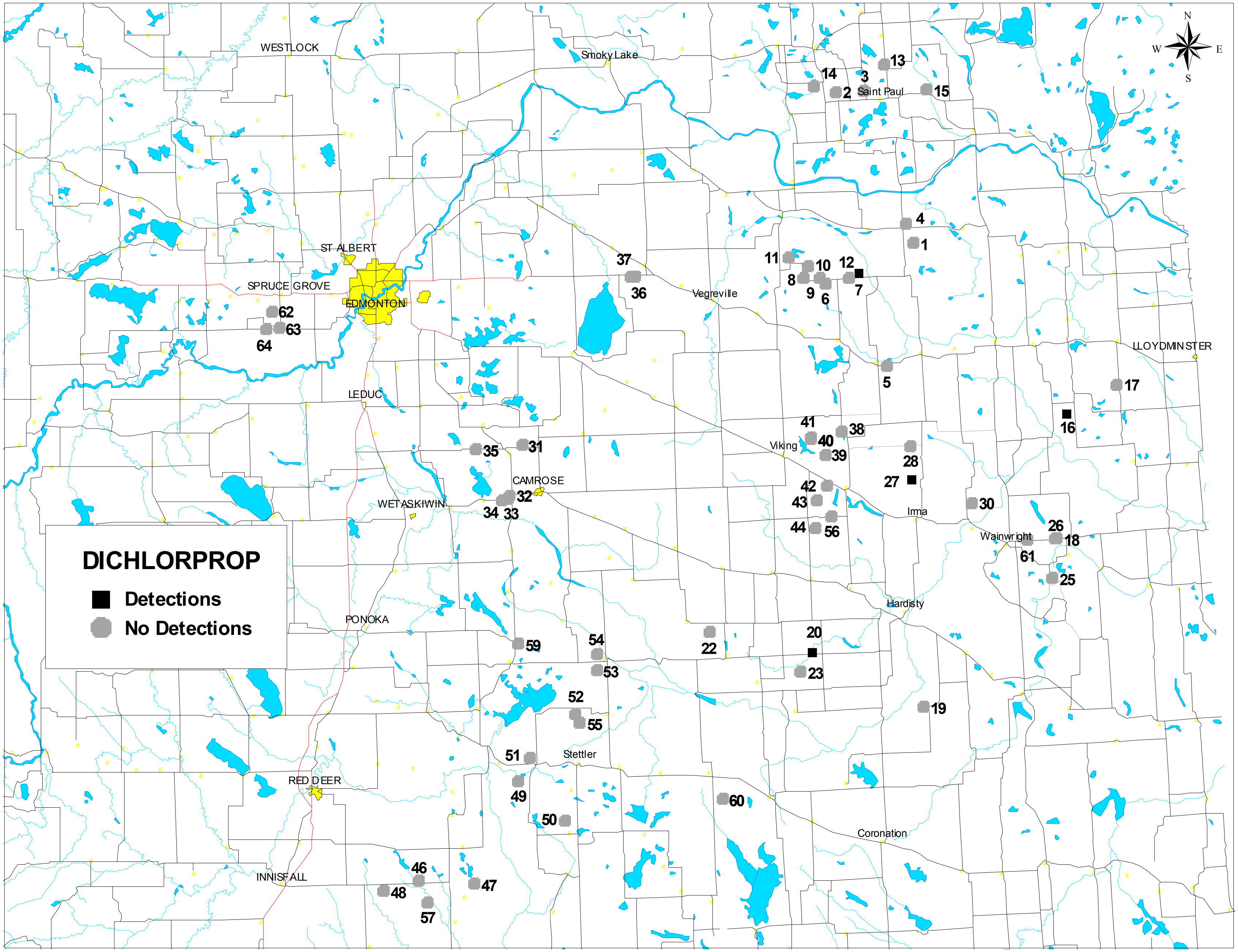


Figure 8h Distribution of dichlorprop detections in wetlands sampled in 2000

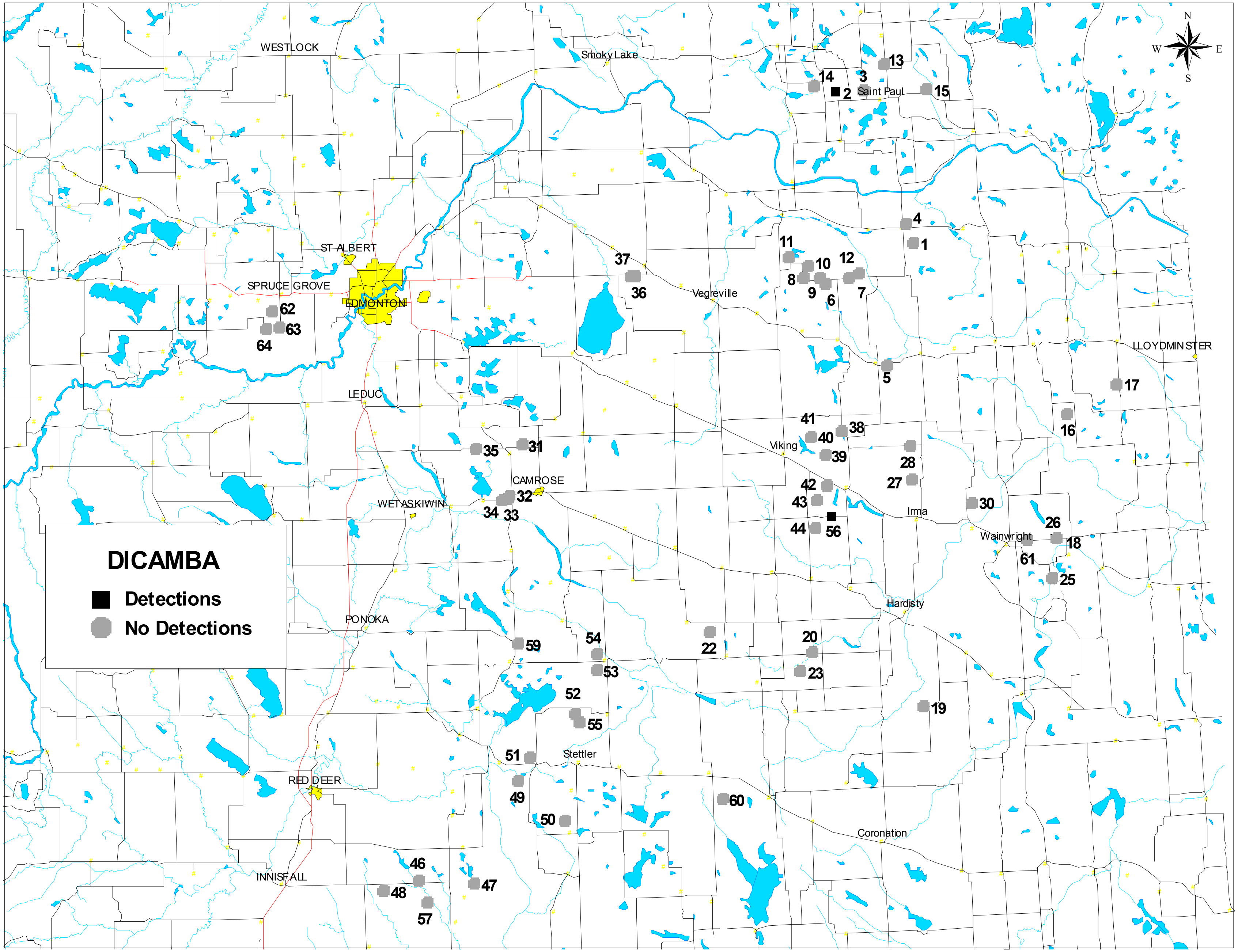


Figure 8i Distribution of dicamba detections in wetlands sampled in 2000

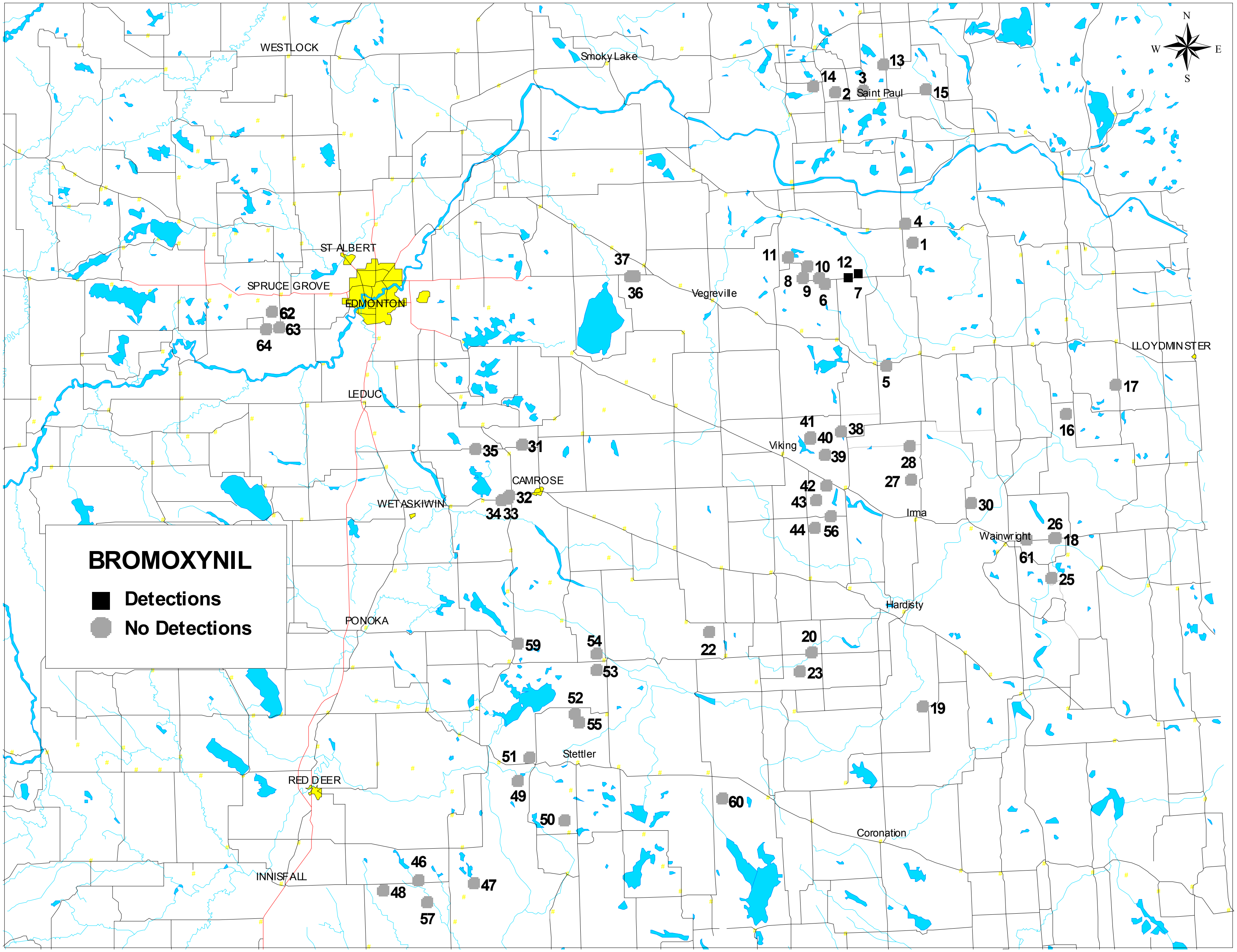


Figure 8j Distribution of bromoxynil detections in wetlands sampled in 2000

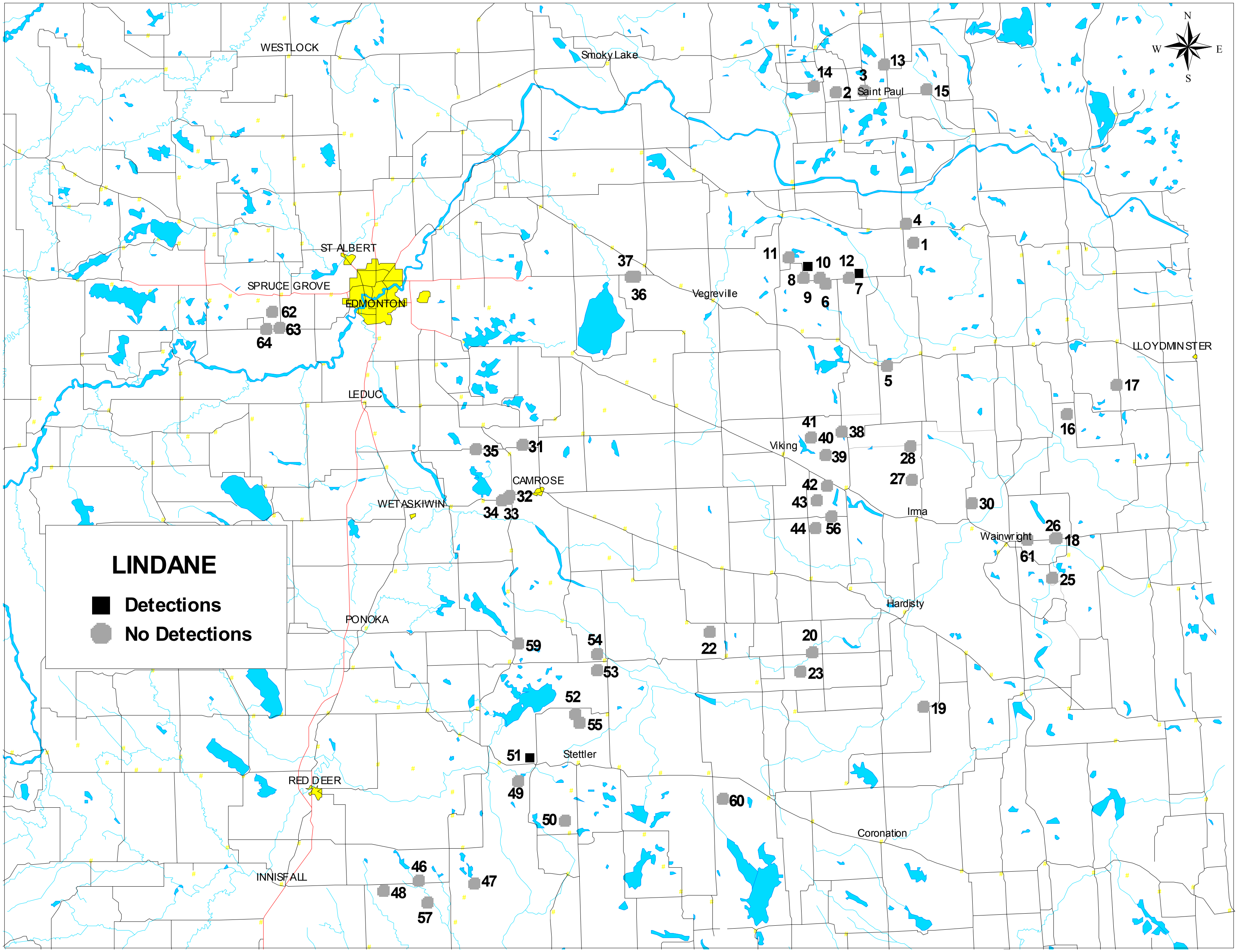


Figure 8k Distribution of lindane detections in wetlands sampled in 2000

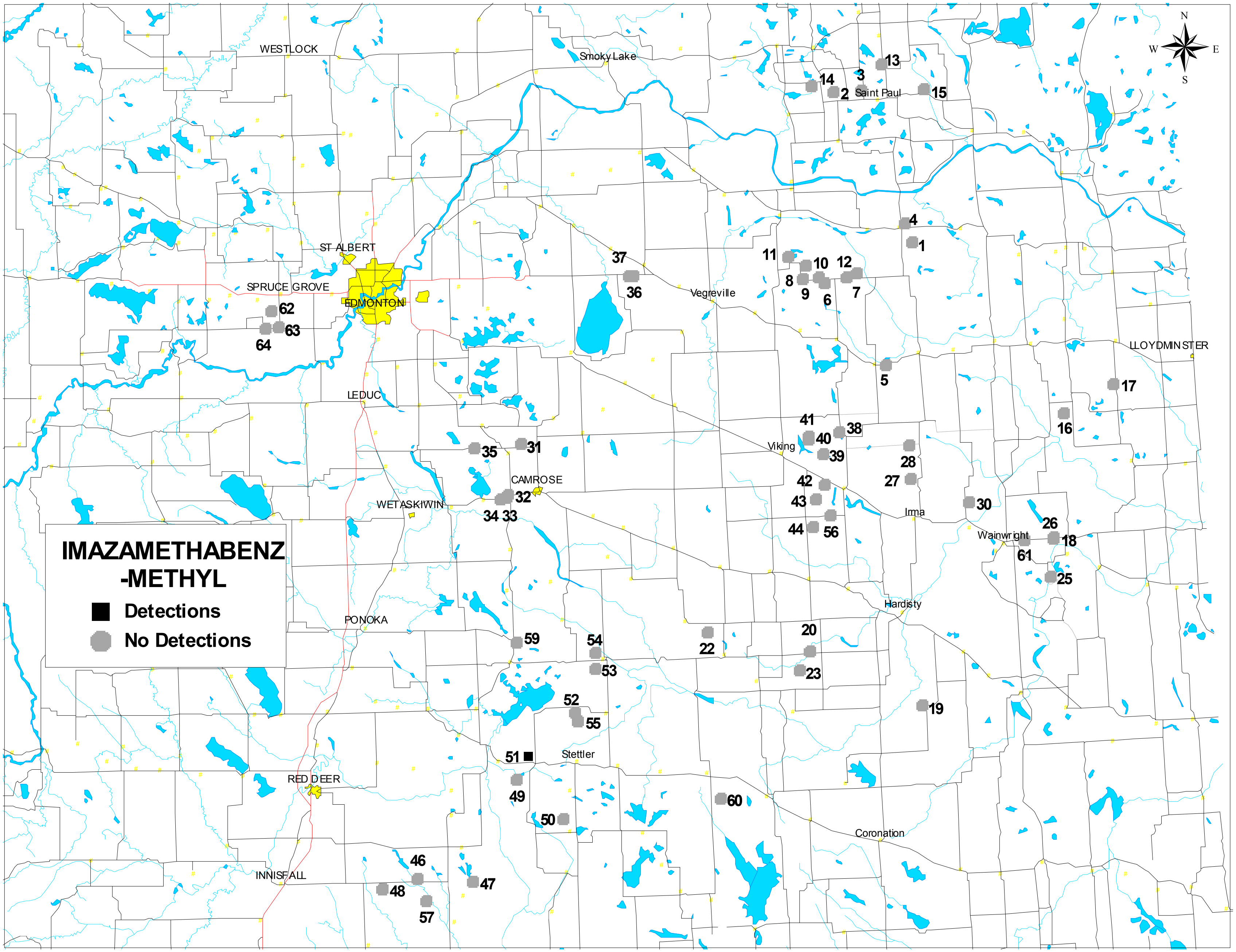


Figure 8l Distribution of imazamethabenz detections in wetlands sampled in 2000

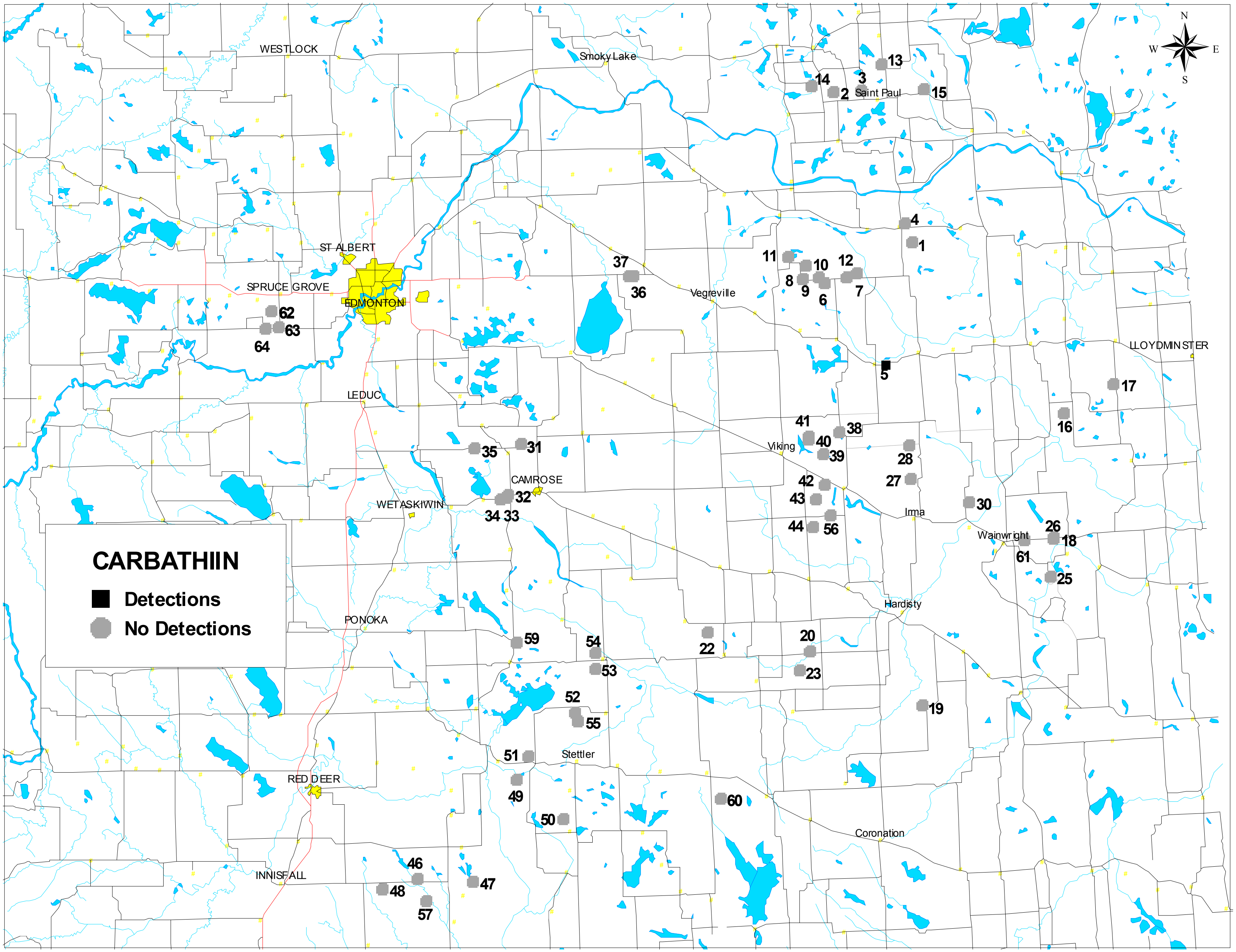


Figure 8m Distribution of carbathiin detections in wetlands sampled in 2000

Wetland #51 had the greatest diversity and consistency in pesticide detections. It was sampled monthly and imazamethabenz, clopyralid, MCPA and 2,4-D were detected in all or most samples; lindane and glyphosate were also detected in that wetland.

With a total pesticide concentration of 14.921 μg/L, wetland #12 had the highest overall pesticide concentration. This high concentration was the result of detections of MCPA (1.812 μg/L), 2,4-D (1.697 μg/L), bromoxynil (0.216 μg/L) and an especially high record of picloram (11.196 μg/L). Wetlands 62 had the second highest concentration (7.257 μg/L) as a result of detections of glyphosate (3.633 μg/L), AMPA (3.568 μg/L) and clopyralid (0.056 μg/L). There were 10 wetlands in total which had overall pesticide concentrations greater than 1 μg/L (i.e., #12, 16, 20, 31, 35, 37, 38, 51, 56 and 62).

3.2.2 Rain Samples

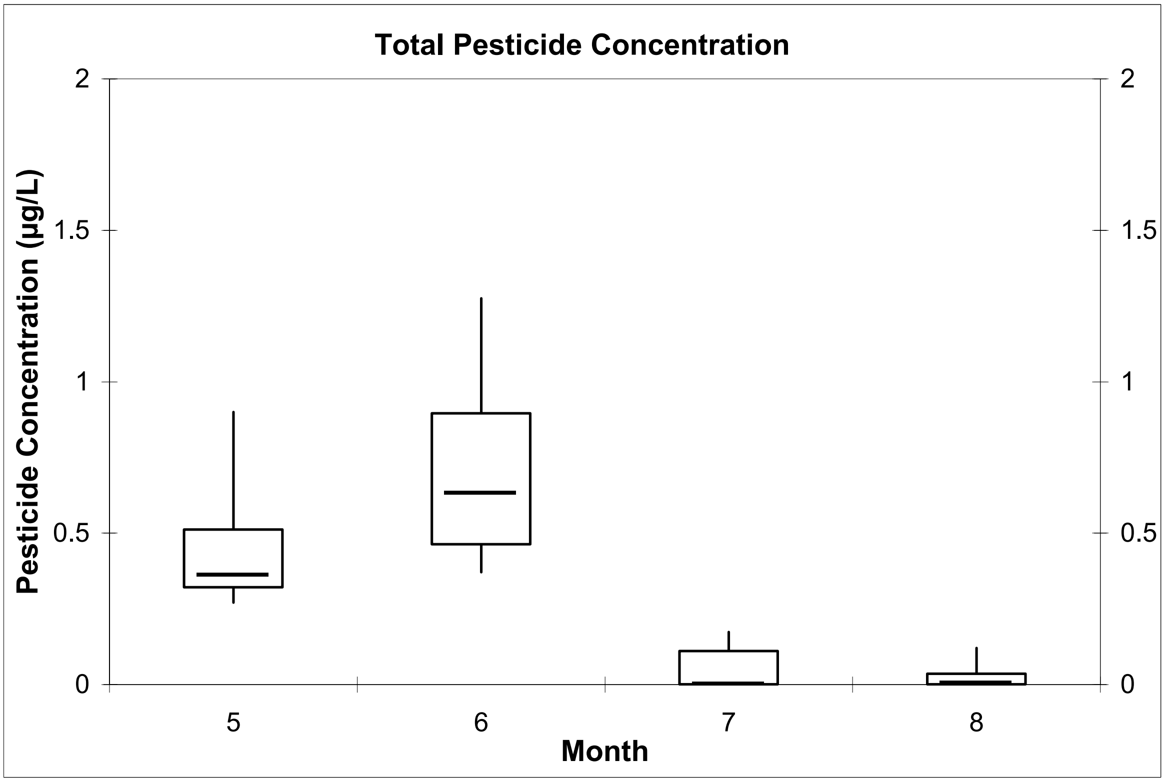
Eight pesticides (MCPA, 2,4-D, glyphosate, clopyralid, lindane, bromoxynil, MCPP and triallate) were detected in rain samples collected at the research station in Vegreville from May to July inclusive (Figure 2). As in water, 2,4-D and MCPA were the most frequently detected compounds. Triallate was detected in rainwater, but not in wetland's water; however, picloram, imazamethabenz, and AMPA, which were commonly found in wetland's water were not detected in precipitation samples.

