L. Bruer

PROCEEDINGS OF THE

ENTOMOLOGICAL SOCIETY OF MANITOBA

VOLUME 47 1991

Proceedings of the Entomological Society of Manitoba.

VOLUME 47

1991.

A.P. Wiens,

Editor

Winnipeg, Manitoba.

CONTENTS

SYMPOSIUM ABSTRACTS:
PEST MANAGEMENT: ARE THERE ANY ALTERNATIVES?

SUBMITTED PAPER ABSTRACTS:

RESEARCH PAPERS:

ADVERTISEMENTS

Minutes of the 47th Annual Business Meeting of the Entomological Society of Manitoba

13:30 h, 8 November 1991

Freshwater Institute
Winnipeg, Manitoba

The President, Dr. R. Westwood, presided. A quorum being present, the President called the meeting to order and asked the Secretary, C.J. Demianyk, to take minutes of the meeting.

ATTENDANCE

Executive:	R. Westwood, President	
	N.D.G. White, President-Elect	
	L. Manaigre, Member-at-Large	
	P. Fields, Regional Director to ESC	
	B. Lamb, Past President	
Executive Staff:	C.J. Demianyk, Secretary	
	L. Grenkow, Treasurer	
	A. Wiens, Editor - Proceedings	
	B. Galka, Editor - Newsletter	
Members:	R.E. Roughley	N. Holliday
	P.A. MacKay	R.M. Gadawski
	B. Turnock	S. Loschiavo
	R. Currie	R. Ellis
	F. Madrid	I. Wise
	B. Fingler	B. Hunter
	W.B. Preston	R. Brust
	D. Smith	D. Dixon
	A. Robbie-Draward	J. Guthrie

1. C. Demianyk recorded minutes of the meeting. At this time, the ESM Scholarship was presented to R. Brandt.

2. **Agenda** (Appendix A) **Motion:** N. Holliday/R. Gadawski. That the proposed agenda be adopted. CARRIED

3. **Minutes of the 46th Annual Meeting** **Motion:** D. Dixon/R. Lamb. That the minutes of the 46th Annual Business Meeting of the Entomological Society of Manitoba, held 3 November 1990 and published in Volume 46 of the Proceedings of the ESM, be accepted. CARRIED

4. **Business Arising from Previous Minutes**: None.

5. **Executive Reports**

   a. President (Appendix B).

   b. Treasurer (Appendix C - Financial Statements).

   c. Editor - Proceedings of the E.S.M. (Appendix D).

   d. Regional Director the Entomological Society of Canada (Appendix E).

      Re: joint meeting - our organization should attend the ESC National Meeting to observe organizational planning. **Motion**: P. MacKay/R. Gadawski. That the membership show support for D. Dixon as chair of the joint meetings. CARRIED

   e. Endowment Fund Board (Appendix F).

      R. Gadawski suggested a professionally managed fund may give a better return. The new ad-hoc committee will investigate this option.

   f. Ad Hoc Committee on long-term Financial Planning.

      N. White has struck the committee which will report to the Executive and the annual general meeting in 1992. Members included B. Fingler, J. Conroy, R. Gadawski and P. MacKay.

6. **Committee Reports**

   a. Finance Committee (Appendix G). **Motion:** White/Lamb. That the interest from GIC's from the endowment fund not be placed into savings account; leave decision to the Ad Hoc Committee. CARRIED

   b. Publicity, Newsletter (Appendix H).

c. Social (Appendix I)

d. Education and Youth Encouragement (Appendix J): P. Fields reported for C. Salki saying that a number of presentation were made to school and day cares.

e. ESC Common Names (Appendix K): R. Roughley will contact ESC regarding common names.

f. Archivist (Appendix L).

g. Manitoba Environmental Council (Appendix M).

h. Honourary Members (ESC): Discussion suggested that this committee could be deleted; further discussion will occur with the new executive.

i. Student awards (Appendix N).

j. E.S.C. Scholarship (Appendix O).

k. E.S.M. Scholarship (Appendix P).

l. Scientific Program Committee and annual meeting local arrangements. (Appendix Q).

m. E.S.C. and E.S.M. Membership (Appendix R).

n. Fund Raising (Appendix S): Total sales of shirts, caps and sweatshirts have been over $1000, only a few items remain with several partially filled backorders. **Motion:** R.Westwood/N. White. That the Executive provide this committee with funds to complete the back orders. CARRIED

Motion: J. Guthrie/R. Brust. That all committee reports be received. CARRIED

7. **1990-1991 Election Results 1991-1992 (Appendix T)**

Congratulations to R. Gadawski, president-elect, and R. Ellis, member-at-large.

Motion: R. Westwood/N. Holliday. That the ballots be destroyed. CARRIED

8. **Transfer of Office**: R. Westwood called upon N. White to assume the office of President.

9. **Other Business**

a. Gypsy Moth Infestation of Manitoba - requested survey.

F. Madrid made a presentation requesting ESM support for this survey. Debate arose to whether the society should sponsor or show support for individual projects, or for entomological research, in general. No concensus of opinion resulted. The Executive will formulate a policy to deal with these types of requests, and reply to this request in writing after additional discussion.

10. **Adjournment**. (15:37 h)

APPENDIX A

ENTOMOLOGICAL SOCIETY OF MANITOBA
47TH ANNUAL BUSINESS MEETING

November 8, 1991

AGENDA

1. Appointment of Secretary to record proceedings of the Annual Business Meeting.

2. Acceptance of Agenda.

3. Minutes of last Annual Meeting (Nov. 2, 1990).

4. Business arising from the minutes.

5. Reports - Executive, Trustees.

a.	President	R. Westwood
b.	Treasurer (Auditor)	L. Grenkow
c.	Editor of the Proceedings	A. Wiens
d.	Regional Director to ESC	P. Fields
e.	Endowment Fund Board	B. Fingler
f.	Ad hoc Committee on Long Term Financial Planning	N. White

6. Reports - Committees.

a.	Finance Committee	B. Fingler
b.	Publicity, Newsletter	B. Galka
c.	Social	P. MacKay
d.	Education and Youth Encouragement	C. O'Neil
e.	ESC Common Names	R. Roughley
f.	Archivist	R. Roughley
g.	Manitoba Environment Council	I. Wise
h.	Honourary Members (ESC)	W. Turnock
i.	Student Awards (ESM)	B. Galloway
j.	ESC Scholarship	J. Conroy
k.	ESM Scholarship	J. Conroy
l.	Scientific Program and Annual Meeting local arrangements	R. Gadawski
m.	ESC Membership	R. Westwood
n.	ESM Membership	R. Westwood
o.	Fund Raising	R. Westwood

7. 1991-1992 Election Results.

Scrutineer Committee C. Demianyk

8. Transfer of Office

9. Other Business

"Gypsy Moth Infestation of Manitoba" - requested survey - F. Madrid.

10. Adjournment

PRESIDENT'S REPORT APPENDIX B

The past year has been an active one for the Entomological Society of Manitoba. This year many members have contributed to the ongoing activities of the society, with several "new faces" playing key roles in 1991. While most of our activities are described in the proceedings, there are a number of activities that require special mention.

A strong financial base is critical to the well being of any society and through the guidance and work of our Finance committee, Endowment fund board and our new Treasurer, Larry Grenkow, the Entomological Society of Manitoba remains on sound financial footing. During the past year the executive has debated the future direction of the society in terms of financial policy. It is clearly evident that over the years the society has benefited from good fiscal management which continued in 1991. While the society should be commended for developing an excellent endowment fund, in my opinion, it will be essential that in the future funds can be redirected to stimulate new activities.

Both Lynn Manaigre and Don Dixon deserve special thanks for their extra effort and hard work with the fund raising committee. The production of T-shirts, sweatshirts and caps is another excellent example of our membership enhancing both our image and finances. As stated earlier, the active involvement of "new faces" in society is greatly appreciated. During 1991 there was turnover in several of our key positions. Our new Secretary, Colin Demianyk, and our new Treasurer, Larry Grenkow, deserve special thanks for their efforts. The president and executive must rely heavily on our various committees and on behalf of the society I would like to thank them for their time and energy to make our society and it's activities enjoyable and interesting. During 1991 the committee chairs included Barry Fingler, Finance Committee; Brian Galka, Newsletter; Par MacKay, Social; Cathy O'Neil, Youth Encouragement; Rob Roughly, ESC Common Names and Archivist; Ian Wise, Manitoba Environment Council; Bill Turnock, Honourary Members (ESC); Bill Galloway, Student Awards (ESM); John Conroy, ESC and ESM Scholarship; and Randy Gadawski, Scientific Program and Annual Meeting local arrangements. Al Wiens was once again editor of the Proceedings and Paul Fields, Regional Director to ESC.

Pat MacKay arranged several excellent luncheons and a well attended new members social during 1991, each providing an interesting guest speaker. The editors of the newsletter produced four newsworthy issues and their efforts are greatly appreciated. The culmination of our year's activities is the annual general meeting, chaired by Randy Gadawski. This year the meeting committee has gone "all out", inviting a number of out of province speakers and having 14 submitted papers. The theme for this years meeting is "Pest Management - Are there any Alternatives", with the guest speaker being Dr. G.A. Surgeoner, University of Guelph.

In conclusion, I have enjoyed my term as president and thank both the executive and membership for your help and time in making 1991 a successful one for the society. I look forward to working with the incoming president, Noel White, and the new executive.

Richard Westwood, President 1990-91

APPENDIX C

AUDITOR'S REPORT

To the Directors of the
Entomological Society of Manitoba Inc.

I have examined the balance sheet of the Entomological Society of Manitoba Inc. as of August 31, 1991 and the statement of income for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I consider necessary in the circumstances.

In common with may non-profit organizations, the organization derives some cash revenue, the completeness of which is not susceptible to conclusive audit verification. Accordingly, I am unable to determine whether any adjustments for unrecorded receipts from these sources might be necessary to income or surplus balances.

In my opinion these financial statements present fairly the financial position of the company as at August 31, 1991 and the results of its operations and the changes in its financial position for the year ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Winnipeg, Canada
October 10, 1991

Original signed by Doug Nicholson
Certified General Accountant

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
BALANCE SHEET
AUGUST 31, 1991

ASSETS

	1991	1990
Cash advances (note 2)	$350	$550
Cash in bank (note 3)	4,791	6,441
Investments (note 4)	29,000	27,006
	$34,141	$33,797

LIABILITIES

Liabilities	nil	nil

SURPLUS

Surplus	$34,141	$33,797

APPROVED BY THE BOARD

_____Director

_____Director

The accompanying notes form an integral part of these financial statements.

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
STATEMENT OF INCOME AND EXPENSES
YEAR ENDED AUGUST 31, 1991

	1991	1990
REVENUE (note 1)		
Annual meetings	$1,371	$1,513
Donations	450	200
Fund raising committee	800	60
Heritage	---	300
Interest income	3,068	2,976
Members fees	1,524	1,609
Social committee	---	225
Subscriptions	591	514
Student awards	---	100
Youth encouragement and public education	$ 400	3
	8,204	7,500
EXPENSES (note 1)		
Awards and scholarships	1,202	1,208
Fundraising committee	1,750	--
General	769	769
Heritage	--	2,959
Meetings	2,035	3,195
Newsletter	862	112
Other committees	--	33
Proceedings	962	860
Social committee	280	433
	7,860	9,569
EXCESS (DEFICIT) OF INCOME OVER EXPENSES	$ 344	$(2,069)
Surplus, beginning of the year	33,797	35,866
SURPLUS, END OF THE YEAR	$34,141	$33,797

The accompanying notes form an integral part of these financial statements

ENTOMOLOGICAL SOCIETY OF MANITOBA INC.
NOTES TO THE FINANCIAL STATEMENTS
AUGUST 31, 1991

1. SIGNIFICANT ACCOUNTING POLICIES

Income and expenses are recorded on the cash basis of accounting. There are no accruals of receivables or payables at the year end. Fixed assets are written off when acquired and therefore, there are no annual depreciation allowances.

2. STANDING ADVANCES

Treasurer	L. Grenkow	$ 25.00
Secretary	C. Demianyk	100.00
Editor	A. Wiens	25.00
Newsletter	B. Galka	200.00
		$ 350.00

3. CASH IN BANK

Savings account	$ 3,384.00
Current account	1,407.00
	$ 4,791.00

4. INVESTMENT CERTIFICATES

7053937	$ 2,000.00
7053959	2,000.00
7053706	3,024.33
8421072	1,775.67
7058513	2,000.00
7058436	3,000.00
7053805	2,000.00
12007930	2,000.00
7053871	7,200.00
70538930	2,006.48
14577420	1,993.52
	$29,000.00

APPENDIX D

REPORT OF THE PROCEEDINGS EDITOR - 1991

The editor's work has become somewhat easier over the last two years with the provision of the Annual Meeting and Committee Reports on disk by the Secretary. This has enabled me to format Volumes 45 and 46 in publication style with a minimum amount of editing. The same easing of effort has occurred in publication of research papers in the Proceedings. I'm pleased to say that the scientific content has risen with the inclusion of two papers in the last two years, and I believe this has slowed the rate of subscription loss. Referees are currently reviewing another paper for inclusion in Volume 47, and I anticipate that our scientific profile will again be enhanced.

Allen P. Wiens, Editor
October 31, 1991

APPENDIX E

REPORT OF THE REGIONAL DIRECTOR TO E.S.C.

The Annual Meeting of the Governing Board of the Entomological Society of Canada was held in Montreal on 19 and 23 Sept. 1991. I will not delve into all the details of the board meeting as the minutes will be published in the next Bulletin of the Entomological Society of Canada.

The items of most interest to our members are:

1. The ESM received $400 for public awareness. This sum is usually only $200 a year, however due to a lost letter, we did not receive the money we asked for in the previous year. Oddly enough only a few regional societies ask for these funds. The Entomological Society of British Columbia asked for and received a total of $500. They matched this with $500 of their own funds to support projects in schools and nature centres. They advertised the availability of the funds, the nature of the projects they would support and received many more applications than they could fund.

2. The board graciously accepted our offer to host the Annual ESC Meeting in 1994. Dr. Don Dixon has accepted the position as chair. The 1992 ESC Meetings will be held in Saskatoon from Sept. 27-30 with sustainable agriculture as its theme.

3. Again the costs and advantages of being a member of the Canadian Federation of Biological Societies was discussed. Originally CFBS wanted to double their fees as of January 1992, however they have decided to make this increase over more than one year. The increase in fees for members of the ESC will be paid by the Society, however these fees are to be paid directly by the members as of 1993. There is concern that an increase in the fees will mean a decrease in the membership. The advantages of the ESC being in the CFBS is that there has been a noticeable shift in the focus of the CFBS from the laboratory to the field. One example of this is their involvement in the long term study of different ecological zones across Canada.

4. The book project "Diseases and Insects Pests of Vegetable Crops in Canada" caused some concern as it will not be published until 1992, and the committee responsible did not give a firm budget.

Sincerely yours,

Paul Fields
Regional Director

APPENDIX F

ANNUAL REPORT OF THE ENDOWMENT FUND BOARD

The Endowment Fund continues to be a major source of revenue for the Society. It provides a basis for funding the Student Scholarship ($1,000.00), the publication of the Proceedings ($700.00) and the promotion of publication of scientific papers in the Proceedings ($400.00). Also, the Fund contributes approximately $500.00 toward the costs associated with the Annual General Meeting of the Society. Therefore, the Endowment Fund is committed to about $2,600.00 annually.

In the 1990-91 fiscal year, $3,068.00 of investment income was generated from a principal amount of $29,000.00. A similar amount of revenue will be generated through the Fund in the 1991-92 fiscal year.

The upper limit on Endowment Fund investments was increased from $30,000.00 to $35,000.00 at the 46th Annual General Meeting (1990). It is anticipated that unless the Society commits additional funding to new and/or current programs and events, approximately $2,000.00 will be added to the Fund in 1991-92.

A description of the current Endowment Fund investments is provided below.

Guaranteed Investment Certificates with Royal Trust

Cert. No.	Amount ($)	Interest Rate (%)	Maturity Date	Annual Int. ($)
7053937*	2,000.00	10.500	Oct. 2, 1991	210.00
7053959	2,000.00	9.250	Feb. 19, 1992	185.00
7053706	3,024.33	10.750	Dec. 15, 1992	325.12
8421072	1,775.67	10.750	Jan. 26, 1993	190.88
7058513	2,000.00	10.500	June 9, 1993	210.00
7058436	3,000.00	10.750	Dec. 13, 1993	322.50
7053805	2,000.00	11.250	Apr. 5, 1994	225.00
12007930	2,000.00	10.750	Oct. 11, 1994	215.00
7053871	7,200.00	10.750	Nov. 14, 1994	774.00
7053893	2,006.48	11.500	Aug. 28, 1995	230.75
14577420	1,993.52	10.750	Dec. 19, 1995	214.30**
TOTAL	29.000.00	10.695		2,888.25

Note:

* reinstated at 9.75%, maturity date October 2, 1996.
** not included in total annual interest.

October 21, 1991
Randy Gadawski
Larry Grenkow
Barry Fingler, Chairperson

APPENDIX G

ANNUAL REPORT OF THE FINANCE COMMITTEE

The Finance Committee met on October 18 to review the Society's financial situation. It was determined that in 1990-91, revenues exceeded expenses by $344.00.