The variety of pesticides detected in precipitation was highest in May and June with as many as six compounds detected (Figure 9). All precipitation samples collected in May and June had at least one pesticide detection, but some samples in July and August had no detections.

Higher total pesticide concentrations were measured in May and June rather than in July and August (Figure 9). The maximum total pesticide concentration in precipitation (1.276 μg/L) was recorded on June 12, 2000. 2,4-D, MCPA and glyphosate were the compounds which contributed most to the total pesticide concentration in these months (Figure 10). Glyphosate was detected over a longer period of time in precipitation than in wetland's water (May and June compared to May only). Lindane and MCPP were detected in May, triallate in July and clopyralid in August.

Precipitation data compiled for 12 weather stations across the study area are summarised in Figure 11. Spring (March to June) was generally very dry in the Aspen Parkland in 2000 and total monthly precipitation was less than 50 mm. Dry conditions persisted in the southeast portion of the study area throughout the summer (monthly precipitation was <50 mm for Coronation and Haynes Creek). The rest of the study area experienced rain in July often exceeding a total of 100 mm (highest record was Wainwright with over 200 mm rain in July).

Atmospheric loading of pesticides was computed from pesticide concentrations in precipitation collected at the ARC station and precipitation volume recorded in Vegreville, and from the monthly extremes recorded at stations across the study area (Table 6). For most compounds detected in rain, atmospheric loading was highest in May and June, despite the low precipitation volume recorded in these months. The potential influence of atmospheric deposition on wetland pesticide concentrations was calculated based on the assumptions that the atmospheric loading



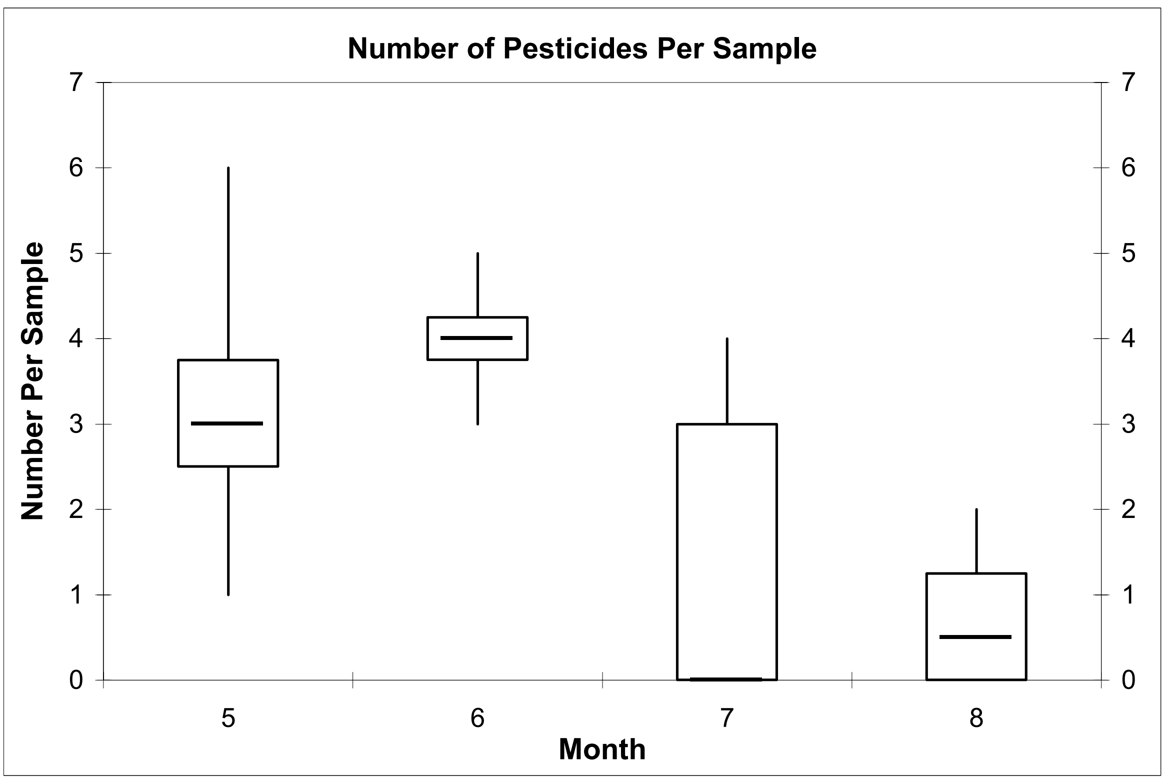


Figure 9 Seasonal trends in pesticide detections in rain collected at ARC, Vegreville in 2000

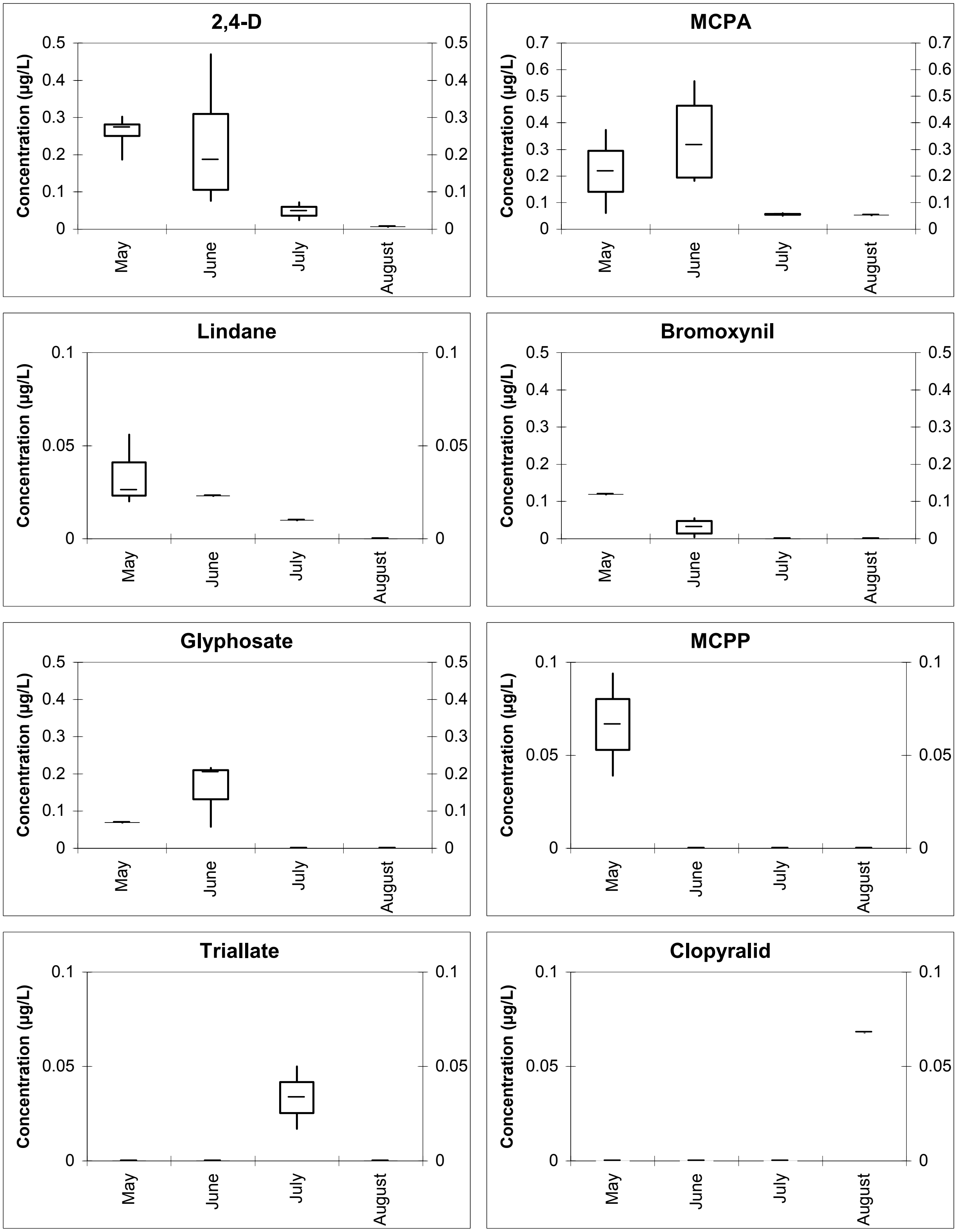


Figure 10 Seasonal trends in pesticide concentrations in rain collected at ARC, Vegreville in 2000

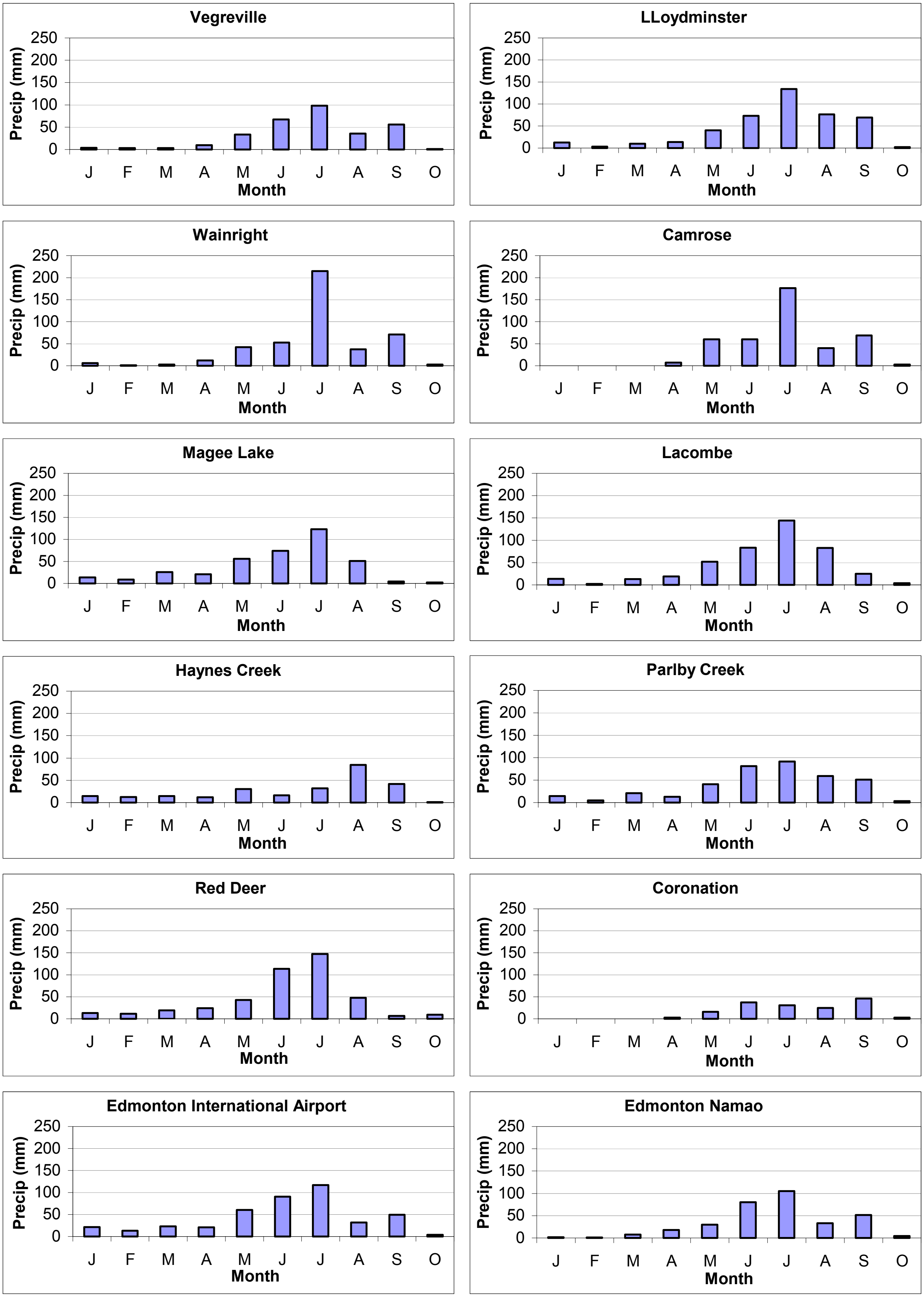


Figure 11 **Total monthly precipitation for 2000 at several weather stations in the Aspen Parkland of Alberta**

Table 6 Estimate of atmospheric loading and potentially resulting pesticide concentrations in wetlands

Variable	Median Concentration in Rain (µg/L)	Monthly Loading (µg/m²) Derived from Rainfall Records at Vegreville and Across the Aspen Parkland			Wetland Concentration (µg/L) Predicted from Atmospheric Loading(1)			Actual Concentrations (µg/L) Measured in Wetlands in 2000(2)		
		Vegreville	Minimum	Maximum	Vegreville	Minimum	Maximum	Minimum	Median	Maximum
MAY										
Total Monthly Precipitation (mm)		***33.5***	***16.0***	***60.5***						
Bromoxynil	0.119	1.131	1.904	7.200	0.002	0.003	0.013	ND	ND	ND
Clopyralid	ND	-	-	-	-	-	-	0.056	0.316	0.576
Glyphosate	0.069	0.656	1.104	4.175	0.001	0.002	0.008	0.338	0.483	3.633
Imazamethabenz	ND	-	-	-	-	-	-	0.323	0.323	0.323
Lindane	0.026	0.889	0.416	1.573	0.002	0.001	0.003	0.006	0.013	0.019
MCPA	0.217	4.306	3.472	13.129	0.008	0.006	0.024	0.008	0.008	0.008
MCPP	0.067	1.029	1.064	4.023	0.002	0.002	0.007	ND	ND	ND
Picloram	ND	-	-	-	-	-	-	0.149	0.149	0.149
Triallate	ND	-	-	-	-	-	-	ND	ND	ND
2,4-D	0.273	8.771	4.360	16.486	0.016	0.008	0.030	ND	ND	ND
JUNE										
Total Monthly Precipitation (mm)		***67.0***	***16.5***	***114.0***						
Bromoxynil	0.031	1.491	0.512	3.534	0.003	0.001	0.006	ND	ND	ND
Clopyralid	ND	-	-	-	-	-	-	0.066	0.292	0.517
Glyphosate	0.204	7.467	3.366	23.256	0.014	0.006	0.042	0.086	0.111	0.136
Imazamethabenz		-	-	-	-	-	-	0.220	0.220	0.220
Lindane	0.023	0.932	0.380	2.622	0.002	0.001	0.005	0.013	0.017	0.021
MCPA	0.316	20.759	5.206	35.967	0.038	0.009	0.065	0.026	0.075	0.173
MCPP	ND	-	-	-	-	-	-	ND	ND	ND
Picloram		-	-	-	-	-	-	ND	ND	ND
Triallate	ND	-	-	-	-	-	-	ND	ND	ND
2,4-D	0.186	11.555	3.061	21.147	0.021	0.006	0.038	0.005	0.045	0.472

Table 6 Estimate of atmospheric loading and potentially resulting pesticide concentrations in wetlands (continued)

Variable	Median Concentration in Rain (µg/L)	Monthly loading (µg/m²) derived from rainfall records at Vegreville and across the Aspen Parkland			Wetland Concentration (µg/L) Predicted from Atmospheric Loading[1]			Actual Concentrations (µg/L) Measured in Wetlands in 2000[2]		
		Vegreville	Minimum	Maximum	Vegreville	Minimum	Maximum	Minimum	Median	Maximum
JULY										
Total Monthly Precipitation (mm)		***98.0***	***31.0***	***215.0***						
Bromoxynil	ND	-	-	-	-	-	-	0.008	0.112	0.112
Clopyralid	ND	-	-	-	-	-	-	0.017	0.135	0.714
Glyphosate	ND	-	-	-	-	-	-	ND	ND	ND
Imazamethabenz	ND	-	-	-	-	-	-	0.117	0.117	0.117
Lindane	0.010	0.070	0.310	2.150	0.000	0.001	0.004	0.013	0.013	0.013
MCPA	0.056	2.588	1.721	11.933	0.005	0.003	0.022	0.006	0.043	1.812
MCPP	ND	-	-	-	-	-	-	0.003	0.032	0.472
Picloram	ND	-	-	-	-	-	-	0.038	0.133	11.196
Triallate	0.034	2.244	1.039	7.203	0.004	0.002	0.013	ND	ND	ND
2,4-D	0.048	3.228	1.488	10.320	0.006	0.003	0.019	0.004	0.053	2.572
AUGUST										
Total Monthly Precipitation (mm)		***36.0***	***25.0***	***84.5***						
Bromoxynil	ND	-	-	-	-	-	-	ND	ND	ND
Clopyralid	0.068	2.448	1.700	5.746	0.004	0.003	0.010	0.116	0.116	0.116
Glyphosate	ND	-	-	-	-	-	-	0.804	0.804	0.804
Imazamethabenz	ND	-	-	-	-	-	-	0.180	0.180	0.180
Lindane	ND	-	-	-	-	-	-	ND	ND	ND
MCPA	0.053	2.942	1.325	4.479	0.005	0.002	0.008	0.010	0.013	0.015
MCPP	ND	-	-	-	-	-	-	ND	ND	ND
Picloram	ND	-	-	-	-	-	-	ND	ND	ND
Triallate	ND	-	-	-	-	-	-	ND	ND	ND
2,4-D	0.007	0.035	0.175	0.592	0.000	0.000	0.001	0.057	0.057	0.057

(1) based on median depth of wetlands sampled in 2000 (i.e., 0.55 m)

(2) concentrations based on monthly surveys of seven wetlands, except for July where medians apply to all July samples

ND = not detected

Note:

Loading for the Vegreville site were calculated from the sum of loadings derived from pesticide concentrations in precipitation and the precipitation volume that occurred between the day following the collection of the previous rain sample until and including the day the current samples was taken

Maximum and minimum loading was derived from the maximum and minimum total monthly precipitation record for the Aspen Parkland area in 2000 and the median concentration record in precipitation calculated for the ARC station is broadly applicable to the rest of the Aspen Parkland; wetlands have a depth of 0.55 m (i.e., median wetland depth sampled in 2000) and an initial pesticide concentration of zero. Results presented in Table 6 indicate that atmospheric loading of pesticides could account for a substantial amount of 2,4-D and MCPA measured in wetlands, up to 40% of glyphosate, up to 30% of lindane and up to 10% of clopyralid. Since picloram and imazamethabenz were not detected in atmospheric deposition samples their presence is wetlands could be due to local runoff.

3.2.3 Tissue Samples

Only five compounds (2,4-D, clopyralid, desethyl atrazine, desisopropyl atrazine and imazamethabenz) were detected in tissue samples taken from wetlands in June and July.

The relationship between detections in tissue samples and detections in water is not consistent as some compounds were found in tissue, but not in water and vice versa.

- 2,4-D was detected in seven of the 13 tissue samples and at concentrations that ranged between 0.165 and 134.968 µg/g-wet weight. In all wetlands where 2,4-D was detected in tissue samples, 2,4-D was also detected in water. In wetland #51 where the highest 2,4-D concentration was measured in tissue samples, the herbicide was commonly detected in water, but at relatively low levels (i.e., <0.01 µg/L).

- Clopyralid was detected in four tissue samples from wetlands #10, 31, 40 and 62. While the compound was detected in water from wetland #40 and #62 it was not reported in the other two.

- Imazamethabenz was found in three wetlands: twice in #10, and once in #51 and #62. All water samples from wetland #51 had imazamethabenz, but this herbicide was not found in water from the other two wetlands.

- Desethyl atrazine and desisopropyl atrazine were found in tissue from wetland #62. These compounds were not found in water samples nor was the parent compound atrazine.

3.2.4 Surface Film Samples

Surface film samples were collected from seven wetlands in June. No pesticides were detected in any of the surface film samples although a variety of compounds was reported in the water at the time surface film samples were collected. Sampling of surface film was complicated by strong winds and wave action which made the collection of accurate samples difficult. Strong winds would also have disrupted the distribution of surface film (and pesticides) over the wetland.

3.3 Exploration of Relationships Between Pesticides in Water and Other Wetland Features

Various factors can influence the level of pesticide contamination in surface waters, including the amount of antecedent rainfall and the width of the buffer zone between the water and the fields where pesticides are applied. An attempt was made to explore these relationships in the wetland's data set.

3.3.1 Influence of Rainfall on Pesticide Contamination

Spring 2000 was very dry in the Aspen Parkland of Alberta; later some areas continued to be very dry (e.g., Coronation area) while others received substantial amounts of rain in July (e.g., Wainwright area). This spatial difference in rainfall pattern made it possible to carry out a scoping level evaluation of the effect of rainfall on pesticide contamination. Two subgroups of wetlands were defined based on precipitation records (Figure 11) and field notes. The first group, qualified as "dry", comprises wetlands in the general area of Stettler, Coronation and Hardisty; the second group, qualified as "wet", comprises wetlands in the Wainwright – Lloydminster-Vegreville triangle. Field notes indicate that many wetlands in the "wet" group had received 15 cm of rain in the two weeks preceding the sampling, whereas there was no mention of rainfall for the wetlands in the "dry" area. Table 7 provides a comparison of pesticide results between the two groups. It suggests that a greater number of compounds was detected in the "wet" subgroup and that total pesticide concentrations, and concentrations of 2,4-D, MCPA, and picloram were somewhat higher than in the "dry" sub-group.

These results suggest that in a fairly uniform set of wetlands, heavy rainfall received by some wetlands may explain local differences in pesticide contamination. However, even at this relatively small geographic scale differences in crops and pesticide use may also influence pesticide detections. Based on field notes canola was relatively common in the "dry" group and some pesticides commonly applied on canola crops were not part of the screen. These herbicides include clethodim, sethoxydim, fluazifop-p-butyl, quizalofop-p-ethyl, ethalmetsulfuron-methyl and thifensulfuron-methyl. If these compounds had been applied to canola in the 'dry area' and had been present in wetlands they would not have been reported. Considering that these compounds are used for broadleaf weed control on other crops than canola they could also have been used in the 'wet area', the possibility that different use patterns may have influenced the outcome of the analysis at this scale is slight. The larger number of wetlands in the 'wet area' (20) compared to the dry area (11) may also have introduced a bias.

3.3.2 Influence of Set Back Distance Between Water's Edge and Cultivated Land (buffer zone width)

The influence on pesticide contamination of the setback distance of cultivated land relative to the water's edge was evaluated based on field records for July 2000 (Table 8). Field technicians were asked to classify the distance between the water's edge and cultivated land in five groups (0-5 m, 5-20 m, 20 – 50 m, 50 – 100 m and >100 m; see also Appendix 2). Wetlands were grouped according to these distance classes and pesticide data were compared among distance groups. This evaluation is broad and cursory in nature because it relies on simple visual

Table 7 Comparison of July 2000 pesticide data for wetlands located in a dry and a wet area of the Aspen Parkland

Variable	WETLANDS IN 'DRY' AREA (< 50 mm rain)				
	Number of Detections	Detection Frequency (%)	Concentration (µg/L) Minimum	Median	Maximum
# Detections:			0.000	1.000	4.000
Total Concentration:			0.000	0.094	0.924
Bromoxynil	nd	nd	nd	nd	nd
Carbathiin	nd	nd	nd	nd	nd
Clopyralid	2	18.2	0.056	0.287	0.517
Dicamba	nd	nd	nd	nd	nd
Dichlorprop	nd	nd	nd	nd	nd
Lindane	nd	nd	nd	nd	nd
MCPA	6	54.5	0.028	0.106	0.178
MCPP	nd	nd	nd	nd	nd
Picloram	1	9.1	0.092	0.092	0.092
2,4-D	7	63.6	0.026	0.053	0.094

Variable	WETLANDS IN 'WET' AREA (> 100 mm rain)				
	Number of Detections	Detection Frequency (%)	Concentration (µg/L) Minimum	Median	Maximum
# Detections:			0.000	2.000	5.000
Total Concentration:			0.000	0.110	14.921
Bromoxynil	2	10.0	0.008	0.112	0.216
Carbathiin	1	5.0	0.025	0.025	0.025
Clopyralid	3	15.0	0.017	0.022	0.148
Dicamba	2	10.0	0.003	0.008	0.012
Dichlorprop	3	15.0	0.014	0.024	0.272
Lindane	1	5.0	0.013	0.013	0.013
MCPA	13	65.0	0.016	0.034	1.812
MCPP	3	15.0	0.003	0.031	0.036
Picloram	5	25.0	0.038	0.133	11.196
2,4-D	12	60.0	0.018	0.066	2.572

"dry area" weather stations in area (Figure 11) recorded less than 50 mm rain in July
wetlands included in analysis: 19, 20, 22, 49, 50, 51, 52, 53, 54, 55, 60
"wet area" weather stations in area (Figure 11) recorded more than 100 mm rain in July
wetlands included in analysis: 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 17, 18, 25, 26, 27, 28, 30, 61
nd = not detected

Table 8 Comparison of pesticide detections in wetlands differing in vegetative buffer zone width

Buffer Zone Width: # of Wetlands:	0 - 5 m n = 12					5 - 20 m n = 34					20 - 50 m n = 17				
Variable	Number of Detections	Detection Frequency (%)	Min (conc. in µg/L)	Med (conc. in µg/L)	Max (conc. in µg/L)	Number of Detections	Detection Frequency (%)	Min (conc. in µg/L)	Med (conc. in µg/L)	Max (conc. in µg/L)	Number of Detections	Detection Frequency (%)	Min (conc. in µg/L)	Med (conc. in µg/L)	Max (conc. in µg/L)
# Pest. Detect.:			0.000	1.000	5.000			0.000	2.000	4.000			0.000	1.000	4.000
Avg Total Pest. Conc. Per Sample:			0.000	0.084	1.248			0.000	0.146	2.623			0.000	0.057	14.921
Bromoxynil	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	1	5.9	0.216	0.216	0.216
Carbathiin	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Clopyralid	2	16.7	0.370	0.388	0.405	10	29.4	0.061	0.206	0.714	1	5.9	0.056	0.056	0.056
Dicamba	nd	nd	nd	nd	nd	2	5.9	0.012	0.104	0.195	nd	nd	nd	nd	nd
Dichlorprop	nd	nd	nd	nd	nd	2	5.9	0.014	0.019	0.024	nd	nd	nd	nd	nd
Imazamethabenz	1	8.3	0.547	0.547	0.547	2	5.9	0.117	0.169	0.220	nd	nd	nd	nd	nd
Lindane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MCPA	6	50.0	0.018	0.092	0.331	24	70.6	0.019	0.044	0.483	10	58.8	0.016	0.050	1.812
MCPP	nd	nd	nd	nd	nd	2	5.9	0.003	0.238	0.472	nd	nd	nd	nd	nd
Picloram	1	8.3	0.060	0.060	0.060	6	17.6	0.057	0.108	0.899	2	11.8	0.092	5.644	11.196
2,4-D	4	33.3	0.092	0.111	0.341	24	70.6	0.014	0.045	2.572	11	64.7	0.004	0.048	1.697

Buffer Zone Width: # of Wetlands:	50 - 100 m n = 5					>100 m n = 9				
Variable	Number of Detections	Detection Frequency (%)	Min (conc. in µg/L)	Med (conc. in µg/L)	Max (conc. in µg/L)	Number of Detections	Detection Frequency (%)	Min (conc. in µg/L)	Med (conc. in µg/L)	Max (conc. in µg/L)
# Pest. Detect.:			1.000	3.000	5.000			0.000	2.000	4.000
Avg Total Pest. Conc. Per Sample:			0.131	0.293	0.796			0.000	0.083	1.131
Bromoxynil	1	20.0	0.008	0.008	0.008	nd	nd	nd	nd	nd
Carbathiin	1	20.0	0.025	0.025	0.025	nd	nd	nd	nd	nd
Clopyralid	1	20.0	0.022	0.022	0.022	0	0.0	0.000	0.070	0.122
Dicamba	nd	nd	nd	nd	nd	0	0.0	0.000	0.008	0.012
Dichlorprop	1	20.0	0.272	0.272	0.272	nd	nd	nd	nd	nd
Imazamethabenz	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Lindane	1	20.0	0.013	0.013	0.013	nd	nd	nd	nd	nd
MCPA	3	60.0	0.052	0.053	0.154	3	33.3	0.006	0.027	0.049
MCPP	1	20.0	0.036	0.036	0.036	1	11.1	0.032	0.032	0.032
Picloram	4	80.0	0.038	0.125	0.268	1	11.1	1.020	1.020	1.020
2,4-D	3	60.0	0.018	0.076	0.541	3	33.3	0.039	0.056	0.073

nd = not detected

estimates of distances rather than actual measurements. Furthermore, many other factors will influence pesticide contamination of wetlands, including local topography, the nature of the buffer zone, climatic conditions such as wind and rain, pesticide characteristics and mode of application. These factors could not be standardised in this comparison. There was no significant (ANOVA, $p>0.05$) difference in the number, type, or concentration of pesticides detected per sample among the different groups (Table 7 and Figure 12a, b).

The results of this analysis are considered somewhat inconclusive as the lack of standardization of the wetlands that were used in this comparison could have affected the outcome of the analysis. Field notes indicate that samples for wetlands in the distance class of 50 – 100 m were all taken after heavy rains; this could have resulted in somewhat higher concentrations and number of pesticides per sample for that class. The high total pesticide concentration recorded in the 20-50 m class is due to a very high detection of picloram.

3.3.3 Relationship Between Pesticide and Chlorophyll-a Levels

Since herbicides are designed to kill or control unwanted vegetation, it is possible that their presence in surface waters could suppress the diversity and growth of aquatic vegetation. Quantitative data for macrophyte biomass or for plant diversity were not obtained in this study, but chlorophyll-*a* is a suitable indicator of phytoplankton biomass. Because phytoplankton biomass varies with season, only summer data (June to August) were used here. In this data set there was no significant ($p>0.05$) correlation between Chl-*a* and total phosphorus or conductivity in the water. Figure 13 suggests a negative association between Chl-*a* and total pesticide concentration and the number of pesticide detected per sample (i.e., Chl-*a* decreases as pesticide concentration increases). While there is no statistically significant correlation, the apparent association is worthy of verification in further wetlands studies or investigations on the effects of pesticide contamination on aquatic ecosystems.