In 1990-91, approximately $2,000.00 was taken from the Society's savings account and invested into the Endowment Fund, thereby increasing the principal amount of the Fund to $29,000.00. Also of note was the revenue generated by the Fund Raising Committee ($1,250.00) through the solicitation of corporate sponsorship and the sale of T-shirts.

The Finance Committee had the responsibility of reviewing each of the Committee budgets and prepared an overall budget for the Society. An accounting of the revenue and expenses for 1990-91 and projections for the next two fiscal years is attached.

ENTOMOLOGICAL SOCIETY OF MANITOBA

BUDGET ITEMS	1990-91 ACTUAL	1991-92 ACTUAL & PROJECTED	1992-93 PROJECTED
Endowment Fund	$29,000.00	$31,000.00	$33,000.00
REVENUE			
Membership Dues	1,524.00	1,525.00	1,525.00
Proceedings	591.00	1,052.00[2]	400.00
Social Committee	239.00	250.00	250.00
Youth/Education Committee	400.00	200.00	200.00
Fund Raising Committee	1,250.00	1,200.00	1,000.00
Student Awards and Scholarships	0.00	200.00[3]	100.00
Meetings	1,371.00	1,544.00	1,550.00
Investment Income	3,068.00	3,250.00	3,450.00
Other Committees:	0.00	0.00	0.00
TOTALS	$ 8,443.00	$ 9,221.00	$ 8,475.00
EXPENSES			
General Society Expenses	$ 769.00	$ 800.00	$ 850.00
Proceedings	962.00	1,440.00[2]	700.00
Newsletter	862.00	500.00	550.00
Social Committee	519.00	716.00	750.00
Youth/Education Committee	0.00	600.00	300.00
Fund Raising Committee	1,750.00	0.00	500.00
Student Awards and Scholarship	1,202.00	1,300.00	1,300.00
Meetings	2,035.00[1]	2,955.00	3,000.00
Other Committees:	0.00	0.00	0.00
TOTALS	$ 8,099.00	$ 8,311.00	$ 7,950.00
Net Gain (Loss) for Year Ending August 31st	$ 344.00	$ 910.00	$ 525.00

1. item does not include $500.00 advanced in 1989-90 toward 46th AGM.
2. includes revenue and expenses for printing 2 Proceedings: Vols. 46 (1990) and 47 (1991).
3. includes funds for SWAT STUDENT AWARD not requested in 1990-92.

October 21, 1991
Robert Currie
Randy Gadawski
Larry Grenkow
Allen Wiens
Barry Fingler, Chairperson

APPENDIX H

ANNUAL REPORT OF THE NEWSLETTER AND PUBLICITY COMMITTEE - 1991

The ESM Newsletter was again this year a quarterly publication. Volume 18, Numbers 1-4 were dispatched in January, April, August, and October.

Inclusion of the 1990 Proceedings, enclosures concerning the 1991 ESM Annual Meeting, the ESM Membership List, and enclosures from the Social Committee were mailed with issues of the Newsletter. This resulted in reduced envelope and postage costs to the Society.

My thanks to Gene Fortney and Valerie Converse for their help in gathering information and packaging of the Newsletter, and to others who made contributions in the form of submissions and/or production.

B. Galka, Chairperson
Newsletter and Publicity Committee
24 October 1991

APPENDIX I

ANNUAL REPORT OF THE SOCIAL COMMITTEE

The Entomological Society of Manitoba met at Aalto's in the Norlander Inn for two luncheons. On February 7, 1991, 41 members gathered to hear Bob Lamb speak on the topic of "Whale Footprints in the Sea of Cortez". On April 25, 1991, 44 members met to hear Don Dixon speak on "Sri Lanka: the Bee Paradise".

The New Members Social was held in the Tartan Room, U of M, on the evening of March 23, 1991. A total of 52 attended, including 3 new members, Yves Alarie, Larry Grenkow and Doug Wilcox. Alex Zellermeyer of the Canadian Parks Service spoke to the gathering on the topic of "National Parks from the High Arctic to the Grasslands".

In conjunction with the Scientific Program Committee for the Annual Meeting, the Social Committee arranged for the Meet the Speakers Mixer on November 7, 1991, held at the home of Bob Lamb and Pat MacKay and attended by 45 people. The ESM Annual Dinner was held at the Downtown Mandarin: a Touch of Thai. Classical guitarist Dana Starkell entertained 58 people at the event.

P.A. MacKay
Chair, Social Committee
November 8, 1991

APPENDIX J

YOUTH ENCOURAGEMENT AND PUBLIC EDUCATION COMMITTEE (YEPEC) 1991 ANNUAL REPORT

Let me first say how happy I am for the opportunity to be involved once again with YEPEC. I remember several of this Committee's tender years, when a number of very dedicated people (Robin Graham, Terry Galloway, Bill Preston, Jim Madder, Kathy McGuiness, to name but a few) creatively encouraged its growth and development.

We are happy to have Dr. Paul Fields, Ms. Barb Deneka, and Ms. Lynn Manaigre associated with the Committee. We are looking forward to 'creative encouragement' in 1992.

During 1991, Paul Fields travelled to Lorette and Steinbach to give interactive presentations (involving unique costuming) "en français" to primary grade students. I gave presentations to and talked with 13 hearing-disabled children at Sign-Talk Pre-School and 15 ESL student at a Wpg. public school. Several day cares (Gr. levels 1-6) requested our presentations in August.

For the second year, the City of Winnipeg's Environmental Awareness Program requested that YEPEC host a half-day program called "Insect Private Eyes". Barb Deneka and I were kept busy for 2 half-days, with a total of 90 children (ages 5 to 12) being bussed by the City to the Department of Entomology. In addition to a stimulating slide presentation, the children were given observational and hands-on investigative opportunities to learn about insects in the Department's teaching lab.

YEPEC is currently developing an activity booklet (K-4) for distribution after each school presentation. The Committee also will be planning for a "renewal" meeting with members of its Young Entomologists.

It is my hope that in 1992 YEPEC will continue to develop strong educational priorities and provide all participants with fun-filled stimulating learning experiences. Of course, in order to achieve our goals, we need ESM members to come forward with their ideas and energy? Here's bugging you...

Catherine Salki
Chairperson

APPENDIX K

REPORT OF THE COMMON NAMES COMMITTEE

There have been no applications from E.S.M. members during the past year for new common names, nor changes in old common names, and therefore no local activities to report.

R.E. Roughley, Chairperson

APPENDIX L

REPORT OF THE ARCHIVIST

The Archives materials of the Entomological Society of Manitoba are held in Room 213B of the Department of Entomology, University of Manitoba. Within the next few months this material will be transferred to Room 213. Two copies of the E.S.M. Newsletter are received at each publication, and these are added to the Archives. Any donations of any other material for the Archives would be welcome.

R.E. Roughley, Chairperson

APPENDIX M

REPRESENTATIVE TO THE MANITOBA ENVIRONMENTAL COUNCIL ANNUAL REPORT 1991 FISCAL YEAR

The Manitoba Environmental Council was subject to major changes in its funding this year. The Provincial budget in April eliminated the 2 person years allocated the Council by the province, and cut its overall support funding by one-third. A part time secretary was hired to assist the Council executive with the office functions that were previously handled by the Department of the Environment. The Council has set up its own bank account, and will be allowed to accept funding from other government and non-government sources. A new executive was appointed headed by Chairperson Dr. Alan Lansdown, University of Manitoba. Council membership has been reduced to 50 appointed members following the reappointment of several members, including myself.

The Council corresponded with the Minister of Environment on a number of important environmental concerns the past year. These included the need for environmental assessments for the Conawapa Dam and Bipole III transmission line, a broadening of the process for developing a sustainable development strategy for Manitoba, the opposing of the license to allow construction of an office complex by Ducks Unlimited Canada at Oak Hammock Marsh, and providing input on the Shoal Lake Sensitive Area Regulation, Plan Winnipeg, and amendments to the City of Winnipeg Act and the Wildlife Act.

The major environmental issue being addressed by the Environmental Chemicals Committee, which contains 2 members of the ESM, is the pesticide container recycling program operated by the Association for a Clean Rural Environment (ACRE). At issue are concerns with the ability of the program to meet its overall objective of safely recycling pesticide containers within the province. This issue has received considerable media attention recently after the export of shredded plastic containers to the United States.

Any ESM member who would like further information on these matters or who wishes to submit environmental concerns to the Council can contact me at the following address.

Ian L. Wise
Agriculture Canada
195 Dafoe Road
Winnipeg, Manitoba
Phone: 983-1450

APPENDIX N

REPORT OF THE E.S.M. STUDENT AWARD COMMITTEE

The Committee reviewed the nominations received for the Student Achievement Award and the SWAT Student Award. Mr. S. Burgin was selected to be the recipient of the Student Achievement Award. Mr. A. MacKay has been selected to receive the SWAT Student Award. This award will be presented at the Banquet following the Annual Meeting.