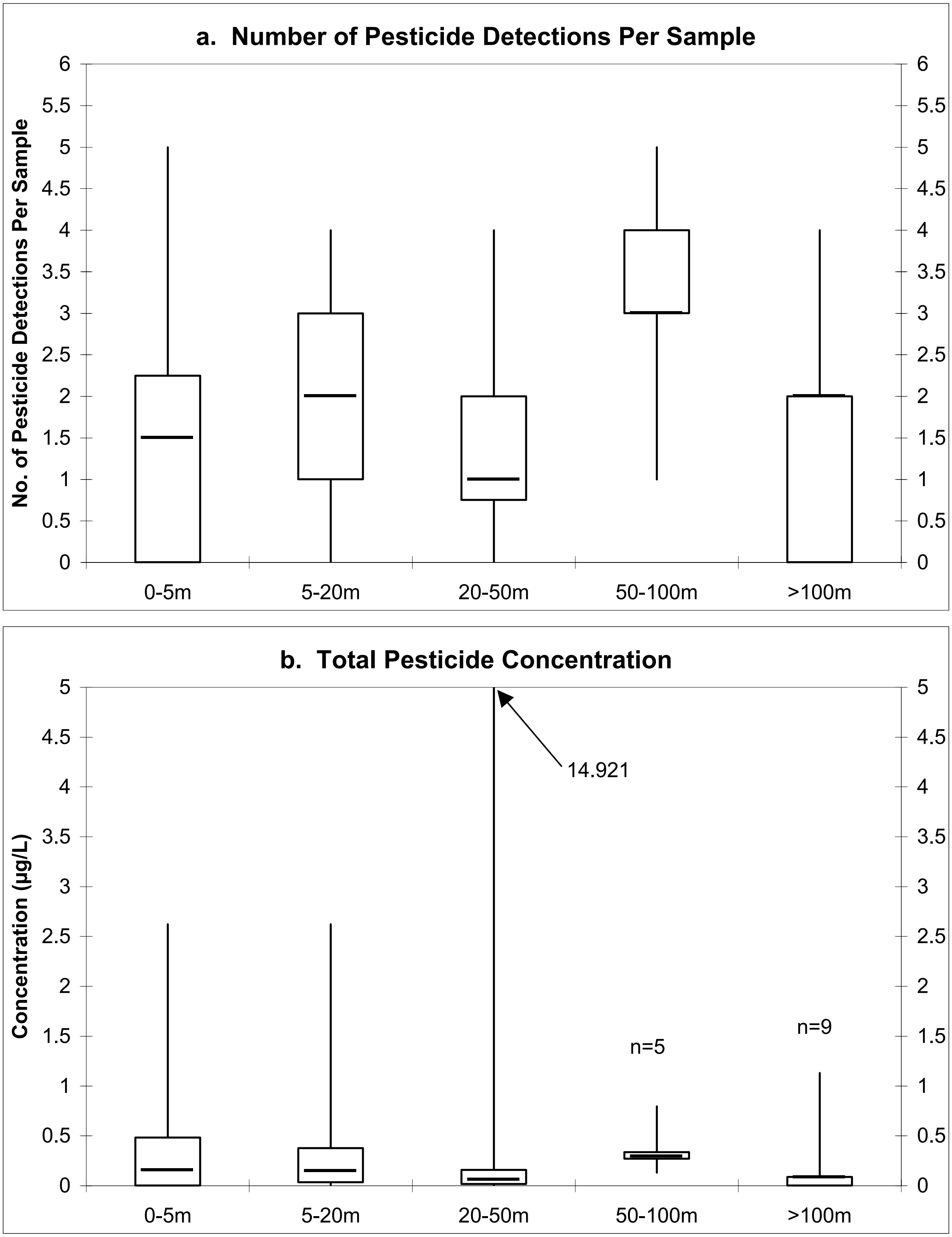
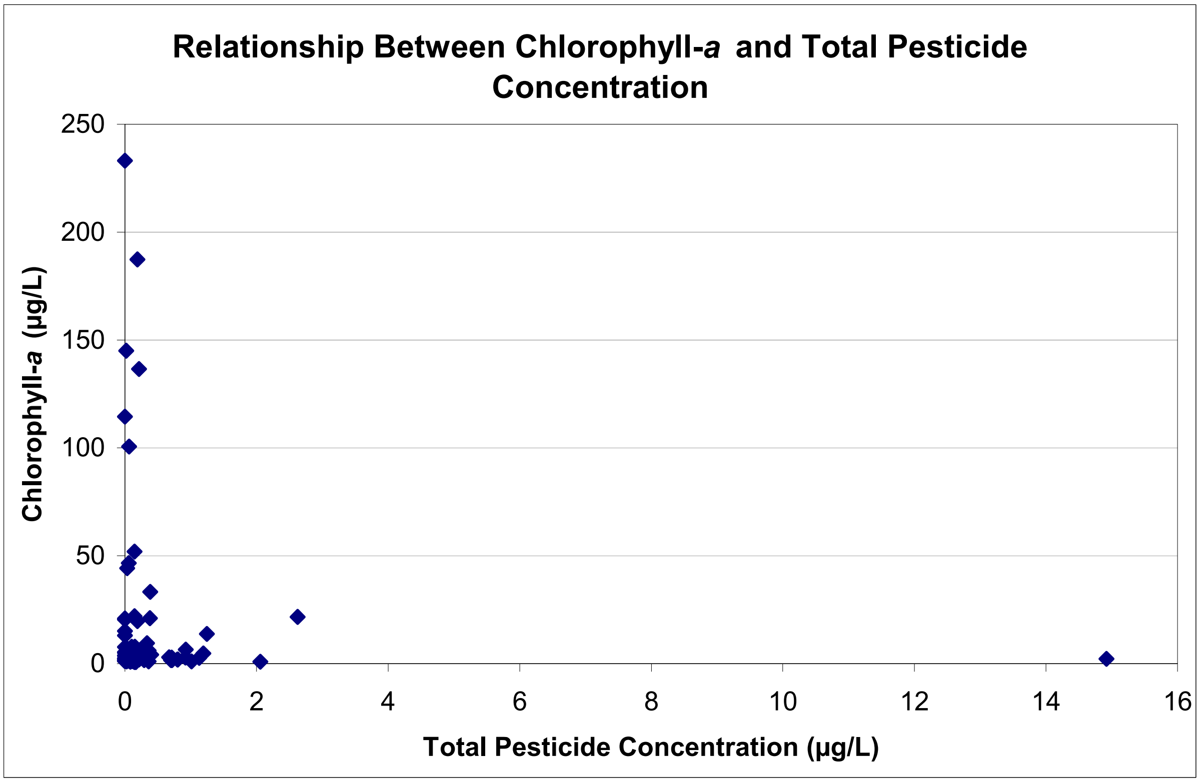


Figure 12 Influence of buffer strip width on the number and total concentration of pesticides detection in wetlands of the Aspen Parkland in 2000



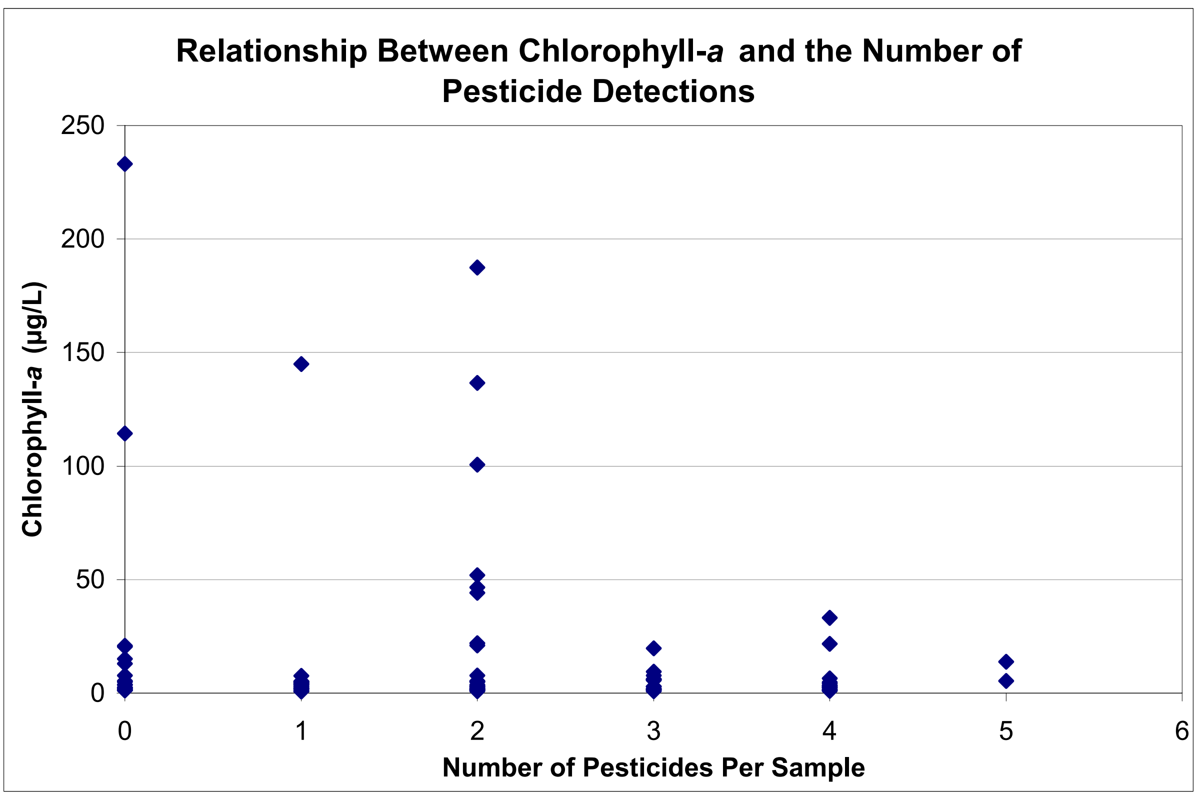


Figure 13 **Relationship between total pesticide concentration, number of pesticide detections and chlrophyll-*a* concentrations in wetlands of the Aspen Parkland**

4.0 DISCUSSION

In Alberta, intensive monitoring of water quality has documented the wide-spread occurrence of herbicides in agricultural streams (Anderson et al. 1998, Anderson, 1999, 2000, Donahue 2000). The present study shows that pesticide residues are also commonly detected in the wetlands of the Aspen Parkland. These results are compatible with findings in Saskatchewan where a monitoring program initiated by Environment Canada in 1991 has reported pesticide residues in wetlands, shallow lakes and ponds (Donald and Syrgiannis 1995, Donald et al. 1999, Donald et al. 2000, Waite et al. 1992). Grover and Cessna (1996) and Grover et al. (1997) also reported on the widespread distribution of some pesticides in Saskatchewan dugouts.

Use patterns account largely for the diversity of herbicides detected in surface waters. The Alberta screen includes 40 compounds and many, but not all, are high selling pesticides in the Aspen Parkland. Of the compounds analysed 16 were detected in wetlands. The Saskatchewan wetland study focussed on high use pesticides (e.g., 2,4-D, MCPA, dicamba, mecoprop, dichlorprop, bromoxynil, trifluralin, triallate, imazamethabenz and lindane) and detections were reported for all compounds analysed (Donald et al. 2001). There are many similarities in the detection patterns in Alberta and Saskatchewan wetlands. The pesticides reported to be in high use in Saskatchewan are also in high use in Alberta and all, except trifluralin, were detected in Aspen Parkland wetlands. In Alberta, as in Saskatchewan, 2,4-D and MCPA are among the most commonly used herbicides and they are also the most commonly detected in wetlands. As a result of our broader analytical screen several additional compounds are reported in this study (i.e., clopyralid, picloram, glyphosate, AMPA, and carbathiin) suggesting that the analysis of less commonly used compounds is useful in the evaluation of surface water pesticide contamination. However, considering that not all high selling pesticides were analyzed in Aspen Parkland wetlands it is probable that the pesticide diversity in wetlands is even larger than reported here.

Donald et al. (1999) and Donald et al. (2001) summarise several years of data and comparisons of pesticide detection frequency and concentration ranges with results of our one-year study may be misleading. Nevertheless it would appear that the detection frequency of lindane in Saskatchewan wetlands as reported in Donald et al. (1999) is considerably higher (73% of the samples analysed) than in Alberta (< 1% samples analysed). This difference may be indicative of differences in contamination level, or it may reflect the influence of differences in analytical methodology on detection frequency. In this respect, lindane is one of the few compounds for which Donald et al. (1999) report a lower method detection limit compared to this study (0.001 µg/L versus 0.005 µg/L).

Because glyphosate is the most commonly used herbicide in Alberta and especially in the Aspen Parkland of Alberta (Byrtus 2000), its detection and that of its breakdown product, AMPA, is of particular interest. Glyphosate is commonly used for chemical fallow and pre-harvest weed control and the main application periods for these purposes are spring and fall. Until now efficient methods had not been available for glyphosate monitoring in surface waters in Alberta and assumptions, based on literature evidence, had been made regarding its presence in surface waters. Giesy et al. (2000) describe glyphosate as being very soluble in water, but with limited mobility because of its strong sorption to soils. Consequently, glyphosate is unlikely to leach into groundwater or be of significance in runoff to surface waters. Runoff and leaching are important routes for pesticide contamination of surface waters, but the potential for atmospheric deposition needs to be considered as well. Atmospheric deposition can occur as wet or dry (i.e., dust) deposition. Wind-eroded soils have been identified as a potential hazard for off-site air and water quality contamination for surface applied herbicides such as trifluralin, triallate, diclofop, bromoxynil mecoprop and 2,4-D (Larney et al. 1999). In this study glyphosate was detected in precipitation in a number of samples, however no distinction was made between dry and wet deposition. Spring 2000 was exceptionally dry in the Aspen Parkland of Alberta and it is highly unlikely that runoff or wet precipitation would account for the presence in May of glyphosate in water. At that time significant cultivation and seeding activity in the general area resulted in visible dust-cloud formation. It is speculated that in our study the major pathway for glyphosate contamination of the wetlands was dry deposition of the chemical adsorbed to dust particles.

In a six-year study of pesticide contamination of Saskatchewan wetlands Donald et al. (1999) found that there was an increase in pesticide diversity and concentration with increasing amount of rainfall. The average number of pesticides detected increased from 1.8 to 3.2 in areas which had received < 21 mm or > 90 mm rain during the previous 15 days, respectively. Over the same precipitation range the proportion of wetlands in which at least one pesticide exceeded Canadian Water Quality Guidelines for the protection of aquatic life increased from 0 to 60%. In our one-year study, which occurred in a dry year, the influence of precipitation on pesticide contamination is not as pronounced. Nevertheless, a trend towards increased pesticide diversity and concentration is apparent when comparing wetlands in dry areas with wetlands in areas that had received substantial amounts of precipitation.

Several researchers have established that atmospheric deposition of pesticides is an important pathway to surface waters in Canada's Prairie Provinces (e.g., Waite et al. 1995, Rawn et al. 1999 a, Rawn et al. 1999b. and Donald et al. 2001). In Alberta, Hill et al. (in press) and Byrtus (1999) have monitored pesticides in wet and dry precipitation across Alberta for a number of years. In addition to being found in wet and dry precipitation, a variety of pesticides have also been reported in air sampled at four locations in Alberta, including the Vegreville site sampled in this study (Kumar 2001). Hill et al. (2002b) and Byrtus (1999) conclude that the greatest atmospheric loading occurs between April and July; loading is strongly correlated to the amount and frequency of precipitation; and the nature of pesticides detected most frequently varies across the province indicating the influence of local use patterns. Active ingredients detected most often in the period May to July are post-emergent herbicides with a high solubility. After July, detections in precipitation tend to be infrequent perhaps because products used are not as water soluble or not part of routine analytical screens (e.g., glyphosate, some fungicides).

Various studies have reported pesticide-loading rates for 2,4-D and MCPA. Loading rates calculated for 18 sampling locations in Alberta from April to July 1999 and 2000 in central Alberta ranged from 44 to 137 $\mu g/m^2$ for 2,4-D, and from 13 to 171.2 $\mu g/m^2$ for MCPA (Hill et al. 2002b). In 1998 Byrtus (1999) calculated loading rates of 25.53 $\mu g/m^2$ for 2,4-D and 15.55 $\mu g/m^2$ for MCPA in Edmonton and 19.12 $\mu g/m^2$ for 2,4-D and 28.52 $\mu g/m^2$ for MCPA in Haynes Creek, an agricultural watershed in Central Alberta. Waite et al. (1995) determined the cumulative deposition over the growing season of several herbicides including 2,4-D (93.25 $\mu g/m^2$) in a small southern Saskatchewan watershed. The cumulative loading calculated for 2,4-D and MCPA in this study at the Vegreville station for May to August 2000 (33.59 and

30.59 μg/m^2 for 2,4-D and MCPA, respectively) is in the lower range of published records, possibly because of the low amount of rainfall recorded in the main period of application.

Although pesticide levels recorded in wetlands in 2000 are somewhat lower than expected based on published data, there is literature evidence that indicates that in Alberta, pesticide in precipitation can reach levels which could damage sensitive terrestrial vegetation. Hill et al. (2002 a) conducted laboratory bio-assays to determine responses of various crops to rain simulation with water containing a mixture of 2,4-D, bromoxynil, MCPA and dicamba at concentrations encountered in precipitation. Responses differed among crops tested: beans and tomatoes suffered permanent sub-lethal effects, sugar beets showed transient effects and sunflowers showed enhanced effects. It would be of value to carry out similar bio-assays with a typical range of wetland vegetation species.

According to Donald et al. (2001) broad scale atmospheric processes can account for both the concentration and the relatively uniform distribution of herbicides in wetlands on all landscape types. This is likely the case for compounds such as MCPA or 2,4-D, which are so common in atmospheric precipitation samples. In this study several compounds such as picloram, and imazamethabenz were detected in wetlands, but not in precipitation, indicating that local contamination (e.g., localised atmospheric deposition, surface runoff or direct contact) is a more likely source.

Vegetative buffers have been recognized for their capacity to reduce pesticide loading in runoff from fields to surface waters (e.g., Wauchope et al. 1994). Their effectiveness has been the topic of much research (e.g., Arora et al. 1996, Assmussen et al. 1977, Cole et al. 1997, Patty et al. 1997, and Rode et al. 1980) and they are recommended by several agencies as a 'beneficial management practice' (BMP) to protect water quality from a variety of contaminants, including pesticides. Efficiency of buffers would be expected to increase positively with their size (i.e., the distance between cultivated land and the water's edge). Such relationship was not clear in our data set, presumably because runoff events during which effectiveness of buffers would manifest itself, did not occur at many sites. Conclusions drawn by Donald et al. (2001) suggest that buffers of any size may be of low overall value in reducing pesticide flux to surface waters in the Canadian prairies because atmospheric deposition is a more important pathway. Such conclusions could have broad scale management implications on crop farming in the Prairies. There is a need for comprehensive, site-specific evaluations of the influence of vegetative buffers on the flux of pesticides that are used in the Canadian Prairies.

While the documentation of baseline conditions was the main focus in this study, the evaluation of the significance of contaminant levels to aquatic life is a logical next step. The use of surface water quality guidelines is the most straightforward method to evaluate the significance of contaminant concentrations. In this study, lindane was the only pesticide detected at concentrations that exceed the guideline for the protection of aquatic life. This situation is considerably less alarming than the contamination level reported in Saskatchewan wetlands by Donald et al (1999). There up to 24% of the wetlands had pesticide residues in excess of guidelines and among these 2,4-D, triallate and lindane were exceeding guidelines the most frequently. Although the situation in Alberta appears to be less severe, it is clear that the results of both studies are influenced by the duration of the study and meteorological conditions. The results of our study may provide a misleadingly optimistic view of the situation because of its short duration and the dry conditions that prevailed.

Although guidelines are the most straightforward tool to evaluate the environmental significance of pesticides, it is important to recognise that this tool is imperfect in some ways. Not all pesticides have established guidelines. Furthermore, guidelines apply to single compounds and do not address interactions among multiple environmental contaminants. In some cases, guidelines may not offer the expected protection. Forsyth et al. (1997) tested the effects of 2,4-D, picloram and Tordon 202C (i.e., 2,4-D + picloram) on *Potamogeton pectinatus* and *Myriophyllum sibericum* in in-situ experiments. They reported various forms of injury from picloram and Tordon 202C at test concentrations of 0.1 mg/L (100 µg/L) and 0.01 mg/L (10 µg/L). The CCME guideline for the protection of aquatic life is 29 µg/L, a concentration which is about three times higher than the test concentrations at which effects were measured in the above-mentioned study. In wetland #12 picloram levels were in the range where Forsyth et al. (1997) measured negative effects on two macrophytes. It is important to note that the picloram CCME guideline for the protection of aquatic life is based on NOEL for cutthroat trout. There is a need to revise this guideline with test data on aquatic plants. An irrigation guideline for picloram is also needed.

Spring and early summer are critical times of year for the reproduction and growth of many aquatic organisms; it is also the time of year where the greatest pesticide diversity and concentrations can be expected. Even if pesticides detected in water do not occur at concentrations high enough to cause noticeable chronic or acute toxicity responses, they may induce changes in community composition and dynamics. Peterson et al. (1994) concluded after testing the phyto-toxicity of 23 pesticides that diatoms are particularly sensitive to glyphosate and that wetland contamination could alter the natural diatom assemblage with consequences to upper trophic levels. The implication of such changes on waterfowl feeding habits needs to be evaluated. Spring and early summer are also the time of year when waterfowl mate, nest and rear their young. The implications of the presence of pesticide residues in air, water and food organisms on the health and success of waterfowl populations needs to be understood.

5.0 LITERATURE CITED

Arora, K., S.K. Mickelson, J.L. Baker, D.P. Tierney, and C.J. Peter. 1996. Herbicide retention by vegetative buffer strips from runoff under natural rainfall. Trans of the ASAE 30(6):2155-2162.

Anderson, A.-M. 1999. Water quality monitoring program 1997 annual technical report. Water quality monitoring of small streams in agricultural areas. Prepared for the AESA Water Quality Committee. Published by Alberta Agriculture, Food and Rural Development. Edmonton, Alberta, Canada. 30 pp.

Anderson, A.-M. 2000. Water quality monitoring program 1998 annual technical report. Water quality monitoring of small streams in agricultural areas. Prepared for the AESA Water Quality Committee. Published by Alberta Agriculture, Food and Rural Development. Edmonton, Alberta, Canada. 30 pp.

Anderson, A.-M., D.O. Trew, R.D. Neilson, N.D. MacAlpine,, and R. Borg. 1998. Impacts of agriculture on surface water quality in Alberta. Part II: Provincial Stream Survey. Prepared for CAESA Water Quality Committee. Published by Alberta Agriculture, Food and Rural Development, Edmonton, Alberta, Canada. 91 pp. plus tables and figures.

Asmussen, L.E., A.W. White Jr., E.W. Hauser, and J.M. Sheridan. 1977. Reduction of 2,4-D load in surface runoff down a grassed waterway. J. Environ. Qual. 6(2):159-162.

Byrtus, G. 1999. Pesticides in precipitation and ambient air. Presented at Western Trace Organics workshop. April 27-30, Calgary

Byrtus, G. 2000. Overview of 1998 pesticide sales in Alberta. Municipal Program Development Branch, Environmental Science Division, Environmental Service, Alberta Environment. 58 pp.

CCME 1987. Canadian Water Quality Guidelines. Canadian Council of Ministers of the Environment Task Force on Water Quality Guidelines. Environment Canada. Ottawa, Ontario, Canada. 6 Chapters plus XXII Appendices.

CCME 1999. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Environment Canada. Hull, Quebec. 8 Chapters

Cole, J.T., J.H. Baird, N.T. Basta, R.L. Huhnke, D.E. Storm, G.V. Johnson, M.E. Payton, M.D. Smolen, D.L. Martin, and J.C. Cole. 1997. Influence of buffers on pesticide and nutrient runoff from bermudagrass turf. J. Environ. Qual. 26:1589-1598.

Cotton, M.M. and G. Byrtus. 1995. Pesticide sales trends in Alberta. In: Cross et al. 1995. Selection of soil landscape units and study design considerations for the surface water monitoring program. Appendix A2. Prepared for CAESA Water Quality Committee. Published by Alberta Agriculture, Food and Rural Development, Edmonton. 73 pp.

Dieken, F.P., F. Skinner, A. Wharmby, and S. Wu. 1996. Methods Manual for Chemical Analysis of Water and Wastes. Environmental Chemistry, Water Analysis Laboratory. Alberta Environmental Centre, Vegreville, Alberta. AECV87-M1.

Donahue, W. 2000. Water quality monitoring program 1999 annual technical report. Water quality monitoring of small streams in agricultural areas. Prepared for the AESA Water Quality Committee. Published by Alberta Agriculture, Food and Rural Development. Edmonton, Alberta, Canada..

Donald, D.B., J. Syrgiannis. 1995. Occurrence of pesticides in prairie lakes in Saskatchewan in relation to drought and salinity. J. Environ. Qual. 24: 266-270.

Donald, D.B., J. Syrgiannis, F. Hunter, and G. Weiss. 1999. Agricultural pesticides threaten the ecological integrity of northern prairie wetlands. The Science of the Total Environment. 231: 173-181.

Donald, D.B., N.P. Gurprasad, L. Quinnett-Abbott, and K. Cash. 2001. Diffuse geographic distribution of herbicides in northern prairie wetlands. Environmental Toxicology and Chemistry. Vol 20, No. 2. pp .273-279.

Forsyth, D.J., P.A. Martin, and G.G. Shaw. 1997. Effects of herbicides on two submersed aquatic macrophytes, *Potamogeton pectinatus* L. and *Myriophyllum sibiricum* Komorov, in prairie wetlands. Environmental Pollution, Vol 95, No. 2. pp 259-268.

Giesy, J.P., S. Dobson, and K.R. Solomon. 2000. Ecotoxicological risk assessment for roundup herbicide. Rev. Environ. Contam. Toxicol: 167:35-120.

Grover, R. and A.J. Cessna. 1996. A prairie-wide perspective of pesticides and farm water quality. I. Farm Dugouts. GCI/AAFC – Technical Report No. 96-1.

Grover, R., D. Waite, A.J. Cessna, W. Nicholaichuk, D.G. Irvin, L.A. Kerr, and K. Best. 1997. Magnitude and persistence of herbicide residues in farm dugouts and ponds in the Canadian prairies. Environmental Toxicology and Chemistry, Vol. 16. No.4: 638-643.

Hill, B., D. Inaba, and S. Byers. 1999. Herbicide detections in Lethbridge-area rainfall 1998. Agriculture and Agri-Food Canada. Research Centre, Box 3000, Lethbridge, AB T1J 4B1.

Hill, B.D., K.N. Harker, P. Hasselback, J.R. Moyer, D.J. Inaba, and S.D. Byers. 2002 a. Phenoxy herbicides in Alberta rainfall: Potential effects on sensitive crops. Can. J. Plant Sci. 82 (2): 481-484.

Hill, B.D., K.N. Harker, P. Hasselback, D.J. Inaba, S.D. Byers, and J.R. Moyer. 2002 b. Herbicides in Alberta rainfall as affected by location, use and season: 1999-2000. Water Quality Research Journal of Canada. Vol 37: 515-543.

Holm-Hansen. O., C. Lorenzen, R.W. Holmes, and J.D.H. Strickland. 1965. Fluorometric determinations of chlorophyll. J.Cons. Perm. Int. Explor. Mer. Vol. 30: 3-15.

Kumar, Y. 2001. Pesticides in ambient air in Alberta. Prepared for Science and Standards Division, Alberta Environment. 30 pp.

Larney, F.J., A.J. Cessna, and M.S. Bullock. 1999. Herbicide transport on wind-eroded sediment. J. Environ. Qual. 28: 1412-1421.

Muir, D.C.G., D.F. Kennedy, N.P. Grift, R.D. Robinson, R.D. Titman, and H.R. Murkin. 1991. Fate and acute toxicity of bromoxynil esters in an experimental prairie wetland. Environ, Sci. Technol. 10: 395-405.

Patty, L., B. Real, and J.J. Gril. 1997. The use of grassed buffer strips to remove pesticides, nitrate and soluable phosphorous compounds from runoff water. Pesticide Sci. 49:243-251.

Peterson, H.G., C. Boutin, P.A. Martin, K.E. Freemark, N.J. Ruecker, and M..J. Moody. 1994. Aquatic phyto-toxicity of 23 pesticides applied at expected environmental concentrations. Aquatic toxicity 28: 275-292.

Rawn, D.F.K., T.H.J. Halldorson, B.D. Lawson, and D.C.G. Muir. 1999. A multi-year study of four herbicides in air and precipitation from a small prairie watershed. J.Environ. Qual., 28(3) 898-906.

Rawn, D.F.K., T.H.J. Halldorson, W.N. Turner, R.N. Woychuck, J.-G. Zakrevsky, and D.C.G. Muir. 1999. A multi-year study of four herbicides in surface water of a small prairie watershed. J. Environ. Qual. 28:906-917.

Rhode, W.A., L.E. Asmussen, E.W. Hauser, R.D. Wauchope, and H.D. Allison. 1980. Trifluralin movement in runoff from a small agricultural watershed. J. Environ. Qual. 9(1):37-42.

Smillie, D.R., Y. Kumar, J. Headley, I. Ahmad and I. Johnon. 1996. Methods Manual for Chemical Analysis of Trace Organics and Pesticides in Environmental Samples. Alberta Research Council, Vegreville, Alberta.

Sokal, R.R. and F.J. Rohlf, 1969. Biometry. The principles and practice of statistics in biological research. Published by W.H. Freeman and Company, San Francisco. 776 pp.

Strickland, J.D.H. and T.R. Parsons. 1965. A manual of seawater analysis, 2nd ed. Fisheries Resource Board of Canada, Ottawa.

Stewart, R.E., and H.A. Kantrud. 1971. Classification of natural wetlands, ponds and lakes in glacial prairie regions. U. S. Dept. of the Interior, U. S. Fish and Wildlife Service Resource Publication 92.

Waite, D.T., R. Grover, and N.D. Westcott 1992. Pesticides in ground water, surface water and spring runoff in a small Saskatchewan watershed. Environmental Toxicology and Chemistry. 11: 741-748.

Waite, D.T., R. Grover, N.D. Westcott, D.G. Irvine, L.A. Kerr and H. Sommerstad. 1995. Atmospheric deposition of pesticides in a small southern Saskatchewan watershed. Environ. Toxicol. Chem. 14: 1171-1175.

Waite, D.T., A.J. Cessna, R. Grover, and E.J. Woodsworth. 2000. Duplicate sampling of surface films and associated pond water for herbicides. J. Environ. Qual. 29: 9001 – 906.

Yentsch, C.S. and D.W. Menzel. 1963. A method for determination of phytoplankton chlorophyll and phaeophytin by fluorescence. Deep-Sea Res. Vol. 10: 221-231.

6.0 APPENDICES

Appendix 1 Project ABS085: Pesticides Wetlands Aspen Parkland Field and Information Sheet

Date: ____________________
Time (MST): ______________
Sampled by: ______________

Sample Number ________________________________
Wetland: AENV code ____________________________
Lat/Long ____
Name/ description of access: _______________________
____

Photos:
of wetland ☐
of surrounding land
views NE ☐ NW ☐ SE ☐ SW ☐
Sketch: rough outline, showing shape, presence emergent vegetation, access, sampling points, approximate size, etc.

General (%) description of land use around wetland

	Crop land*	Hay land	Pasture	Bush/trees
NE				
NW				
SE				
SW				

(*)Type of crop: 1. Cereal, 2. Oilseed, 3 pulse, 4, fallow, 5 other, specify

Pesticide application history of nearby land:____
____

Average distance between water's edge and cultivated land
☐ 0-5 m ☐ 5-20 m ☐ 20 – 50 m ☐ 50 – 100m ☐ > 100m
If present describe dominant land use and composition of wetlands margins__________________
________________________ ____________________________________

Wetland Total Surface Area ______________Surface Area of Open Water__________________
Dominant emergent vegetation____
____
Dominant submerged vegetation____
____

Approximate area of open water covered by submerged vegetation
☐ **0-20%** ☐ **20-50%** ☐ **50-80 %** ☐ **> 80%**

Water samples

	Water Depth in m	DO	PH	T	Cond.	Secchi in m
1						
2						
3						
4						
5						

Weather/moisture conditions preceding sampling
____**Misc.**______________
____
____
____

Appendix 2 Summary of field notes from wetlands sampled in July 2000

Wet-land No.	Sample Date	Crops Average Cover (%)							Pesticide Application	Average Distance Between Crops and Water (m)					Land Use Around Wetland	Wetland Surface Area (ha)	Emergent Vegetation Type	Submerged Vegetation					Average Depth (m)	Misc. Comments
		Canola	Cereal	Fallow	Flax	Hay	Pasture	Bush/Trees		0 - 5	5 to 20	20 to 50	50 - 100	>100				Type	0-20%	20 to 50%	50 to 80%	>80%		
1	11-Jul		90					10				X			grasses	12.1	grasses	little	X				0.35	heavy rain yesterday, wetland probably came up 15 cm in past 2 weeks, the wetland s likely no deeper than 45 cm, so half the water is from rain and runoff
2	10-Jul	25					25	50						X	pasture, Beckmania, yellow rag worth, foxtail, willow, aspen	2.8	small number of bulrush nd cattail	Potamogeton and cattail			X		0.55	farmstead, lawns, corrals, dog breeder
3	11-Jul		75			8	10	8	?			X			native forbes	8.1	grasses, yellow rag wort	coontail		X			0.2	heavy rain preceeding 2 weeks, receives drainage from 50 cow operation corral, dried up several times in 90's
4	11-Jul					100								X	dense scirpus beds, border of trees	2.8	scirpus and grasses	none	X				0.25	heavy rains during july weekend and day prior to sampling, all this rain must account for the water in the wetland
5	11-Jul		60			20	20		?				X		some pasture and bush	3.6	cattails	coontail and lemna		X			0.6	heavy rain day before, I.e. DU project: dammed creek, farm upstream creek flows through corrals
6	11-Jul	20	40	5				35	small field sprayed with round-up				X			0.4	cattails	pondweed	X				0.4	heavy rain in the last 2 days, fallow field has small erosion gullies, NOTES UNCLEAR WITH RESPECT TO CROP
7	11-Jul		50					50	?				X		cattails	1.6	cattails	coontail					0.75	15 cm rain in last 2 weeks, some fast and heavy
8	12-Jul		75					25	?			X			native grasses and willows	8.1	scirpus and grasses	Potamogeton vaginatus and Lemna	X				0.7	10 to 15 cm rain in last 12 days. *Crop not specified, assumed cereal*
9	12-Jul		50			50			no?		X				native grass and willows	0.4	backmonia	coontail and Lemna			X		0.65	10 to 15 cm rain in last 12 days

Wet-land No.	Sample Date	Crops Average Cover (%)							Pesticide Application	Average Distance Between Crops and Water (m)					Land Use Around Wetland	Wetland Surface Area (ha)	Emergent Vegetation Type	Submerged Vegetation					Average Depth (m)	Misc. Comments
		Canola	Cereal	Fallow	Flax	Hay	Pasture	Bush/Trees		0 - 5	5 to 20	20 to 50	50 - 100	>100				Type	0-20%	20 to 50%	50 to 80%	>80%		
10	12-Jul	50	50								X				sedge, grasses, some willows and aspen	0.8	narrow fringe of smartweed	some filamentous algae, not much else	X				0.5	10 to 15 cm rain in previous 12 days; land to north and west drains towards wetland
10	18-Jul	100							yes		X				crop			Potamogeton, duckweed, coontail					0.5	
11	12-Jul		75					25	?		X				cattail, sedge, yellow ragwort, some willows	1.6	yellow ragwort, cattail	~0	X				0.45	10 to 15 cm rain in last two weeks, water has gone up by 30 cm, large number of Daphnia
12	12-Jul	70						30				X			willows, native grasses and cattails	0.8	cattails very dense	duckweed and coontail	X				0.8	10 to 15 cm rain in previous 12 days; wetland has recently risen by 20 to 30 cm
13	10-Jul		50			25		25	yes		X				cattail and beckmania	0.6	cattail and beckmania	coontail and lemna			X		0.6	a little rain the previous night, 6 cm in preceeding 10 days
14	10-Jul		40	30				30				X			smartweed, yellow ragweed, nettles, Canada thistle, aspen, willow	1.2	smartweed	Potamogeton, Lemna		X			0.55	light rain, approx 6cm on previous weekend, small gully from fallow to pond; large number snail shells, road directly south was oiled in previous yr.
15	10-Jul													X	sedge meadow, willows	40.5	cattail and sedge	pondweed and duckweed			X		0.4	light rain last night,heavy rain july weekend
16	18-Jul			45			45	10	yes (roundup?)		X				grass and cattail	5	beckmonia z, cattail, roundstem bullrush, foxtail	0	0				0.2	10 to 15 cm rain in last 2 weeks, wetland dry before that

Wet-land No.	Sample Date	Crops Average Cover (%)							Pesticide Application	Average Distance Between Crops and Water (m)					Land Use Around Wetland	Wetland Surface Area (ha)	Emergent Vegetation Type	Submerged Vegetation					Average Depth (m)	Misc. Comments
		Canola	Cereal	Fallow	Flax	Hay	Pasture	Bush/Trees		0 - 5	5 to 20	20 to 50	50 - 100	>100				Type	0-20%	20 to 50%	50 to 80%	>80%		
17	18-Jul		90				10		yes		X				yellow ragwort, grasses, willow and shrubs	24.3	0	coontail, filamentous algae	0					10 to 15 cm rain fell in preceding 2 weeks, large drainage area, sandy bottom
18	19-Jul	75	25						not this yr		X				grasses, canada thistle, sow thistle, some sedges and willows	1.2	soft stem bulrush	coontail, lemna, others	X				0.6	approximately 41/2inches of rain in mid-June
19	19-Jul		85					15	yes			X			willow, aspen and cattail	0.8	cattails	ver1 little	X				0.6	rain preceeding sampling, active beaver colony, this may not be the wetland originally selected as that one dried up
20	27-Jul		90					5				X			grassland and bush	0.8	cattails	Ceratophyllum , Potamogeton, Lemna				X	0.3	very little zooplankton
22	20-Jul	50	25				25				X				cattail, grasses, Beckmania, willow	6.1	dense cattail ans roundstem bulrush	a little coontail	X				0.35	abundance of invertebrates in the samples, presumed Daphnia
25	18-Jul		100						?		X				grasses	0.8	0	0	0				0.04	10 to 15 cm rain fell in preceding 2 weeks, wetland dry before that <u>only pest sample analyzed, rest discarded</u>
26	18-Jul		40				20	40						X	cattail, foxtail, sedge	2.8	none	filamentous algae, unknown type of pondweed	X				0.7	heavy rains (10 to 15 cm) in past 2 weeks
27	19-Jul		100						no?		X				crop is being grazed	0.4	bulrush, cattails	pondweed some coontail	X				0.55	crop infested with canola and otherweeds, wetland almost completely covered by emergent vegetation, weed used by ducks