W.J. Gallaway (Chairperson)
J. Conroy, B. Fingler, W. Preston

APPENDIX O

ENTOMOLOGICAL SOCIETY OF CANADA SCHOLARSHIP COMMITTEE REPORT

The Entomological Society of Canada Scholarship Committee met and discussed **seventeen** applications for the **ESC Postgraduate Awards.**

The ESC Scholarship Committee recommended that the ESC Postgraduate Awards be made to Ms. **Heather Anne Higo** and Mr. **Eric Lucas.**

Ms. Higo is from Simon Fraser University and is supervised by Dr. Mark Winston. Her research topic will be on honey bees, more specifically on worker response to queen mandibular gland pheromone with respect to foraging and recruitment behaviour.

Mr. Lucas is from the University of Quebec at Montreal. His supervisor is Dr. Daniel Coderre. His research topic will involve an assessment of the impact of two species of coccinellids as predators of Colorado potato beetle eggs and their larvae as predators of aphid nymphs and adults.

John C. Conroy
ESM Representative
ESC Scholarship Committee

APPENDIX P

ENTOMOLOGICAL SOCIETY OF MANITOBA SCHOLARSHIP COMMITTEE REPORT TO THE ANNUAL MEETING, NOVEMBER 8, 1991

The Entomological Society of Manitoba Scholarship Committee met and discussed **two** applications for the **ESM Postgraduate Awards.**

The ESM Scholarship Committee unanimously recommends that the ESM Postgraduate Award be made to Mr. **Randall Brandt**, Department of Entomology, University of Manitoba.

Mr. Brandt is currently working on his M.Sc. degree under the supervision of Dr. R.J. Lamb, Agriculture Canada Research Station. His thesis looks at the susceptibility of four crucifer species to damage by the flea beetle (*Phyllotreta cruciferae*).

The Committee members were Dr. Bill Gallaway, Department of Zoology, Brandon University, and Professor Marianne Hardy, Department of Biology, University of Winnipeg.

John C. Conroy
Chairman, ESM Scholarship Committee

APPENDIX Q

SCIENTIFIC PROGRAM COMMITTEE

The 47th Annual Meeting of the Entomological Society of Manitoba was held at the Freshwater Institute, 501 University Crescent, Winnipeg on November 7-8, 1991. The keynote speaker was Dr. Gordon Surgeoner, Professor, Department of Environmental Biology, University of Guelph, Guelph, Ontario, who presented a paper entitled "Pest management: are there any alternatives?" A symposium, with the same general theme and moderated by Dr. Bill Turnock, included speakers: JoAnne Buth, Manitoba Agriculture, Carman; Bob Lamb, Agriculture Canada, Winnipeg; Sandy Smith, University of Toronto, Toronto; Ernest Dankwa, Abbott Laboratories, Chicago; and Mike Weiss, North Dakota State University, Fargo.

In the submitted paper session, chaired by Dr. Noel White, fourteen papers were presented, of which six were given by graduate students who participated in the Student Paper Competition. The $100 price was awarded to Steve Pernal, a student of Professor Neil Holliday of the University of Manitoba. Sixty-nine individuals were registered for the Annual Meeting, of whom 20 were students.

An "Evening Mixer" was held at the home of Drs. Pat McKay and Bob Lamb on November 7, and November 8 a banquet was held at the Downtown Mandarin. Musical entertainment was provided by Mr. Dana Starkell.

The Scientific Program Committee sincerely thanks those members who helped in the function and organization of the meeting and especially Autumn Robbie-Draward, Linda Glowacki and Lynn Manaigre.

R.M. Gadawski (Chairperson)
R.A. Ellis
P.A. MacKay
A.R. Westwood
N.D.G. White
A.P. Wiens

APPENDIX R

ESM AND ESC MEMBERSHIP COMMITTEE

The membership of the Entomological Society in 1990 was 135 members. During 1991, ten new members were welcomed at the new members social, with an eleventh new member joining in fall of the 1991. The membership within the society fluctuates from year to year, but has remained relatively stable during the last several years. No efforts were undertaken concerning the ESC Membership committee in 1991.

Richard Westwood

APPENDIX S

FUND RAISING COMMITTEE

The fund raising committee, consisting of Lynn Manaigre, Don Dixon and myself had a fairly ambitious year. The primary effort was to raise funds through the society by sales of T-shirts, sweatshirts and baseball caps. Lynn organized the artwork and contacted potential producers, also looking after the pricing and financing of the project. Once prices were set and a source was confirmed the committee arranged for advertising by contacting the ESC and all sister provincial or regional societies in Canada. Letters and advertisements were sent across the country. Don Dixon arranged for the filing and mailing out of all orders as well keeping the inventory. To date sales have been brisk with many sizes of various items now sold out. At the date of printing the final amount of sales were not yet available as all stock was not sold. Preliminary tallies indicate the project has been very successful. Many thanks to Lynn and Don for their time and efforts.

As has been done over the last 7 years funds have also been raised through solicitation of private industry to support our annual meeting. In 1991 16 companies were contacted and asked to help sponsor our meeting. To date (October 28, 1991) 10 companies have donated $50.00 each toward our meeting.

Don Dixon
Lynn Manaigre
Richard Westwood, Chair

APPENDIX T

REPORT OF THE SCRUTINEER COMMITTEE ESM 1991-92 ELECTION

Because the chairperson of the scrutineer committee was one of the candidates for this years election, C. Demianyk was asked to fulfil this role at the third executive meeting.

- Total number of ballots issued 134
- Number of ballots returned
  (deadline 31 September 1991) 86
- Number of spoiled ballots 0

Successful candidate president elect: **R. Gadawski.**
Successful candidate member-at-large: **R. Ellis.**

I declare that the ballots received by the deadline were accurately counted and re-checked, and that the above results are correct.

C.J. Demianyk
Secretary ESM
22 October 1991

L. Grenkow
Treasurer ESM

ABSTRACTS OF PAPERS PRESENTED TO THE ANNUAL MEETING, 1991

GUEST SPEAKER

PEST MANAGEMENT: ARE THERE ANY ALTERNATIVES? G.A. Surgeoner, Department of Environmental Biology, University of Guelph, Guelph, ON. N1G 2W1.

The Province of Ontario has initiated a major 15-year program entitled "Food Systems 2002: An Ecological Systems Approach to Sustainable Production". One of the major objectives is to reduce pesticide use by 50% in the province by the Year 2002. The program funded in five-year increments involves: (1) education of producers, (2) an infrastructure of pest management personnel, and (3) major research initiatives. Basically, it is a master game plan for pest management over the next 15 years. The agricultural community has been highly supportive including mandatory licensing to allow farmers to purchase pesticides. There are many underlying forces compelling producers to reduce pesticides and embrace the concepts of pest management which includes judicious use of pesticides. The environmental and health concerns are one component but there are compelling economic and changing demographic reasons to do so as well. Ontario is committed to pest management; there is a long-term program in place and I will discuss the reasons behind the program, the mechanisms of the program and how we have progressed in the last four years.

SYMPOSIUM

Pest Management: are there any alternatives?

BIOLOGICAL CONTROL OF WEEDS IN MANITOBA - A SUCCESS STORY. J. Buth, Manitoba Agriculture, Box 667, Carmen, MB, R0G 0J0.

Leafy spurge is a serious perennial weed which infests over 47,000 ha of pasture and native grassland in Manitoba. It causes losses of over $500,000 annually. In 1983 a root feeding flea beetle, *Aphthona nigriscutis*, from Hungary was released on leafy spurge in the Spruce Woods area. The beetles overwintered successfully and by 1986 the number of flowering stems and the dry weight of the spurge around the release site was reduced. Beetles have been harvested from this site and released at over 250 additional sites in Manitoba. Studies of other *Aphthona* spp. and other insects is continuing.

CROP RESISTANCE: A STRATEGY FOR CONTROLLING FLEA BEETLES IN CANOLA. R.J. Lamb, Canada Agriculture, 195 Dafoe Road, Winnipeg, MB. R3T 2M9.

In the presentation I will describe the process of selecting and identifying canola genotypes that are resistant to flea beetles, and discuss what forms that resistance takes. At present we know that the resistant plants are antixenotic and also tolerant to damage; they may also be antibiotic. I will finish the presentation with a discussion of what research is required

to exploit crop resistance as a control strategy, and what barriers there are to developing crop resistance for insect control.