Wet-land No.	Sample Date	Crops Average Cover (%)							Pesticide Application	Average Distance Between Crops and Water (m)					Land Use Around Wetland	Wetland Surface Area (ha)	Emergent Vegetation Type	Submerged Vegetation					Average Depth (m)	Misc. Comments
		Canola	Cereal	Fallow	Flax	Hay	Pasture	Bush/Trees		0 - 5	5 to 20	20 to 50	50 - 100	>100				Type	0-20%	20 to 50%	50 to 80%	>80%		
28	19-Jul		90				10		yes				X		foxtail and other grasses	1.2	bulrushes	filamentous algae		X			0.68	heavy rains (10 to 15 cm) in past 2 weeks
30	20-Jul	25	75						yes					X	grasses, willow and aspen	3.2	none	Potamogeton richardsoni +other				X	0.6	rain last night, 10 to 15 cm in last 12 days
31	21-Jul		100						yes			X			cattails	1.4	cattails	sparse Potamogeton + filamentous green algae		X			0.75	fierce H2S smell to disturbed water
31	19-Jul		100								X				cropland, aspen and willows	0.5	cattails	pondweed		X			0.95	lots of moisture in past week, numerous waterfowl species and red-winged blackbird use the wetland
32	19-Jul		100						yes		X				crop	0.4	bullrushes	coontail and pondweed			X		1	lots of planktonic algae
32	4-Jul		100								X						cattails	Aphanizomenon in water					0.9	
33	19-Jul					100			no		X				hay	0.6	cattails	coontail			X		1	
34	19-Jul		50					50	yes		X				crop, trees, railway track	1.3	cattails and beaked sedge	coontail				X	1.1	lots of water fowl present!
35	18-Jul	100							yes		X				sedge and reeds	4.6	reeds	coontail and filamentous			X		0.87	lots of Daphnia
35	19-Jul	15						85			X				cropland, aspen poplar, willows, balsam poplar, road	2.5	sedges, bullrush, cattails	coontail				X	1.15	lots of freshwater shrimp, dragon and damselfies. Ducks, old beaver dam
36	25-Jul		100						?				X		bullrushes	0.5	bullrushes	pondweed and cattail	X				0.1	very soft sediments, samples taken along edge *(sampling depth not indicative of water depth)*
36	18-Jul		100								X							coontail	X				0.6	
37	25-Jul		25			25		45	yes					X	cattails	0.4	cattails	coontail				X	0.25	lots of rain in past week
38	25-Jul		100						yes	X					cattails	0.2	cattails	coontail and duckweed			X		1	hot and sunny, lots of rain in past week

Wet-land No.	Sample Date	Crops Average Cover (%)							Pesticide Application	Average Distance Between Crops and Water (m)					Land Use Around Wetland	Wetland Surface Area (ha)	Emergent Vegetation Type	Submerged Vegetation					Average Depth (m)	Misc. Comments
		Canola	Cereal	Fallow	Flax	Hay	Pasture	Bush/Trees		0 - 5	5 to 20	20 to 50	50 - 100	>100				Type	0-20%	20 to 50%	50 to 80%	>80%		
39	20-Jul	100							yes	X					cropland	0.3	bulrush, cattails	coontail		X			1.1	distinct drop (like a step) from edge of crop to wetlands
40	28-Jul	100							yes		X				cattails	0.1	cattails					X	NA	hot, sunny, some rain preceeding sampling
40	27-Jul	100									X				reeds and grasses, some willows	0.5	reeds	coontail				X	0.6	rain 4 days ago, canola crop in full bloom, weeds more pronounced since last visit
41	20-Jul	50	50						yes		X				cropland	0.1	bulrush	pondweed				X	0.4	
42	18-Jul	65						35	yes			X			cropland, aspen poplar, willows, foxtail barley	0.7	bulrush and sedges	none (no open water)	X				0.3	overcast, light rain, in past couple days, very shallow wetland with no open water, sits in a depression, steep banks on most sides up to cropland
43	18-Jul		20					80	no			X			bush, trees, grass and cattle, crop	1	bulrush	common bladderwort		X			0.1	rain on and off in past 2 days, wading into wetlands not possible, depth not indicative of actual depth, ducks and gulls present
44	20-Jul		75					25				X				1	cattails	coontails				X		open water patchy throughout wetland, cattails in bunches and patches throughout wetland
46	26-Jul		100							X					cleaver, foxtail barley	0.4	cattails	duckweed				X	0.3	hot, evening showers, entire pond covered by duckweed, crop recently seeded, still at 4-leaf stage (DU Wetland)
46	5-Jul						100				X				pasture	0.04	cattails	duckweed				X	0.6	(AENV Wetland - not same as above)
47	26-Jul	100								X					cropland	0.8	cattail, spruce rush, alkali bullrush, hardstem bullrush	milfoil	X					hot, evening showers _NO ICE IN COOLER. Warm samples
47	5-Jul	100									X					0.6	bulrush	coontail		X			0.9	very green, lots of algae ****this wetland was sampled twice by DU staff

Wet-land No.	Sample Date	Crops Average Cover (%)							Pesticide Application	Average Distance Between Crops and Water (m)					Land Use Around Wetland	Wetland Surface Area (ha)	Emergent Vegetation Type	Submerged Vegetation					Average Depth (m)	Misc. Comments
		Canola	Cereal	Fallow	Flax	Hay	Pasture	Bush/Trees		0 - 5	5 to 20	20 to 50	50 - 100	>100				Type	0-20%	20 to 50%	50 to 80%	>80%		
48	27-Jul					50		50						X	hayland, sedge willow, poplar	0.8	cattail	milfoil, pondweed				X		hot and dry intermittent thunderstorms
49	27-Jul						100							X	pasture, willow, poplar, sedge, baltic rush	0.4	cattails	milfoil, duckweed		X			0.8	hot, dry, intermittent thundershowers
50	26-Jul					100				X					hayland	0.2	cattails, whitetop	duckweed, cattail, milfoil	X				0.3	hot, evening showers
50	5-Jul					100			no		X				hay	0.02	cattails	filamentous algae				X	0.2	lots of filamentous algae
51	27-Jul	100							yes		X				reeds	0.5	reeds	scenescent coontail, cladophora, lots of dead reeds			X			dry weather preceeding sampling, lots of copepods
51	12-Jul	100							2*1/2L Transorb	X					sedge, foxtail	0.4	sedge	1					NA	AMA: cannot find **transorb** in blue book sample had many detections inc. clopyralid (transline) and its registered mixes 2,4D and MCPA. Less Wetter involved in sampling here
51	6-Jul	100									X				sedges and reeds	0.6	reeds	reeds	X				0.7	intermittent rain last week
52	22-Jul		100								X				ungrazed bush and grass, sedge and bulrush	1.2	bullrushes	filamentous algae		X			0.5	Dry weather, wetland may be deeper in the middle
52	20-Jul		100									X			reeds and sedges	2	bull rushes	Myriophyllum, duckweed		X			2.2	
53	22-Jul								Buctril M, Horizon			X			cropland and cattails		cattail	milfoil				X	0.5	very dry, low water level FIGURE OUT WHAT CROP WAS FROM PESTICDES???
54	22-Jul		100						refine + MCPA			X			cattails, willows no grazing	0.6	cattails	milfoil			X		0.5	hot and dry, water level low

Wet-land No.	Sample Date	Crops Average Cover (%)							Pesticide Application	Average Distance Between Crops and Water (m)					Land Use Around Wetland	Wetland Surface Area (ha)	Emergent Vegetation Type	Submerged Vegetation					Average Depth (m)	Misc. Comments
		Canola	Cereal	Fallow	Flax	Hay	Pasture	Bush/Trees		0 - 5	5 to 20	20 to 50	50 - 100	>100				Type	0-20%	20 to 50%	50 to 80%	>80%		
54	4-Jul		95				5				X				bush and grass	0.09	cattails	coontail				X	0.4	
55	22-Jul	100										X			cattails, Beckmania, bulrush	0.4	cattail	milfoil			X		0.2	wetland is low, very shallow
56	18-Jul		85					15	yes		X				crop	0.7	bulrush	water buttercup		X			0.9	overcast light rain on and off, wetland in low spot surrounded by cropland, good runoff potential into the wetland, ducks in area
57	27-Jul	50	50								X				sedge, willows, poplar	2	cattail	algae, milfoil, duckweed				X	0.8	hot, dry, thunderstorm in evenings
59	14-Jul		100							X					cattails	0.4	cattails	milfoil, lemna	X				NA	rain possibly the day before
60	17-Jul		100									X			cropland, willow, sedge	4.1	cattail and sedges	milfoil	X				0.4	(DU Wetland)
60	4-Jul					90		10						X		7.8	cattails	none	X				0.3	(AENV Wetland - not same as above)
61	4-Jul				100							X				0.3			X				0.25	
61	14-Jul				100					X					cropland, clover, foxtail, willow	4.1	sedge, cattail	Potamogeton richardsoni, smartweed, duckweed, milfoil				X	0.4	note: I.e flax crop, firm bottom
62	26-Jul		100						yes	X					cropland	2.1	bulrushes	coontail				X		hot sunny, rain previous night (DU Wetland)
62	19-Jul		50			30		20			X					45.7	cattails	Potamogeton, coontail, plenty of filamentous green algae, some Lemna			X		0.6	rainy and wet past couple weeks, something about subdivision, invertebrates corixids and amplipods (AENV Wetland - not same as above)
63	26-Jul		100						yes		X				cropland	0.6	slough grass	duckweed	X					hot sunny, rain previous night
64	26-Jul		100						yes	X					cattails	0.7	cattails					X	NA	rain night before
20?	20-Jul		90					10	yes		X				grasses, some thistle, willows, cattail	0.4	dense cattail	coontail, Lemna tri.				X	0.55	

Appendix 3 Results of pesticide analyses: A. Water samples, B. Precipitation samples, C. Plankton tissue samples, D. Surface film samples

Station Name	Date/Time	100667 2,4-D	100668 2,4-DB	100669 Dichlor prop	100670 Alpha-Benzenehexa chloride	100671 Alpha-Endo sulfan	100672 Gamma-Benzenehexa chloride	100673 Methoxychlor (P,P-Methoxychlor)	100674 Atrazine	100675 Bromacil	100676 Bromoxy nil	100677 Carbathiin (Carboxin)
A. WATER SAMPLES												
Wetland #1	7/11/00 8:30	0.03	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #2	6/20/00 15:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #2	7/10/00 10:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #3	7/10/00 12:45	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #4	7/11/00 7:30	0.056	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #5	7/11/00 11:00	0.076	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	0.025
Wetland #6	7/11/00 12:30	0.018	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #7	7/11/00 13:15	L0.005	L0.005	0.272	L0.005	L0.005	0.013	L0.03	L0.005	L0.03	0.008	L0.1
Wetland #8	6/20/00 11:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #8	7/12/00 9:10	0.146	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #9	6/20/00 13:00	0.01	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #9	7/12/00 8:15	0.033	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #10	4/26/00 12:45	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #10	5/26/00 12:00											
Wetland #10	6/21/00 8:30	0.005	L0.005	L0.005	L0.005	L0.005	0.021	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #10	7/12/00 10:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #10	7/18/00 15:00	0.036	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #10	8/16/00 11:45	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #10	9/21/00 13:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #10	10/18/00 10:20	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #11	7/12/00 11:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #12	7/12/00 7:30	1.697	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	0.216	L0.1
Wetland #13	7/10/00 11:20	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #14	7/10/00 8:00	0.004	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #15	7/10/00 13:20	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #16	7/18/00 11:00	2.572	L0.005	0.024	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #17	7/18/00 9:10	0.027	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #18	6/28/00 15:00	0.087	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #18	7/19/00 10:45	0.053	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #19	7/19/00 8:00	0.094	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	4/27/00 12:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	5/24/00 13:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	6/29/00 10:30	0.044	L0.005	0.031	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	7/20/00 10:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	7/27/00 9:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	8/17/00 13:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	9/21/00 11:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	10/18/00 14:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #22	7/20/00 13:15	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #23	6/28/00 13:00	0.1	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1

Station Name	Date/Time	100667 2,4-D	100668 2,4-DB	100669 Dichlor prop	100670 Alpha-Benzenehexa chloride	100671 Alpha-Endo sulfan	100672 Gamma-Benzenehexa chloride	100673 Methoxychlor (P,P-Methoxychlor)	100674 Atrazine	100675 Bromacil	100676 Bromoxy nil	100677 Carbathiin (Carboxin)
Wetland #25	7/18/00 14:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #26	6/29/00 8:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #26	7/18/00 13:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #27	7/19/00 11:00	0.089	L0.005	0.014	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #28	7/19/00 12:00	0.541	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #30	7/20/00 6:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #31	5/24/00 9:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #31	6/22/00 9:15	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #31	7/19/00 13:00	0.033	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #31	7/21/00 12:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #31	8/17/00 9:15	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #31	9/29/00 11:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #32	7/4/00 16:10	0.186	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #32	7/19/00 15:00	0.18	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #33	7/19/00 17:00	0.039	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #34	7/19/00 16:30	0.029	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #35	7/18/00 8:45	0.025	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #35	7/19/00 14:00	0.026	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	4/26/00 9:10	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	5/26/00 10:00											
Wetland #36	6/20/00 9:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	7/18/00 13:00	0.022	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	7/25/00 10:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	8/16/00 10:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	9/21/00 14:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	10/18/00 8:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #37	7/25/00 9:00	0.073	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #38	6/21/00 12:30	0.196	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #38	7/25/00 13:30	0.101	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #39	7/20/00 15:30	0.12	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	4/26/00 13:40	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	5/24/00 15:00	L0.005	L0.005	L0.005	L0.005	L0.005	0.019	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	6/21/00 9:45	0.045	L0.005	L0.005	L0.005	L0.005	0.013	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	7/25/00 14:00	0.06	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	7/27/00 11:40	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	8/16/00 13:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	9/21/00 12:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	10/18/00 12:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #41	6/21/00 11:00	0.159	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #41	7/20/00 17:00	0.045	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #42	6/28/00 11:30	0.133	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #42	7/18/00 10:00	0.021	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #43	7/18/00 11:00	0.031	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1

Station Name	Date/Time	100667 2,4-D	100668 2,4-DB	100669 Dichlor prop	100670 Alpha-Benzenehexa chloride	100671 Alpha-Endo sulfan	100672 Gamma-Benzenehexa chloride	100673 Methoxychlor (P,P-Methoxychlor)	100674 Atrazine	100675 Bromacil	100676 Bromoxy nil	100677 Carbathiin (Carboxin)
Wetland #44	7/20/00 14:00	0.209	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #46	7/5/00 12:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #46	7/26/00 14:10	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #47	7/5/00 13:00	0.025	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #47	7/26/00 13:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #48	7/27/00 10:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #49	7/27/00 12:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #50	7/5/00 14:00	0.053	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #50	7/26/00 11:15	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	4/27/00 15:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	5/24/00 11:30	L0.005	L0.005	L0.005	L0.005	L0.005	0.006	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	7/6/00 11:00	0.067	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	7/12/00 12:00	0.092	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	7/27/00 14:00	0.051	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	8/17/00 11:05	0.057	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	9/21/00 12:06	0.024	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	10/31/00 14:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #52	7/6/00 12:00	0.048	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #52	7/22/00 15:00	0.081	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #53	7/22/00 12:00	0.064	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #54	7/4/00 14:30	0.047	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #54	7/22/00 10:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #55	7/22/00 17:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #56	7/18/00 12:30	0.044	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #57	7/27/00 11:30	0.014	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #59	7/17/00 10:30	0.341	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #60	7/4/00 12:30	0.039	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #60	7/17/00 13:15	0.026	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #61	7/4/00 13:15	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #61	7/17/00 14:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	5/23/00 12:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	6/19/00 10:15	0.472	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	7/19/00 14:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	7/26/00 17:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	8/29/00 14:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	10/3/00 10:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	11/1/00 11:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #63	6/19/00 13:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #63	7/26/00 18:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #64	6/19/00 12:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #64	7/26/00 19:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1

Station Name	Date/Time	100667 2,4-D	100668 2,4-DB	100669 Dichlor prop	100670 Alpha-Benzenehexa chloride	100671 Alpha-Endo sulfan	100672 Gamma-Benzenehexa chloride	100673 Methoxychlor (P,P-Methoxychlor)	100674 Atrazine	100675 Bromacil	100676 Bromoxy nil	100677 Carbathiin (Carboxin)
B. PRECIPITATION SAMPLES												
ARC - Vegreville	5/3/00 0:00	0.271	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	5/15/00 11:00	0.302	L0.005	L0.005	L0.005	L0.005	0.02	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	5/26/00 0:00	0.187	L0.005	L0.005	L0.005	L0.005	0.056	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	5/30/00 11:00	0.274	L0.005	L0.005	L0.005	L0.005	0.026	L0.03	L0.005	L0.03	0.119	L0.1
ARC - Vegreville	6/9/00 9:30	0.076	L0.005	L0.005	L0.005	L0.005	0.023	L0.03	L0.005	L0.03	0.017	L0.1
ARC - Vegreville	6/12/00 11:00	0.47	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	0.045	L0.1
ARC - Vegreville	6/19/00 11:00	0.115	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	0.004	L0.1
ARC - Vegreville	6/21/00 11:00	0.256	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	0.055	L0.1
ARC - Vegreville	7/4/00 11:00	0.072	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	7/7/00 13:00	0.024	L0.005	L0.005	L0.005	L0.005	0.01	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	7/11/00 9:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	7/26/00 10:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	8/2/00 9:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	8/14/00 10:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	8/25/00 9:00	0.007	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	9/5/00 8:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
ARC - Vegreville	7/18/00 9:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
C. PLANKTON TISSUE SAMPLES												
Wetland #10	21-Jun-00 00:00	1.024	0	0	0	0	0	0	0	0	0	0
Wetland #10	18-Jul-00 00:00	0.328	0	0	0	0	0	0	0	0	0	0
Wetland #20	29-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0	0
Wetland #20	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0
Wetland #31	22-Jun-00 00:00	2.961	0	0	0	0	0	0	0	0	0	0
Wetland #31	21-Jul-00 00:00	0.218	0	0	0	0	0	0	0	0	0	0
Wetland #36	20-Jun-00 00:00	4.776	0	0	0	0	0	0	0	0	0	0
Wetland #36	18-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0
Wetland #40	27-Jul-00 00:00	0.165	0	0	0	0	0	0	0	0	0	0
Wetland #51	06-Jul-00 00:00	134.968	0	0	0	0	0	0	0	0	0	0
Wetland #51	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0
Wetland #62		0	0	0	0	0	0	0	0	0	0	0
Wetland #62	19-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0
D. SURFACE FILM SAMPLES												
Wetland #10	6/21/00 9:05	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #20	6/29/00 10:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #31	6/22/00 9:30	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #36	6/20/00 9:05	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #40	6/21/00 9:45	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #51	7/6/00 11:00	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1
Wetland #62	6/19/00 10:15	L0.005	L0.005	L0.005	L0.005	L0.005	L0.005	L0.03	L0.005	L0.03	L0.005	L0.1

Notes: ARC = Alberta Research Council

Station Name	Date/Time	100678 Cyanazine	100679 Diazinon	100680 Dicamba (Banvel)	100681 Diclofop-Methyl	100682 Disulfoton (Di-Syston)	100683 Diuron	100684 Chlorpyrifos (Dursban)	100685 Ethalfluralin (Edge)	100686 Ethion	100687 Guthion	100688 Clopyralid (Lontrel)	100689 Malathion	100690 MCPA
A. WATER SAMPLES														
Wetland #1	7/11/00 8:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.032
Wetland #2	6/20/00 15:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.06
Wetland #2	7/10/00 10:00	L0.05	L0.005	0.012	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.017	L0.05	0.028
Wetland #3	7/10/00 12:45	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #4	7/11/00 7:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.027
Wetland #5	7/11/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.154
Wetland #6	7/11/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.022	L0.05	0.053
Wetland #7	7/11/00 13:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #8	6/20/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #8	7/12/00 9:10	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.043
Wetland #9	6/20/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.03
Wetland #9	7/12/00 8:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #10	4/26/00 12:45	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #10	5/26/00 12:00													
Wetland #10	6/21/00 8:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.075
Wetland #10	7/12/00 10:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #10	7/18/00 15:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.022
Wetland #10	8/16/00 11:45	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #10	9/21/00 13:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #10	10/18/00 10:20	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #11	7/12/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.148	L0.05	L0.005
Wetland #12	7/12/00 7:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	1.812
Wetland #13	7/10/00 11:20	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.022
Wetland #14	7/10/00 8:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.025
Wetland #15	7/10/00 13:20	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.122	L0.05	0.024
Wetland #16	7/18/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.024
Wetland #17	7/18/00 9:10	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.019
Wetland #18	6/28/00 15:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.062
Wetland #18	7/19/00 10:45	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.034
Wetland #19	7/19/00 8:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	4/27/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	5/24/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	6/29/00 10:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.039
Wetland #20	7/20/00 10:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	7/27/00 9:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	8/17/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	9/21/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	10/18/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #22	7/20/00 13:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.028
Wetland #23	6/28/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.115