RELEASING PARASITOIDS FOR BIOLOGICAL CONTROL OF FOREST INSECT PESTS. S.M. Smith, Faculty of Forestry, University of Toronto, Toronto, ON, M5S 3B3

The manipulation of insect parasitoids for the control of forest insect pests has been conducted in Canada since the 1940's. In most cases, this has meant the release of exotic parasitoids against specific pests, either introduced or native, with the hope of establishing new parasitoid/host associations. In forestry over the past 10 years, interest in using native parasitoids for biological control of native pests has increased because of the public's desire to preserve a natural forest state. This has meant finding ways to improve the impact of native parasitoids of forest insect pests, one of which is inundative release.

Field trials during the 1980's in Ontario using releases of the egg parasitoid, *Trichogramma minutum*, against the spruce budworm suggest that inundative release could prove to be a useful tool for biological control in forestry. This approach entails collecting native parasitoids from their natural hosts and environment, bringing them to the laboratory or a commercial rearing facility to augment their numbers, and then returning them to the field at the appropriate time for pest suppression. With a sound information base it can provide a feasible alternative to conventional insecticides in environmentally sensitive areas. The present paper will discuss those factors which must be considered when developing a strategy for inundative release under forest conditions and some of the challenges facing the commercialization and implementation of this approach.

INDUSTRY COLLABORATION WITH W.H.O. AND THE USE OF B.t.i. IN THE CONTROL OF ONCHOCERCIASIS IN WEST AFRICA. E. Dankwa, Product Manager, Abbott Laboratories, 1401 Sheridan Road, North Chicago, IL, 60064

The control of onchocerciasis (river blindness), through suppression of its main vector, *Simulium damnosum* depends on highly effective insecticide treatments against the larvae.

As these treatments must be applied weekly over wide areas for many years, ideal conditions for the development of resistance have been created. Resistance to organophosphates has occurred.

Screening for alternate compounds led to the selection of the microbial (*Bacillus thuringiensis* H14), or B.t.i. as a major larvicide for the program.

Abbott Laboratories, a major producer and supplier of B.t. H14 (VectoBac brand) has been collaborating with W.H.O. in the research, development and production of B.t. H14 formulations. The objective of these efforts is to develop higher potency formulations with longer stream carry characteristics to help reduce application and logistics since B.t. H14 has become an important component of the management of the resistance problem.

The presentation is a short review of the Onchocerciasis Control Program (OCP) and the collaboration with Abbott Laboratories relative to B.t. H14 supply to meet OCP's objectives.

MULTIPLE CROPPING: AN INSECT MANAGEMENT TOOL FOR THE NORTHERN GREAT PLAINS? M.J. Weiss, Department of Entomology, North Dakota State University, Box 5346, University Station, Fargo, ND, 58105.

Multiple cropping, the oldest form of agricultural production, provided early agriculturalists some of the benefits that we will require for future systems. Multiple cropping is still the major production system utilized in semi-tropic and tropic ecosystems. In the temperate areas of North America, native Americans traditionally intercropped maize with beans and squash. Recently, the interest in intercropping in various forms (e.g. relay cropping, multiple cropping, double cropping) has increased for use in today's mechanized agriculture. The specific production benefits of these systems can be increased production (e.g. yield, protein/acre) per unit of land, reduction of plant diseases and insect pest species, and increased weed control.

Specifically, I would like to discuss empirical data from our multiple crop studies. That includes the use of cultivar spring wheat blends (resistant and susceptible) on the damage by the wheat stem sawfly, evaluation of field pea:canola intercrop for damage by the crucifer flea beetle, and a drybean:field corn diculture on the European corn borer.

SUBMITTED PAPERS

THE DISTRIBUTION AND EFFECTS OF *PHYLLOTRETA CRUCIFERA* FEEDING ON SEEDLINGS OF FOUR CRUCIFEROUS CROPS (*SINAPIS ALBA, BRASSICA JUNCEA, BRASSICA NAPUS* AND *BRASSICA CAMPESTRIS*). R.N. Brandt and R.J. Lamb, University of Manitoba, Department of Entomology, Winnipeg, MB, R3T 2N2.

Four cruciferous seedling species were exposed to flea beetles to determine the distribution of damage and plant response.

The seedlings were divided into their anatomical components: (1) cotyledons, (2) first true leaves, and (3) stems and petioles. The damaged cotyledons and true first leaves were drawn on tracing graph paper which allowed them to be divided into a series of regions. Feeding pits were tabulated on the stems and petioles of seedlings and correlated with cotyledon damage. Differences in the distribution of damage were observed on the four species.

Morphologically similar seedlings at three growth stages were paired to allow a comparison of growth patterns between damaged and undamaged plants. Damage was assessed on the leaves and cotyledons of exposed plants and the fresh weights of each pair taken at predetermined intervals following beetle exposure. Differences were observed among species in their growth response and feeding damage.

The resulting data were used to test hypotheses that explain the differential susceptibility of the four species to attack by flea beetles.

BLOOD FEEDING SUCCESS OF MOSQUITOES IN RELATION TO VECTOR POTENTIAL. R.A. Anderson and R.A. Brust, Department of Entomology, University of Manitoba, Winnipeg, MB, R3T 2N2.

Blood fed mosquitoes of several species have been examined for interrupted and multiple blood feeding. Multiple feeding rates vary with season and with the available hosts. Mosquito feeding density also affects blood feeding success in that increased biting pressure results in behaviorally defensive hosts and more frequently interrupted blood meals.

SEASONAL DISPERSAL OF THE PEA APHID PARASITOID, *APHIDIUS ERVI* HALIDAY. B. Deneka and P.A. Mackay, Department of Entomology, University of Manitoba, Winnipeg, MB, R3T 2N2.

Dispersal of the pea aphid parasitoid, *Aphidius ervi* Haliday, from overwintering sites in the perennial alfalfa to annual field peas, was investigated. Several sampling techniques were employed to determine the life stage dispersing and quantify the extent and pattern of parasitoid dispersal into peas, as well as their impact on pea aphid populations. Suction trap samples contained no parasitized alate pea aphids, and a few adult parasitoids, indicating that to the extent that dispersal occurs, it is the adult parasitoid which is responsible for it. Sticky traps were used to monitor parasitoid movement from an alfalfa plot into an adjacent field pea plot. In 1990 sticky trap catches were significantly higher in peas close to alfalfa, while in 1991 parasitoids were caught throughout the pea plot. Parasitism rates and adult parasitoid densities in fields of commercial size were low but showed no differences between the edges and the middle. Effective use of *A. ervi* and other parasitic Hymenoptera as biological control agents must consider the lack of dispersal potential and perhaps incorporate enhancements.

A NEW SPECIES OF BLACK FLY (DIPTERA:SIMULIIDAE) FROM GEORGIA AND ALABAMA. S. Burgin, Zoology Department, Brandon University, Brandon, MB, R7A 6A9

Specimens of a new black fly species were obtained from Georgia, Alabama, and South Carolina. This species belongs to the *S. johannseni* species complex. It differs from *S. johannseni/duplex* in the polytene chromosome banding pattern. Specific differences in larval, pupal and adult stages are described.

IMPACT OF POTATO FLEA BEETLE, *EPITRIX CUCUMERIS*, ON YIELD OF RUSSET BURBANK POTATOES IN MANITOBA. S.F. Pernal and N.J. Holliday, Department of Entomology, University of Manitoba, Winnipeg, MB, R3T 2N2.

In 1989 and 1990, cv Russet Burbank potato plants were grown in cages in field plots, and densities of potato flea beetles, *Epitrix cucumeris* (Harris), and Colorado potato beetles, *Leptinotarsa decemlineata* (Say) were introduced in different multiples of naturally occurring densities. Colorado potato flea beetles were introduced only in the early part of the growing season, but potato flea beetles were introduced for the duration of the season. In 1989, plant yield was found to be inversely proportional to flea beetle density, however, severe aphid infestations confounded results and did not allow any further relationships to be determined. In 1990, without early season injury by Colorado potato beetle, plants exhibited an over-

compensatory yield response up to 290 flea beetles per plant; above this density, yield was inversely proportional to flea beetle density. Depending upon current economic conditions, the level of economic damage ranged from 0.43-1.56%, equivalent to a peak density of 300-327 beetles per plant. No yield compensation occurred in plants having early season Colorado potato beetle injury, and economic injury levels were between a peak density of 4-16 potato flea beetles per plant. This latter economic injury level indicates that previously injured potato plants are quite sensitive to defoliation during the bloom period. The economic injury levels are preliminary, but suggest most commercial insecticide applications for potato flea beetle in Manitoba are justified.

CAN WARBLE FLIES DETECT BOVINE B.O.? C. Olyarnyk, Zoology Department, Brandon University, Brandon, MB, R7A 6A9.

The hypothesis that females of *Hypoderma bovis* locate their oviposition hosts using host body odours was addressed. Preliminary results from odour choice chamber experiments suggested that olfaction may be important. To confirm that warble flies actually can detect odours, a SEM study of antennal sensillae was undertaken. Results are presented.

USE OF MARK-RECAPTURE METHODS TO ESTIMATE DISPERSAL AND POPULATION OF EARWIGS (*FORFICULA AURICULARIA* L., DERMAPTERA:FORFICULIDAE) IN A PEAR ORCHARD. S.R. Booth, D.J. Lactin, R.P. Powlowski, and L.L. Edwards, Integrated Crop Management, Inc. P.O. Box 164, Okanagan Centre, B.C., V0H 1P0.

Simple shelters were attached to the trunks of all 112 trees in a diamond-shaped area within a producing pear orchard. Earwigs were marked using model paints and released in two patterns. In the first pattern (point release), ca. 280 earwigs were released on each of three trees near the centre of the experimental area. Earwigs on each such tree were marked with a characteristic colour. In the second pattern (diffuse release), three marked earwigs were released on each of 87 trees; two colours were used, assigned in a checkerboard pattern. The diffuse release occurred 15 days after the point release. Controls were maintained to estimate rates of mortality and ecdysis of marked earwigs. Numbers of earwigs in each shelter were counted periodically, starting the day after release.

Earwig dispersal was measured in two ways. Using data from the point release, the dispersal rate was measured directly from the temporal change in the distribution pattern of marked earwigs. Using data from the diffuse release, the dispersal rate was estimated from the rate at which earwigs of the two colours mixed. Dispersal rates as estimated by the two methods are comparable.

Earwig populations were estimated using the Lincoln index, applied separately to the two release patterns, and also by removal trapping. Lincoln index estimates obtained from the point release data were consistently lower than those from the diffuse release. Emigration of marked earwigs is a plausible explanation for this difference. The trapping-out estimates are comparable to the Lincoln index estimates.

USE OF EARWIGS (*FORFICULA AURICULARIA* L., DERMAPTERA:FORFICULIDAE) TO CONTROL PEAR PSYLLA (*CACOPSYLLA PYRICOLA* (FOERSTER), HOMOPTERA:PSYLLIDAE) UNDER FIELD CONDITIONS. D.J. Lactin, R.P. Powlowski, S.R. Booth, and L.L. Edwards. Integrated Crop Management, Inc., P.O. Box 164, Okanagan Centre, B.C. V0H 1P0.

A simple shelter, attached to the trunk of the tree, accumulates numerous earwigs. In 1990, two treatments were compared: "trees with shelters" and "trees without shelters". In 1991 a third treatment was added: "earwigs excluded from trees". Numbers of earwigs per shelter, and of pear psylla immatures (eggs and nymphs) per leaf, were monitored regularly in each growing season.

Earwigs catch varied among shelters, and increased gradually over time. Numbers of pear psylla immatures per leaf were consistently lower in trees with shelters than in those without shelters and in those from which earwigs were excluded. In trees with shelters, the number of psylla immatures was inversely related to the number of earwigs in the shelters. Clearly, the earwigs which accumulate in the shelters spend at least part of their foraging time in the trees. Use of such shelters is a potentially important facet of a psylla control strategy based on maximizing the impact of predators.

LARVAL MORPHOLOGY OF NEARCTIC *HYDROPORUS* CLAIRVILLE AND *HYGROTUS* STEPHENS (COLEOPTERA:DYTISCIDAE). Y. Alarie, Department of Entomology, University of Manitoba, Winnipeg, MB, R3T 2N2.

Many larval features, especially those of chaetotaxy and porotaxy of head capsule, head appendages, legs, last abdominal segment, and urogomphi were found to be useful for taxonomic and phylogenetic comparisons of genera *Hydroporus* Clairville and *Hygrotus* Stephens. The comparisons suggested that both genera form a monophyletic unit, that each of them is a distinct monophyletic unit, and that *Hydroporus*(s.lat.) is the sister-group of *Hygrotus*.

THE LESSER GRAIN BORER, TROUBLE LOOKING FOR A PLACE TO HAPPEN? P. Fields, Agriculture Canada, 195 Dafoe Road, Winnipeg, MB, R3T 2M9.

The lesser grain borer (*Rhyzopertha dominica*) is a major pest of stored grain in the United States, Australia and the tropics. In Canada it has been found sporadically in feed mills, primary elevators and farms with increasing frequency since 1976. In 1990 and 1991, Lindgren multiple funnel traps baited with the lesser grain borer aggregation pheromone were placed across the Prairies. In Alberta and Manitoba over 10,000 lesser grain borers were caught. A few insects were caught at two locations in Saskatchewan, as well as a few beside terminal elevators in Thunder Bay and Vancouver.

Low temperature is believed to be the main reason why many stored product insects, such as the lesser grain borer, have not become established in Canada. To test this hypothesis, adults and wheat containing larvae and pupae were placed in 13 grain bins in Southern Manitoba in November. In February grain temperatures ranged between 2 to -14μ C and six of the bins had some lesser grain borer that survived. However, when these bins were sampled in March or April, none had any live lesser grain borer.

EXO-BREVICOMIN BIOSYNTHESIS IN SCOLYTID BARK BEETLES. D.C. Vanderwel[1], A.C. Oehlschlager[2], and J.H. Brown[2]. [1]Department of Chemistry and [2]Department of Biological Sciences, Simon Fraser University, Burnaby, B.C. V5A 1S6.

The biosynthesis of *exo*-brevicomin, an aggregation pheromone used by several species of scolytid bark beetles, was studied using stable isotope-labelling techniques. The bark beetle *Dendroctonus ponderosae* Hopkins (the mountain pine beetle) and *Dryocoetes confusus* Swaine (the western balsam bark beetle) were exposed to a suspected precursor of this pheromone, (Z)-6-nonen-2-one, which had been enriched in deuterium (a heavy isotope of hydrogen). The *exo*-brevicomin produced by the beetles in the presence of the deuterated (Z)-6-nonen-2-one was significantly enriched in deuterium (as determined by gas chromatography/mass spectroscopy). This and other evidence indicate that (Z)-6-nonen-2-one serves as a precursor of the pheromone *in vivo*.

ANALYSIS OF THE HERBICIDE "GLOWON" (MSMA) FOR SUPPRESSION OF ELM BARK BEETLES IN MANITOBA. I. Pines, Forest Protection, Forestry Branch, Manitoba Natural Resources, 300-530 Kenaston Blvd., Winnipeg, MB, R3N 1Z4.

Sanitation or the removal of dying and diseased elm trees is a major component of the provincial integrated management program for Dutch Elm Disease. A method to supplement sanitation which has proven successful is the use of herbicides to kill diseased trees. Herbicides are injected into the sapwood of elms, killing them, and thus creating trap trees for elm bark beetles. As trees die quickly from the injection, the wood dries out, killing breeding elm bark beetle populations. During 1990 and 1991 the herbicide Glowon was tested for effectiveness in desiccating elm trees and killing elm bark beetle larvae. Preliminary data is reported for the efficacy of treatments done at Portage and Winnipeg, Manitoba.

ELECTROANTENNOGRAM RESPONSES OF FLEA BEETLES, *PHYLLOTRETA CRUCIFERAE* TO PLANT VOLATILES. P. Palaniswamy, Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, MB, R3T 2M9.

An electroantennogram (EAG) method to determine the antennal responses of flea beetles to plant volatiles is described. Different dilutions of extracts of various crucifers were tested on both male and female beetles. All crucifers tested elicited EAG responses and the EAG amplitude varied among crucifers. The Oriental mustard, *B. juncea* (L.) cv. Cutlass produced the greatest EAG response. In general, the EAG data corresponded to the number of beetles collected from different species of plants in the field. Females produced slightly greater EAG responses than males.

MANAGEMENT OF DUTCH ELM DISEASE IN MANITOBA. A.R. Westwood, Forest Protection, Forestry Branch, Manitoba Natural Resources, 300-530 Kenaston Blvd., Winnipeg, MB, R3N 1Z4.

This 13 minute video presentation was developed by the Forestry Branch, Manitoba Natural Resources to replace an outdated Dutch Elm Disease instructional film produced in the mid 1979's. The video incorporates descriptions of the life cycle of the Dutch Elm Disease pathogen in Manitoba and biology of the insect vectors. A description of the current provincial Dutch Elm Disease management program is presented and information on how homeowners can assist in the control of Dutch Elm Disease is included. Footage for this video was shot during the summer of 1990 and the film released in January 1991. The video has been made available to schools throughout Manitoba, town councils and special interest groups and is shown on a number of television channels throughout the year.