Station Name	Date/Time	100678 Cyana zine	100679 Diazinon	100680 Dicamba (Banvel)	100681 Diclofop-Methyl	100682 Disul foton (Di-Syston)	100683 Diuron	100684 Chlor pyrifos (Dursban)	100685 Ethalflura lin (Edge)	100686 Ethion	100687 Guthion	100688 Clopyralid (Lontrel)	100689 Mala thion	100690 MCPA
Wetland #25	7/18/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #26	6/29/00 8:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.053
Wetland #26	7/18/00 13:00	L0.05	L0.005	0.003	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #27	7/19/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.087
Wetland #28	7/19/00 12:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.052
Wetland #30	7/20/00 6:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #31	5/24/00 9:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #31	6/22/00 9:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.026
Wetland #31	7/19/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #31	7/21/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #31	8/17/00 9:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #31	9/29/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #32	7/4/00 16:10	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.061	L0.05	0.045
Wetland #32	7/19/00 15:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.103	L0.05	0.043
Wetland #33	7/19/00 17:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.025
Wetland #34	7/19/00 16:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.124
Wetland #35	7/18/00 8:45	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.496	L0.05	0.119
Wetland #35	7/19/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.714	L0.05	0.19
Wetland #36	4/26/00 9:10	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #36	5/26/00 10:00													
Wetland #36	6/20/00 9:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.083
Wetland #36	7/18/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #36	7/25/00 10:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #36	8/16/00 10:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #36	9/21/00 14:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #36	10/18/00 8:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #37	7/25/00 9:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.006
Wetland #38	6/21/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.301	L0.05	1.563
Wetland #38	7/25/00 13:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.37	L0.05	0.331
Wetland #39	7/20/00 15:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.039
Wetland #40	4/26/00 13:40	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.012
Wetland #40	5/24/00 15:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #40	6/21/00 9:45	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.173
Wetland #40	7/25/00 14:00	L0.05	L0.005	0.012	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.587	L0.05	0.044
Wetland #40	7/27/00 11:40	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.023
Wetland #40	8/16/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.015
Wetland #40	9/21/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.003
Wetland #40	10/18/00 12:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.08	L0.05	L0.005
Wetland #41	6/21/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.053	L0.05	0.459
Wetland #41	7/20/00 17:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.113	L0.05	0.202
Wetland #42	6/28/00 11:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.08
Wetland #42	7/18/00 10:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #43	7/18/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.026

Station Name	Date/Time	100678 Cyana zine	100679 Diazinon	100680 Dicamba (Banvel)	100681 Diclofop-Methyl	100682 Disul foton (Di-Syston)	100683 Diuron	100684 Chlor pyrifos (Dursban)	100685 Ethalflura lin (Edge)	100686 Ethion	100687 Guthion	100688 Clopyralid (Lontrel)	100689 Mala thion	100690 MCPA
Wetland #44	7/20/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.079
Wetland #46	7/5/00 12:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #46	7/26/00 14:10	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #47	7/5/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.037
Wetland #47	7/26/00 13:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.018
Wetland #48	7/27/00 10:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #49	7/27/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #50	7/5/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.091
Wetland #50	7/26/00 11:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #51	4/27/00 15:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.235	L0.05	0.022
Wetland #51	5/24/00 11:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.576	L0.05	0.008
Wetland #51	7/6/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.517	L0.05	0.12
Wetland #51	7/12/00 12:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.405	L0.05	0.144
Wetland #51	7/27/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.185	L0.05	0.044
Wetland #51	8/17/00 11:05	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.116	L0.05	0.01
Wetland #51	9/21/00 12:06	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.133	L0.05	0.17
Wetland #51	10/31/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.223	L0.05	0.091
Wetland #52	7/6/00 12:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.056	L0.05	0.056
Wetland #52	7/22/00 15:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.226	L0.05	0.052
Wetland #53	7/22/00 12:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.178
Wetland #54	7/4/00 14:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.12
Wetland #54	7/22/00 10:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.094
Wetland #55	7/22/00 17:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #56	7/18/00 12:30	L0.05	L0.005	0.195	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.483
Wetland #57	7/27/00 11:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.019
Wetland #59	7/17/00 10:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.037
Wetland #60	7/4/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.049
Wetland #60	7/17/00 13:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #61	7/4/00 13:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.016
Wetland #61	7/17/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.149
Wetland #62	5/23/00 12:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.056	L0.05	L0.005
Wetland #62	6/19/00 10:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.066	L0.05	0.036
Wetland #62	7/19/00 14:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #62	7/26/00 17:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #62	8/29/00 14:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #62	10/3/00 10:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #62	11/1/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #63	6/19/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.097
Wetland #63	7/26/00 18:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #64	6/19/00 12:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.128	L0.05	0.023
Wetland #64	7/26/00 19:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005

Station Name	Date/Time	100678 Cyana zine	100679 Diazinon	100680 Dicamba (Banvel)	100681 Diclofop-Methyl	100682 Disul foton (Di-Syston)	100683 Diuron	100684 Chlor pyrifos (Dursban)	100685 Ethalflura lin (Edge)	100686 Ethion	100687 Guthion	100688 Clopyralid (Lontrel)	100689 Mala thion	100690 MCPA
B. PRECIPITATION SAMPLES														
ARC - Vegreville	5/3/00 0:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
ARC - Vegreville	5/15/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.061
ARC - Vegreville	5/26/00 0:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
ARC - Vegreville	5/30/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.373
ARC - Vegreville	6/9/00 9:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.197
ARC - Vegreville	6/12/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.557
ARC - Vegreville	6/19/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.434
ARC - Vegreville	6/21/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.182
ARC - Vegreville	7/4/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.051
ARC - Vegreville	7/7/00 13:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	0.06
ARC - Vegreville	7/11/00 9:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
ARC - Vegreville	7/26/00 10:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
ARC - Vegreville	8/2/00 9:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
ARC - Vegreville	8/14/00 10:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
ARC - Vegreville	8/25/00 9:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
ARC - Vegreville	9/5/00 8:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	0.068	L0.05	0.053
ARC - Vegreville	7/18/00 9:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
C. PLANKTON TISSUE SAMPLES														
Wetland #10	21-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #10	18-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0.089	0	0
Wetland #20	29-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #20	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #31	22-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #31	21-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0.04	0	0
Wetland #36	20-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #36	18-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #40	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0.026	0	0
Wetland #51	06-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #51	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #62		0	0	0	0	0	0	0	0	0	0	0	0	0
Wetland #62	19-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0	0.024	0	0
D. SURFACE FILM SAMPLES														
Wetland #10	6/21/00 9:05	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #20	6/29/00 10:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #31	6/22/00 9:30	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #36	6/20/00 9:05	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #40	6/21/00 9:45	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #51	7/6/00 11:00	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005
Wetland #62	6/19/00 10:15	L0.05	L0.005	L0.02	L0.02	L0.2	L0.2	L0.005	L0.005	L0.1	L0.2	L0.02	L0.05	L0.005

Notes: ARC = Alberta Research Council

Station Name	Date/Time	100691 MCPB	100692 MCPP (Meco prop)	100693 Picloram (Tordon)	100694 Phorate (Thimet)	100695 Terbu fos	100696 Triallate (Avadex BW)	100697 Trifluralin (Treflan)	102088 Imazameth abenz-Methyl	102609 Desethyl Atrazine	102610 Deiso propyl Atrazine	102611 Quin clorac	102612 Imazetha pyr
A. WATER SAMPLES													
Wetland #1	7/11/00 8:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #2	6/20/00 15:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #2	7/10/00 10:00	L0.02	0.031	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #3	7/10/00 12:45	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #4	7/11/00 7:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #5	7/11/00 11:00	L0.02	0.036	0.046	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #6	7/11/00 12:30	L0.02	L0.005	0.038	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #7	7/11/00 13:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #8	6/20/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #8	7/12/00 9:10	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #9	6/20/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #9	7/12/00 8:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #10	4/26/00 12:45	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #10	5/26/00 12:00												
Wetland #10	6/21/00 8:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #10	7/12/00 10:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #10	7/18/00 15:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #10	8/16/00 11:45	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #10	9/21/00 13:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #10	10/18/00 10:20	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #11	7/12/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #12	7/12/00 7:30	L0.02	L0.005	11.196	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #13	7/10/00 11:20	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #14	7/10/00 8:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #15	7/10/00 13:20	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #16	7/18/00 11:00	L0.02	0.003	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #17	7/18/00 9:10	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #18	6/28/00 15:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #18	7/19/00 10:45	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #19	7/19/00 8:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	4/27/00 12:30	L0.02	L0.005	0.332	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	5/24/00 13:00	L0.02	L0.005	0.149	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	6/29/00 10:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	7/20/00 10:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	7/27/00 9:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	8/17/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	9/21/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	10/18/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #22	7/20/00 13:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #23	6/28/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02

Station Name	Date/Time	100691 MCPB	100692 MCPP (Meco prop)	100693 Picloram (Tordon)	100694 Phorate (Thimet)	100695 Terbufo s	100696 Triallate (Avadex BW)	100697 Trifluralin (Treflan)	102088 Imazameth abenz-Methyl	102609 Desethyl Atrazine	102610 Deiso propyl Atrazine	102611 Quin clorac	102612 Imazetha pyr
Wetland #25	7/18/00 14:00	L0.02	L0.005	0.133	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #26	6/29/00 8:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #26	7/18/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #27	7/19/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #28	7/19/00 12:00	L0.02	L0.005	0.203	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #30	7/20/00 6:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #31	5/24/00 9:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #31	6/22/00 9:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #31	7/19/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #31	7/21/00 12:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #31	8/17/00 9:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #31	9/29/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #32	7/4/00 16:10	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #32	7/19/00 15:00	L0.02	L0.005	0.057	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #33	7/19/00 17:00	L0.02	L0.005	0.187	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #34	7/19/00 16:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #35	7/18/00 8:45	L0.02	L0.005	0.075	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #35	7/19/00 14:00	L0.02	L0.005	0.082	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	4/26/00 9:10	L0.02	L0.005	0.326	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	5/26/00 10:00												
Wetland #36	6/20/00 9:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	7/18/00 13:00	L0.02	L0.005	0.899	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	7/25/00 10:00	L0.02	L0.005	0.268	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	8/16/00 10:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	9/21/00 14:30	L0.02	L0.005	0.175	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	10/18/00 8:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #37	7/25/00 9:00	L0.02	0.032	1.02	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #38	6/21/00 12:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #38	7/25/00 13:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #39	7/20/00 15:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	4/26/00 13:40	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	5/24/00 15:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	6/21/00 9:45	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	7/25/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	7/27/00 11:40	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	8/16/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	9/21/00 12:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	10/18/00 12:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #41	6/21/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #41	7/20/00 17:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #42	6/28/00 11:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #42	7/18/00 10:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #43	7/18/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02

Station Name	Date/Time	100691 MCPB	100692 MCPP (Meco prop)	100693 Picloram (Tordon)	100694 Phorate (Thimet)	100695 Terbufo s	100696 Triallate (Avadex BW)	100697 Trifluralin (Treflan)	102088 Imazameth abenz-Methyl	102609 Desethyl Atrazine	102610 Deiso propyl Atrazine	102611 Quin clorac	102612 Imazetha pyr
Wetland #44	7/20/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #46	7/5/00 12:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #46	7/26/00 14:10	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #47	7/5/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #47	7/26/00 13:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #48	7/27/00 10:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #49	7/27/00 12:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #50	7/5/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #50	7/26/00 11:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #51	4/27/00 15:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	0.213	L0.05	L0.05	L0.005	L0.02
Wetland #51	5/24/00 11:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	0.323	L0.05	L0.05	L0.005	L0.02
Wetland #51	7/6/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	0.22	L0.05	L0.05	L0.005	L0.02
Wetland #51	7/12/00 12:00	L0.02	L0.005	0.06	L0.005	L0.03	L0.005	L0.005	0.547	L0.05	L0.05	L0.005	L0.02
Wetland #51	7/27/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	0.117	L0.05	L0.05	L0.005	L0.02
Wetland #51	8/17/00 11:05	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	0.18	L0.05	L0.05	L0.005	L0.02
Wetland #51	9/21/00 12:06	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	0.151	L0.05	L0.05	L0.005	L0.02
Wetland #51	10/31/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	0.04	L0.05	L0.05	L0.005	L0.02
Wetland #52	7/6/00 12:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #52	7/22/00 15:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #53	7/22/00 12:00	L0.02	L0.005	0.092	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #54	7/4/00 14:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #54	7/22/00 10:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #55	7/22/00 17:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #56	7/18/00 12:30	L0.02	0.472	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #57	7/27/00 11:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #59	7/17/00 10:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #60	7/4/00 12:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #60	7/17/00 13:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #61	7/4/00 13:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #61	7/17/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	5/23/00 12:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	6/19/00 10:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	7/19/00 14:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	7/26/00 17:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	8/29/00 14:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	10/3/00 10:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	11/1/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #63	6/19/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #63	7/26/00 18:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #64	6/19/00 12:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #64	7/26/00 19:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02

Station Name	Date/Time	100691 MCPB	100692 MCPP (Meco prop)	100693 Picloram (Tordon)	100694 Phorate (Thimet)	100695 Terbufo s	100696 Triallate (Avadex BW)	100697 Trifluralin (Treflan)	102088 Imazameth abenz-Methyl	102609 Desethyl Atrazine	102610 Deiso propyl Atrazine	102611 Quin clorac	102612 Imazetha pyr
B. PRECIPITATION SAMPLES													
ARC - Vegreville	5/3/00 0:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	5/15/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	5/26/00 0:00	L0.02	0.094	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	5/30/00 11:00	L0.02	0.039	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	6/9/00 9:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	6/12/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	6/19/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	6/21/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	7/4/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	0.05	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	7/7/00 13:00	L0.02	L0.005	L0.005	L0.005	L0.03	0.017	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	7/11/00 9:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	7/26/00 10:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	8/2/00 9:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	8/14/00 10:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	8/25/00 9:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	9/5/00 8:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
ARC - Vegreville	7/18/00 9:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
C. PLANKTON TISSUE SAMPLES													
Wetland #10	21-Jun-00 00:00	0	0	0	0	0	0	0	1.228	0	0		0
Wetland #10	18-Jul-00 00:00	0	0	0	0	0	0	0	0.735	0	0		0
Wetland #20	29-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #20	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #31	22-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #31	21-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #36	20-Jun-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #36	18-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #40	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #51	06-Jul-00 00:00	0	0	0	0	0	0	0	0.627	0	0		0
Wetland #51	27-Jul-00 00:00	0	0	0	0	0	0	0	0	0	0		0
Wetland #62		0	0	0	0	0	0	0	0	0	0		0
Wetland #62	19-Jul-00 00:00	0	0	0	0	0	0	0	0.182	0.165	0		0
D. SURFACE FILM SAMPLES													
Wetland #10	6/21/00 9:05	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #20	6/29/00 10:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #31	6/22/00 9:30	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #36	6/20/00 9:05	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #40	6/21/00 9:45	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #51	7/6/00 11:00	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02
Wetland #62	6/19/00 10:15	L0.02	L0.005	L0.005	L0.005	L0.03	L0.005	L0.005	L0.05	L0.05	L0.05	L0.005	L0.02

Notes: ARC = Alberta Research Council

Station Name	Date/Time	102613 Fenoxaprop-P-Ethyl	102614 Pyridaben	102618 Dimethoate (Cygon)	103141 Imazamox	103452 Glyphosate	103453 AMPA (Aminomethyl phosphonic)
A. WATER SAMPLES							
Wetland #1	7/11/00 8:30	L0.04	L0.02	L0.05	L0.02		
Wetland #2	6/20/00 15:30	L0.04	L0.02	L0.05	L0.02		
Wetland #2	7/10/00 10:00	L0.04	L0.02	L0.05	L0.02		
Wetland #3	7/10/00 12:45	L0.04	L0.02	L0.05	L0.02		
Wetland #4	7/11/00 7:30	L0.04	L0.02	L0.05	L0.02		
Wetland #5	7/11/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #6	7/11/00 12:30	L0.04	L0.02	L0.05	L0.02		
Wetland #7	7/11/00 13:15	L0.04	L0.02	L0.05	L0.02		
Wetland #8	6/20/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #8	7/12/00 9:10	L0.04	L0.02	L0.05	L0.02		
Wetland #9	6/20/00 13:00	L0.04	L0.02	L0.05	L0.02		
Wetland #9	7/12/00 8:15	L0.04	L0.02	L0.05	L0.02		
Wetland #10	4/26/00 12:45	L0.04	L0.02	L0.05	L0.02		
Wetland #10	5/26/00 12:00					0.338	0.41
Wetland #10	6/21/00 8:30	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #10	7/12/00 10:00	L0.04	L0.02	L0.05	L0.02		
Wetland #10	7/18/00 15:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #10	8/16/00 11:45	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #10	9/21/00 13:30	L0.04	L0.02	L0.05	L0.02	0.196	L1
Wetland #10	10/18/00 10:20	L0.04	L0.02	L0.05	L0.02		
Wetland #11	7/12/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #12	7/12/00 7:30	L0.04	L0.02	L0.05	L0.02		
Wetland #13	7/10/00 11:20	L0.04	L0.02	L0.05	L0.02		
Wetland #14	7/10/00 8:00	L0.04	L0.02	L0.05	L0.02		
Wetland #15	7/10/00 13:20	L0.04	L0.02	L0.05	L0.02		
Wetland #16	7/18/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #17	7/18/00 9:10	L0.04	L0.02	L0.05	L0.02		
Wetland #18	6/28/00 15:00	L0.04	L0.02	L0.05	L0.02		
Wetland #18	7/19/00 10:45	L0.04	L0.02	L0.05	L0.02		
Wetland #19	7/19/00 8:00	L0.04	L0.02	L0.05	L0.02		
Wetland #20	4/27/00 12:30	L0.04	L0.02	L0.05	L0.02		
Wetland #20	5/24/00 13:00	L0.04	L0.02	L0.05	L0.02	1.185	1.036
Wetland #20	6/29/00 10:30	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #20	7/20/00 10:30	L0.04	L0.02	L0.05	L0.02		
Wetland #20	7/27/00 9:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #20	8/17/00 13:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #20	9/21/00 11:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #20	10/18/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #22	7/20/00 13:15	L0.04	L0.02	L0.05	L0.02		
Wetland #23	6/28/00 13:00	L0.04	L0.02	L0.05	L0.02		