A COMPILATION OF DATA ON ARBOVIRUS SURVEILLANCE IN MANITOBA: 1975-1991

Sekla, L. Cadham Provincial Laboratory, 750 William Avenue, Winnipeg, Manitoba, R3C 3Y1
Gadawski, R. City Entomologist, Parks & Recreation Department, The City of Winnipeg, 2799 Roblin Blvd., Winnipeg, Manitoba R3R 0B8
Nayar, G. Veterinary Services Branch, Manitoba Department of Agriculture, 545 University Crescent, Winnipeg, Manitoba R3T 5S6
Brust, R. Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2

Correspondence: Mr. R. Gadawski

ABSTRACT

Data on arboviruses in Manitoba are compiled for a 17 year period, 1975-1991. The Western Equine Encephalitis virus is endemic in Manitoba yet epidemics/epizootics develop infrequently, with four epidemics recorded during the study period: 1975, 1977, 1981 and 1983. A multi-disciplinary surveillance was started in 1975 and remained active for 10 years during which mosquito populations, especially those of Culex tarsalis, mosquito arboviral infection rates, and seroconversion in sentinel chicken flocks were monitored in a number of locations throughout Manitoba. In addition, serosurveys were done on potential reservoir hosts, and serologically confirmed equine and human cases were recorded. After 1986, the surveillance was limited to the City of Winnipeg data on mosquito populations and seroconversion in chicken flocks. Crude criteria were developed to forecast epidemics and were successful in predicting the 1977, 1981 and 1983 outbreaks. Experience has shown that multiple parameters are needed for monitoring arboviral outbreaks, and that the month of July is critical in predicting epidemics. It is proposed that a multi-disciplinary surveillance be re-instituted, and that 1 - 2 locations be monitored for mosquito populations and infection rates, as well as for seroconversion in chickens. If funds are limited, the surveillance could be restricted to a 4 - 6 week period, including the month of July.

INTRODUCTION

Of the many arboviral infections of man, Western Equine Encephalitis (W.E.E.) is the most common in Manitoba. The virus seems to be endemic in the Red River Valley but it is not clear why epidemics develop only in certain years. For an epidemic to develop, two conditions must be fulfilled: (a) a large number of susceptible hosts must be available, and (b) large numbers of infected vectors must be using these hosts for blood meals. The first condition is easy to fulfill as, to date, no vaccine has been licenced for humans and serosurveys have shown that almost all the population is susceptible to W.E.E. (6). A vaccine is available for horses but the degree of compliance with vaccination guidelines is unknown. Cases of WEE are detected only in humans and horses and both are "dead end" hosts. The primary vector for

W.E.E. virus is Culex tarsalis, a mosquito species which feeds on birds early in the summer, then shifts to include mammals (including humans and horses) in mid-summer. The biting activity of Culex tarsalis appears to be dependent on atmospheric conditions, particularly temperature, humidity and wind.

As predictors of human epidemics, the relative merit of monitoring Culex tarsalis populations/virus load, versus monitoring viral activity in sentinel chicken flocks, versus monitoring virus transmission in horses, has been discussed since 1975.

Background:

During the years 1975-1991 Manitoba experienced four epidemics of W.E.E; in 1975, 1977, 1981 and 1983. In the summer of 1975 an epidemic of W.E.E. appeared imminent; to deal with this threat, the Province of Manitoba struck an ad hoc multi-disciplinary committee which remained active until 1985. The committee known as the Manitoba Arboviral Surveillance Committee (M.A.S.C.), had 2 main objectives: (a) monitor early indicators of arboviral activity to give officials time to initiate appropriate preventive measures, and (b) coordinate the diagnosis of cases (human and equine). The experience gained in 1975 was recorded in a supplement to the Canadian Public Health Association Journal (7). Following the 1981 epidemic, a workshop was organized in Winnipeg and the proceedings published in 1982 by Manitoba Health (6). Arbovirus activities in the next years were summarized annually in Canada Disease Weekly Reports (8,3) or in the Canadian Medical Association Journal (4). Human infections were reported only in late summer (i.e. August onwards) in epidemic years. In 1985 M.A.S.C. was dissolved by the Province of Manitoba, mainly because of concern about the cost and efficacy of the aerial spraying used to control the mosquito vector; however, some degree of surveillance was maintained. The City of Winnipeg continued collecting data on mosquito populations and viral activity in sentinel chicken flocks. The Cadham Provincial Laboratory continued providing laboratory services for the diagnosis of human and equine cases of W.E.E., as well as performing serological tests on sentinel chicken flocks (except for 1986 when tests were performed by Dr. H. Artsob of the National Arbovirus Centre in Toronto), and on field sparrows collected from 1983-1986 (5). Laboratory procedures were refined over the years to provide accurate and rapid results for the monitoring and diagnosis of arboviral diseases.

Objectives:

The following is a consolidation of the results obtained since 1975 and an attempt at reviewing the relative value of data on mosquito populations, sentinel chicken flocks, and equine cases in predicting human epidemics of W.E.E. Our objective is to determine if a single parameter can be used for monitoring, whether a combination of parameters is needed, or alternatively, to determine if prediction of epidemics by monitoring is possible.

METHODOLOGY

Minutes of M.A.S.C., annual reports of the various agencies involved, and publications (1 to 8) were used to compile the following tables.

RESULTS

Table 1: Mosquito population data obtained by the City of Winnipeg using standard New Jersey-style light traps and larval collections from 1975-1991.

Table 2: Mosquito population data obtained through the Provincial Surveillance Program, 1976-1981: (a) flock trap data, (b) light-trap data.

Table 3: Virus isolations from mosquitoes, 1975-1985.

Table 4: Serological testing performed on sentinel chicken flocks, 1975-1991.

Table 5: Serological testing performed on sparrows, 1983-1986.

Table 6: Serological testing performed on suspected W.E.E. reservoir hosts, 1976-1983.

Table 7: Serological testing performed on suspected equine cases, 1975-1991.

Table 8: Serosurveys for W.E.E. on human sera submitted to the Cadham Provincial Laboratory, 1968-1985.

Table 9: Results of serological testing done on suspected human cases 1975-1991.

Table 10: A summary of the warning signals used to predict an epidemic of Western Equine Encephalitis by members of the Manitoba Arbovirus Surveillance Committee.

DISCUSSION AND CONCLUSIONS

The sentinel chicken data confirm that the W.E.E. virus is endemic in Manitoba since seroconversion was detected every year from 1975 to 1991 with the exception of 1982. Assuming that W.E.E. is endemic in Manitoba and that human outbreaks occur periodically, two questions need to be addressed: (I) How many parameters need to be monitored to provide an effective early warning system? and (II) Is it possible to forecast a human epidemic?

I. The data compiled suggest that we cannot rely on a single parameter for arbovirus surveillance; four examples will be given.

(1) The actual number of Culex tarsalis mosquitoes may be high, but if the mosquitoes are not infected, epizootics/epidemics do not develop (e.g. 1982).
(2) Culex tarsalis mosquitoes may be present and infected, as evidenced by virus isolation or seroconversion of chicken flocks, yet epidemics do not develop because the mosquitoes become infected only in late summer (e.g. 1984).
(3) Sentinel chicken flocks may seroconvert indicating transmission of the W.E.E. virus, yet an epidemic/epizootic does not develop because at the time of seroconversion the number of Culex tarsalis was low (e.g. 1986) or almost nil in the light traps (e.g. June

1983). It is intriguing to speculate on the species of mosquitoes responsible for infections in the chickens.

(4) Finally, human epidemics do not always follow epizootics in horses (e.g. 1988).

II. The experience of the last 17 years indicates that in Manitoba, when all the monitors listed in Table 10 give a positive signal, (especially when these warnings are synchronized in the month of July), an epidemic of W.E.E. is imminent. The 1977, 1981 and 1983 outbreaks were predicted a few days before the first human cases were diagnozed.

The complexity of Table 10 suggests that, for an epidemic of W.E.E. to be predicted in Manitoba, a number of parameters need to be monitored. Our experience has shown that when W.E.E. epidemics occur, cases are widespread. Since the multi-disciplinary surveillance used prior to 1985 was not costly, such a monitoring system could be re-instated in one or more locations in the Red River Valley to focus mainly on data collected during July or, preferably, data collected from mid June to the end of July. Once an epidemic starts, human cases may be expected as long as infected Culex tarsalis need a blood meal. Most outbreaks end by September but weather conditions may prolong the duration of transmission of W.E.E. infections to humans (as in 1983).

In conclusion, a number of parameters are necessary for predicting an outbreak of W.E.E. in Manitoba, but when properly monitored can accurately give advance warning of the disease.

ACKNOWLEDGEMENT

We wish to acknowledge the collaboration of all members of M.A.S.C., particularly Dr. Roy Ellis. To Wally Stackiw we owe the expertise needed to provide all the laboratory services required.