Station Name	Date/Time	102613 Fenoxaprop-P-Ethyl	102614 Pyridaben	102618 Dimethoate (Cygon)	103141 Imazamox	103452 Glyphosate	103453 AMPA (Aminomethylphosphonic)
Wetland #25	7/18/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #26	6/29/00 8:30	L0.04	L0.02	L0.05	L0.02		
Wetland #26	7/18/00 13:00	L0.04	L0.02	L0.05	L0.02		
Wetland #27	7/19/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #28	7/19/00 12:00	L0.04	L0.02	L0.05	L0.02		
Wetland #30	7/20/00 6:30	L0.04	L0.02	L0.05	L0.02		
Wetland #31	5/24/00 9:30	L0.04	L0.02	L0.05	L0.02	0.71	0.975
Wetland #31	6/22/00 9:15	L0.04	L0.02	L0.05	L0.02	0.086	L1
Wetland #31	7/19/00 13:00	L0.04	L0.02	L0.05	L0.02		
Wetland #31	7/21/00 12:30	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #31	8/17/00 9:15	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #31	9/29/00 11:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #32	7/4/00 16:10	L0.04	L0.02	L0.05	L0.02		
Wetland #32	7/19/00 15:00	L0.04	L0.02	L0.05	L0.02		
Wetland #33	7/19/00 17:00	L0.04	L0.02	L0.05	L0.02		
Wetland #34	7/19/00 16:30	L0.04	L0.02	L0.05	L0.02		
Wetland #35	7/18/00 8:45	L0.04	L0.02	L0.05	L0.02		
Wetland #35	7/19/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #36	4/26/00 9:10	L0.04	L0.02	L0.05	L0.02		
Wetland #36	5/26/00 10:00					0.483	0.431
Wetland #36	6/20/00 9:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #36	7/18/00 13:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #36	7/25/00 10:00	L0.04	L0.02	L0.05	L0.02		
Wetland #36	8/16/00 10:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #36	9/21/00 14:30	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #36	10/18/00 8:30	L0.04	L0.02	L0.05	L0.02		
Wetland #37	7/25/00 9:00	L0.04	L0.02	L0.05	L0.02		
Wetland #38	6/21/00 12:30	L0.04	L0.02	L0.05	L0.02		
Wetland #38	7/25/00 13:30	L0.04	L0.02	L0.05	L0.02		
Wetland #39	7/20/00 15:30	L0.04	L0.02	L0.05	L0.02		
Wetland #40	4/26/00 13:40	L0.04	L0.02	L0.05	L0.02		
Wetland #40	5/24/00 15:00	L0.04	L0.02	L0.05	L0.02	0.411	0.43
Wetland #40	6/21/00 9:45	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #40	7/25/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #40	7/27/00 11:40	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #40	8/16/00 13:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #40	9/21/00 12:30	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #40	10/18/00 12:00	L0.04	L0.02	L0.05	L0.02		
Wetland #41	6/21/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #41	7/20/00 17:00	L0.04	L0.02	L0.05	L0.02		
Wetland #42	6/28/00 11:30	L0.04	L0.02	L0.05	L0.02		
Wetland #42	7/18/00 10:00	L0.04	L0.02	L0.05	L0.02		
Wetland #43	7/18/00 11:00	L0.04	L0.02	L0.05	L0.02		

Station Name	Date/Time	102613 Fenoxaprop-P-Ethyl	102614 Pyridaben	102618 Dimethoate (Cygon)	103141 Imazamox	103452 Glyphosate	103453 AMPA (Aminomethyl phosphonic)
Wetland #44	7/20/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #46	7/5/00 12:00	L0.04	L0.02	L0.05	L0.02		
Wetland #46	7/26/00 14:10	L0.04	L0.02	L0.05	L0.02		
Wetland #47	7/5/00 13:00	L0.04	L0.02	L0.05	L0.02		
Wetland #47	7/26/00 13:30	L0.04	L0.02	L0.05	L0.02		
Wetland #48	7/27/00 10:30	L0.04	L0.02	L0.05	L0.02		
Wetland #49	7/27/00 12:30	L0.04	L0.02	L0.05	L0.02		
Wetland #50	7/5/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #50	7/26/00 11:15	L0.04	L0.02	L0.05	L0.02		
Wetland #51	4/27/00 15:30	L0.04	L0.02	L0.05	L0.02		
Wetland #51	5/24/00 11:30	L0.04	L0.02	L0.05	L0.02	0.429	0.552
Wetland #51	7/6/00 11:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #51	7/12/00 12:00	L0.04	L0.02	L0.05	L0.02		
Wetland #51	7/27/00 14:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #51	8/17/00 11:05	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #51	9/21/00 12:06	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #51	10/31/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #52	7/6/00 12:00	L0.04	L0.02	L0.05	L0.02		
Wetland #52	7/22/00 15:00	L0.04	L0.02	L0.05	L0.02		
Wetland #53	7/22/00 12:00	L0.04	L0.02	L0.05	L0.02		
Wetland #54	7/4/00 14:30	L0.04	L0.02	L0.05	L0.02		
Wetland #54	7/22/00 10:30	L0.04	L0.02	L0.05	L0.02		
Wetland #55	7/22/00 17:00	L0.04	L0.02	L0.05	L0.02		
Wetland #56	7/18/00 12:30	L0.04	L0.02	L0.05	L0.02		
Wetland #57	7/27/00 11:30	L0.04	L0.02	L0.05	L0.02		
Wetland #59	7/17/00 10:30	L0.04	L0.02	L0.05	L0.02		
Wetland #60	7/4/00 12:30	L0.04	L0.02	L0.05	L0.02		
Wetland #60	7/17/00 13:15	L0.04	L0.02	L0.05	L0.02		
Wetland #61	7/4/00 13:15	L0.04	L0.02	L0.05	L0.02		
Wetland #61	7/17/00 14:00	L0.04	L0.02	L0.05	L0.02		
Wetland #62	5/23/00 12:30	L0.04	L0.02	L0.05	L0.02	3.633	3.568
Wetland #62	6/19/00 10:15	L0.04	L0.02	L0.05	L0.02	0.136	L1
Wetland #62	7/19/00 14:30	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #62	7/26/00 17:00	L0.04	L0.02	L0.05	L0.02		
Wetland #62	8/29/00 14:00	L0.04	L0.02	L0.05	L0.02	0.804	L1
Wetland #62	10/3/00 10:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
Wetland #62	11/1/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #63	6/19/00 13:00	L0.04	L0.02	L0.05	L0.02		
Wetland #63	7/26/00 18:00	L0.04	L0.02	L0.05	L0.02		
Wetland #64	6/19/00 12:00	L0.04	L0.02	L0.05	L0.02		
Wetland #64	7/26/00 19:00	L0.04	L0.02	L0.05	L0.02		

Station Name	Date/Time	102613 Fenoxaprop-P-Ethyl	102614 Pyridaben	102618 Dimethoate (Cygon)	103141 Imazamox	103452 Glyphosate	103453 AMPA (Aminomethyl phosphonic)
B. PRECIPITATION SAMPLES							
ARC - Vegreville	5/3/00 0:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	5/15/00 11:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	5/26/00 0:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	5/30/00 11:00	L0.04	L0.02	L0.05	L0.02	0.069	L1
ARC - Vegreville	6/9/00 9:30	L0.04	L0.02	L0.05	L0.02	0.058	L1
ARC - Vegreville	6/12/00 11:00	L0.04	L0.02	L0.05	L0.02	0.204	L1
ARC - Vegreville	6/19/00 11:00	L0.04	L0.02	L0.05	L0.02	0.216	L1
ARC - Vegreville	6/21/00 11:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	7/4/00 11:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
ARC - Vegreville	7/7/00 13:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
ARC - Vegreville	7/11/00 9:00	L0.04	L0.02	L0.05	L0.02	L0.2	L1
ARC - Vegreville	7/26/00 10:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	8/2/00 9:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	8/14/00 10:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	8/25/00 9:00	L0.04	L0.02	L0.05	L0.02		
ARC - Vegreville	9/5/00 8:30	L0.04	L0.02	L0.05			
ARC - Vegreville	7/18/00 9:00	L0.04	L0.02	L0.05	L0.02		
C. PLANKTON TISSUE SAMPLES							
Wetland #10	21-Jun-00 00:00	0	0	0	0		
Wetland #10	18-Jul-00 00:00	0	0	0	0		
Wetland #20	29-Jun-00 00:00	0	0	0	0		
Wetland #20	27-Jul-00 00:00	0	0	0	0		
Wetland #31	22-Jun-00 00:00	0	0	0	0		
Wetland #31	21-Jul-00 00:00	0	0	0	0		
Wetland #36	20-Jun-00 00:00	0	0	0	0		
Wetland #36	18-Jul-00 00:00	0	0	0	0		
Wetland #40	27-Jul-00 00:00	0	0	0	0		
Wetland #51	06-Jul-00 00:00	0	0	0	0		
Wetland #51	27-Jul-00 00:00	0	0	0	0		
Wetland #62		0	0	0	0		
Wetland #62	19-Jul-00 00:00	0	0	0	0		
D. SURFACE FILM SAMPLES							
Wetland #10	6/21/00 9:05	L0.04	L0.02	L0.05	L0.02		
Wetland #20	6/29/00 10:30	L0.04	L0.02	L0.05	L0.02		
Wetland #31	6/22/00 9:30	L0.04	L0.02	L0.05	L0.02		
Wetland #36	6/20/00 9:05	L0.04	L0.02	L0.05	L0.02		
Wetland #40	6/21/00 9:45	L0.04	L0.02	L0.05	L0.02		
Wetland #51	7/6/00 11:00	L0.04	L0.02	L0.05	L0.02		
Wetland #62	6/19/00 10:15	L0.04	L0.02	L0.05	L0.02		

Notes: ARC = Alberta Research Council

Appendix 4 Quality assurance and quality control

A number of quality Assurance and Quality Control samples (QA/QC) were collected during the course of the program or as part of QA/QC of other sampling programs carried out in 2000. The results of the analysis of these samples can be used to evaluate the precision and accuracy of the wetlands pesticide data set. QA/QC samples comprised field blanks, split and spiked samples as well as a comparison of data from composite samples and discrete samples.

1.0 BLANK SAMPLES

Field blanks consisted of trace organic free distilled water obtained from the analytical laboratory. Sample bottles were filled in the field and were handled in a similar way as regular environmental samples, both in the field and in the laboratory. Samples were sent in "blind" to the analytical laboratory as part of routine sample batches. The detection of pesticide residues in field blanks could be indicative of contamination in the field or in the laboratory. It could also be an indicator of a "false positive" bias in the laboratory identification process (i.e., reporting a residue that is not present). Samples with high organic content could be prone to mis-identification due to interferences and thus generate false positives.

Nine field blanks were sent to the Pesticide and Trace Organics Laboratory, ARC, Vegreville from May to August 2000. These samples were analyzed for the suite of 40 pesticides listed in Table 2 of the main body of this report. One additional field blank was analyzed for glyphosate and AMPA.

Results showed residue levels below the detection limits for all samples and all compounds analyzed with the exception of one MCPP detection (0.014 µg/L, i.e., three times the detection limit) in a June sample. This detection was verified and certified by the analytical laboratory and it is determined to be due to field contamination.

MCPP was detected infrequently in this study and there is no evidence that contamination affected the wetlands or the atmospheric deposition data. Overall these results indicate that the likelihood of contamination in field or laboratory is low and the likelihood of false positives is also low.

2.0 SPLIT AND SPIKED SAMPLES

2.1 Spike Results

Split and spiked samples were used to test replicability of concentration measurements and recovery efficiency. Surface water samples were collected with a stainless steel bucket and the water was agitated vigorously before being poured into two pesticide sample bottles. One of these samples was sent to the Quality Control Laboratory, ARC, Vegreville for spiking. Analytical grade dicamba, ethalfluralin, MCPA, triallate, 2,4-D, atrazine and chlorpyrifos were used to spike samples. Expected spiked sample concentrations, assuming that the initial sample concentration was at the detection limit, are listed in Table A4-1. The spiked sample was returned to the Monitoring Branch field office where sample labels were changed to ensure that the sample could not been identified as a spiked sample by the laboratory. Both split samples were sent to ARC as part of routine sample batches. Samples were analyzed for the 40 compounds listed in Table 2 of the main body of this report. A split-spiked sample set was analyzed in April, July and August 2000. Pesticide detections are summarized in Table A4-1.

Percent recoveries ranged from 0% for two ethalfluralin spikes to 115 % for one dicamba spike. Recoveries may be low for some parameters, but not unexpected considering the high organic content of the water analyzed. Organic matter can greatly reduce the efficiency of the extraction procedure (by holding on to the pesticides) and can interfere with the identification of residues. Another factor may be involved in the inability to detect ethalfluralin spikes. Ethalfluralin has a low water solubility, but a high vapour pressure. If there was a head-space in the bottles it is quite possible that the compound gassed off and was released when the bottle was opened.

2.2 Split Results

Low levels of some herbicides, not used for spiking, were detected in some split samples, either in the unspiked split sample (i.e. dicamba and picloram in the July samples), the spiked sample (i.e., 2,4-D in the April sample) or both (picloram in April). Trace residues can be missed, especially when there is interference from organic matter. On the other hand, picloram was detected in the unspiked sample at almost 12 times the detection level, compared to the spiked sample where it was not detected. Picloram is a difficult compound to analyze even in relatively good quality water, and would have been even more difficult to analyze accurately in samples where the level of natural organic matter is high. The reported dicamba concentration was lower than the method detection limit, which indicates that the lab had positive identification, but at a very low level.

Overall, the split and spiked samples suggest that the wetlands pesticide data are conservative with a likelihood for reported concentrations being lower than actual and, in some instances for some very low concentrations not to be reported.

3.0 COMPARISON OF COMPOSITE AND DISCRETE SAMPLES

Five discrete samples were collected from wetlands 10, 36, 51 and 62 in conjunction with the water collected for the composite samples from these wetlands. The purpose was to compare analytical results from discrete samples taken from various locations in the wetlands with the composite samples. Two issues were of particular interest: the distribution of pesticides over the wetlands and the similarity of concentrations derived from discrete samples and composite samples.

Samples were analyzed for the screen of 40 compounds routinely analyzed in this study (see Table 2 in main body of report). Glyphosate or AMPA were not analyzed. The data sets yields a total of 240 cases in which comparisons can be made between results for composite and discrete samples (40 compounds times 6 sets of samples).

A total of six compounds were detected in these samples (i.e. 2,4-D, MCPA, lindane, clopyralid, picloram and imazamethabenz, Table A4-2), yielding 19 cases in which measurable levels of pesticides in the composite and the five discrete samples could be compared (i.e., at least one pesticide was detected in the composite and/or discrete samples).

In 12 of these cases a pesticide residue was detected in the composite and in all five replicate samples. In two cases a compound was found in the composite and four of the replicate samples (wetland 51, July: clopyralid, imazamethabenz); in the composite and three of the replicate sample (wetland 51, July: 2,4-D and MCPA); and in one case in the composite and only one of the replicate samples (wetland 10, June: lindane and wetland 36, July: 2,4-D). There was one case (wetland 36, July) where clopyralid was detected in one of the replicates, but not in the composite sample. These results suggest that in the majority of cases where pesticides were detected they appeared to be distributed over the entire wetland. In some cases, however, there is an indication of a more patchy distribution. In such cases composite samples had a somewhat better likelihood of detection than *individual* replicates.

A paired two-tailed t-test indicates that there was no significant difference ($p>0.05$) between residue levels in composite samples and the *average* concentrations for discrete samples for each of the six compounds.

The absence of pesticide detections in the 221 remaining cases of this data set is also informative. It provides further grounds to believe that false positives are rare in this data set.

Table A4-1 Residue levels in field collected split and spiked samples (concentrations in µg/L)

Variable	Calculated Spike Concentration	Spiked Split Sample Results	% Recovery	Unspiked Split Sample Results	Reproducibility (difference/ detection level)
April 27, 2000					
2,4-D	not spiked	0.016	-	L0.005	2.2 (0.011/0.005)
Dicamba	0.040	0.046	115	L0.02	-
Ethalfluralin	0.050	L0.005	0	L0.005	-
Picloram	not spiked	0.051	-	0.025	5.2 (0.026/0.005)
Triallate	0.020	0.009	45	L0.005	-
July 24, 2000					
Dicamba	not spiked	L0.02	-	0.007 (i.e.,L0.02)	n/a[(1)]
Ethalfluralin	0.020	L0.005	0	L0.005	-
MCPA	0.060	0.046	77	L0.005	-
Picloram	not spiked	L0.005	-	0.058	10.6 (0.053/0.005)
Triallate	0.040	0.016	40	L0.005	-
August 29, 2000					
Atrazine	0.040	0.022	55	L0.005	-
Chlorpyrifos	0.070	0.020	29	L0.005	-
2,4-D	0.060	0.038	63	L0.005	-

(1) Result is below MDL (estimate - not quantifiable), therefore calculations were not done

Table A4-2 Comparison of composite and discrete samples (concentrations in μg/L)

Sample Type	2,4-D	MCPA	Picloram	Clopyralid	Imazamethabenz-methyl	Lindane
WETLAND #10, June 2000						
Composite	0.005	0.075	L0.005	L0.02	L0.05	0.021
Discrete 1	0.008	0.042	L0.005	L0.02	L0.05	L0.005
Discrete 2	0.039	0.109	L0.005	L0.02	L0.05	L0.005
Discrete 3	0.033	0.102	L0.005	L0.02	L0.05	L0.005
Discrete 4	0.032	0.099	L0.005	L0.02	L0.05	L0.005
Discrete 5	0.013	0.076	L0.005	L0.02	L0.05	0.025
WETLAND #10, July 2000						
Composite	0.036	0.022	L0.005	L0.02	L0.05	L0.005
Discrete 1	0.038	0.018	L0.005	L0.02	L0.05	L0.005
Discrete 2	0.042	0.015	L0.005	L0.02	L0.05	L0.005
Discrete 3	0.024	0.022	L0.005	L0.02	L0.05	L0.005
Discrete 4	0.022	0.018	L0.005	L0.02	L0.05	L0.005
Discrete 5	0.024	0.016	L0.005	L0.02	L0.05	L0.005
WETLAND #36, July 2000						
Composite	0.022	L0.005	0.899	L0.02	L0.05	L0.005
Discrete 1	L0.005	L0.005	1.421	0.185	L0.05	L0.005
Discrete 2	0.035	L0.005	1.047	L0.02	L0.05	L0.005
Discrete 3	L0.005	L0.005	0.697	L0.02	L0.05	L0.005
Discrete 4	L0.005	L0.005	0.327	L0.02	L0.05	L0.005
Discrete 5	L0.005	L0.005	0.307	L0.02	L0.05	L0.005
WETLAND #51, July 6, 2000						
Composite	0.067	0.12	L0.005	0.517	0.22	L0.005
Discrete 1	0.043	0.056	L0.005	0.297	0.09	L0.005
Discrete 2	0.078	0.122	L0.005	0.36	0.12	L0.005
Discrete 3	0.08	0.138	L0.005	0.485	0.12	L0.005
Discrete 4	0.088	0.113	L0.005	0.446	0.1	L0.005
Discrete 5	0.072	0.133	L0.005	0.364	0.11	L0.005
WETLAND #51, July 27, 2000						
Composite	0.051	0.044	L0.005	0.185	0.117	L0.005
Discrete 1	0.041	0.025	L0.005	0.196	0.085	L0.005
Discrete 2	0.08	0.035	L0.005	0.215	0.185	L0.005
Discrete 3	L0.005	L0.005	L0.005	0.05	0.405	L0.005
Discrete 4	0.076	0.053	L0.005	0.241	0.252	L0.005
Discrete 5	L0.005	L0.005	L0.005	L0.02	L0.05	L0.005
WETLAND #62, June 2000						
Composite	0.472	0.036	L0.005	0.066	L0.05	L0.005
Discrete 1	0.487	0.035	L0.005	0.064	L0.05	L0.005
Discrete 2	0.508	0.042	L0.005	0.064	L0.05	L0.005
Discrete 3	0.554	0.046	L0.005	0.072	L0.05	L0.005
Discrete 4	0.535	0.04	L0.005	0.077	L0.05	L0.005
Discrete 5	0.413	0.033	L0.005	0.057	L0.05	L0.005