REFERENCES

1. Artsob, H., F. Doane, L. Sekla, W. Stakiw, and R. Brust. 1991. Manitoba virus, a new rhabdovirus isolated from Culex tarsalis mosquitoes collected in Manitoba, Canada. Can. J. Microbiol. 37:329-332.
2. Artsob, H., L. Spence, G. Calisher, L. Sekla, and R. Brust. 1985*a*. Isolation of California encephalitis serotype from mosquitoes collected in Manitoba. J. Amer. Mosq. Control Assoc. 1: 257-258.
3. Artsob, H., L. Spence, and L. Sekla. 1986. Arbovirus activity in Canada in 1985. Can. Disease Weekly Rep. 12 (25):109.
4. Artsob, H., L. Spence, and L. Sekla, 1985*b*. Arbovirus activity in Canada in 1984. Can. Med. Assoc. J. 133:1026.
5. Kucera, E. 1990. Use of sparrows in Western Equine Encephalitis monitoring in Manitoba: 1983-1986. Terrestrial Standards - Studies Report 90-1. Manitoba Department of Environment. 14 pp.
6. Sekla, L. (ed.) 1982. Western Equine Encephalitis in Manitoba. Manitoba Health Services Commission. 296 pp.

7. Sekla, L. (ed.) 1976. Western Encephalitis. Can. J. Public Health 67 (Suppl. 1). 75 pp.
8. Sekla, L. and J. Eadie. 1984. Manitoba arbovirus surveillance, 1983. Can. Disease Weekly Rep. 10 (24) : 94-95.

Table 1. Mosquito population data obtained by the City of Winnipeg using standard New Jersey-style light traps (NJLT) and larval collections from 1975 - 1991.

		All species		Culex tarsalis				
Year	No. of NJLT locations	Date of first larval collection	Average No. of females per trap	Date of first larval collection	Date of first adult collection	Average No. of females per trap	Peak No. of females/trap/ night (date)	
*1975	17	15/4	1950	N/A	26/6	172	16.5	(31/7)
1976	21	5/4	1963	16/6	28/5	81	4.1	(7/7)
*1977	19	7/4	2045	24/5	11/5	198	14.5	(18/7)
1978	19	11/4	3242	8/6	14/6	127	24.3	(19/7)
1979	19	18/4	1357	18/7	13/6	21	1.7	(24/7)
1980	19	8/4	301	6/5	6/6	11	1.0	(24/7)
*1981	19	1/4	1409	12/6	7/6	106	8.8	(4/7)
1982	24	14/4	6060	24/6	24/6	202	15.3	(7/8)
*1983	24	6/4	8998	4/8	13/6	534	50.5	(16/7)
1984	25	28/3	9591	2/7	29/5	264	17.0	(1/8)
1985	25	29/3	2506	8/7	9/5	34	4.1	(6/8)
1986	25	2/4	5588	15/7	10/6	494	64.5	(4/8)
1987	25	6/4	1944	1/6	16/5	76	4.8	(1/8)
1988	25	13/4	1175	2/6	29/5	152	11.6	(8/7)
1989	25	12/4	5630	28/6	22/6	387	21.6	(21/7)
1990	25	9/4	6047	18/6	23/5	227	15.0	(28/8)
1991	25	2/4	22008	19/6	†14/5	1751	445.0	(21/7)

* W.E.E. Epidemic Years

† 1st day of NJLT collection was May 14, 1991

Table 2a. Number of Culex tarsalis and percent of all species collected in five chicken flock traps in Manitoba during 1976 - 1981.

DATE		1976		1977		1978		1979		1980		1981	
		NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
JUNE	1-8	0	0	18	9	0	0	1	<1	0	0	0	0
	9-15	2	<1	21	14	0	0	0	0	0	0	1	4
	16-23	15	3	119	16	3	<1	8	1	0	0	1	1
	24-30	40	5	278	27	33	8	2	<1	2	7	14	17
JULY	1-8	81	20	515	38	12	4	23	3	4	11	336	69
	9-15	73	25	866	64	31	11	97	11	9	24	603	50
	16-23	233	45	1246	79	329	48	76	8	10	16	451	53
	24-31	268	63	795	70	374	53	118	54	3	50	912	78
JULY TOTAL:		655	40	3422	63	746	37	314	15	26	18	2302	62
AUGUST	1-8	29	44	1174	69	149	43	115	44	8	61	143	59
	9-15	75	56	207	49	73	24	42	19	0	-	57	56
	16-23	78	67	6	7	18	51	40	35	-	-	8	3
	24-31	-	-	2	3	-	-	-	-	-	-	27	4
SEASONAL TOTAL:		894	23.7	5247	52.5	1022	25.7	522	13.8	36	16	2553	48.2

Table 2b. Number of Culex tarsalis and percent of all species collected in five standard New Jersey- light traps in Manitoba during 1976 - 1981.

DATE		1976		1977		1978		1979		1980		1981	
		NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
JUNE	1-8	1	<1	156	15	0	0	1	<1	2	2	8	5
	9-15	8	3	124	20	0	0	0	0	7	3	9	2
	16-23	9	5	232	19	12	<1	6	1	6	5	23	2
	24-30	25	8	133	20	63	8	1	<1	7	6	52	5
JULY	1-8	22	8	156	18	32	4	35	6	5	10	100	18
	9-15	23	8	589	63	192	11	42	21	15	14	176	42
	16-23	46	27	1423	68	504	48	73	21	68	32	419	42
	24-31	65	38	1029	44	419	53	215	35	44	43	349	43
JULY TOTAL:		156	16	3197	51	1147	37	365	21	132	23	1044	37
AUGUST	1-8	47	40	1570	50	47	43	244	22	56	33	449	34
	9-15	33	34	327	27	121	24	160	30	47	26	204	27
	16-23	13	21	27	7	38	51	14	4	11	10	103	7
	24-31	-	-	10	4	-	-	1	-	-	-	179	7
SEASONAL TOTAL:		292	13.7	5776	39.2	1428	7.2	792	12.4	268	17.6	2071	17.4

Table 3: Virus isolations from mosquitoes, 1975-1985.

YEAR	Number of pools tested	Number of virus isolations	Percentage of pools positive	Virus identifications¤					Date of first collected W.E.E. infected mosquito
				WEE	CEV	CVV	TURLOCK	HPF	
*1975	72	5	6.9	5	0	0	0	0	¶N/A
1976	882	0	0.0	0	0	0	0	0	-
*1977	1045	†73	7.0	71	0	2	0	0	July 18
1978	581	1	0.2	1	0	0	0	0	N/A
1979	450	7	1.6	4	‡2	0	0	1	N/A
1980	395	0	0.0	0	0	0	0	0	-
*1981	728	35	4.8	32	0	2	0	1	July 6
1982	822	1	0.1	0	0	0	0	1	-
*1983	1663	72	4.3	50	2	6	0	14	July 13
1984	1079	5	0.5	5	0	0	0	0	N/A
1985	1484	19	1.3	3	0	3	12	1	August 7
TOTAL	9201	218	2.4	171	4	13	12	18	-

*Epidemic years (1975 surveillance started in August)

†In addition, a new rhabdovirus was identified (Artsob *et al.* 1991).

‡Includes first isolate of California Encephalitis serotype in Canada (Artsob *et al.* 1985a)

¤Western Equine Encephalitis Virus (WEE)
California Encephalitis Virus (CEV)
Cache Valley Virus (CVV)
Hart Park Flanders Virus (HPF)

¶Information is unavailable

Table 4: Serological testing performed on sentinel chicken flocks, 1975 - 1991

Year	Number of locations	Number tested	Number positive	Percent positive	Date of first significant seroconversion
*1975	11	820	214	26.1	‡N/A
1976	20	1080	8	0.7	N/A
*1977	15	830	135	16.3	August 1st week
1978	10	600	19	3.2	N/A
1979	10	1041	6	0.6	N/A
1980	10	743	5	0.7	N/A
*1981	5	344	63	18.3	July 21
1982	10	150	0	0	None
*1983	10	272	90	33.1	June 29
1984	10	658	14	2.1	N/A
1985	10	563	5	0.9	July 24
†1986	5	352	15	4.3	July 17
1987	5	269	2	0.7	August 18
1988	5	491	12	2.4	July 19
1989	5	321	1	0.3	August 15
1990	5	363	7	1.9	August 7
1991	5	350	6	1.7	July 23

* Epidemic years (1975 surveillance started in August)

‡ Information is not available

† Tests performed at National Arbovirus Reference Centre

Table 5. Serological testing performed on sparrows, 1983 - 1986.*

Year	Number of locations	Number tested	Number Positive	Percent Positive
1983	24	188	10	5.3
1984	14	409	11	2.7
1985	12	435	12	2.8
1986	15	789	0	0

* Kucera 1990

Table 6: Serological testing performed on suspected W.E.E. reservoir hosts, 1976 - 1983.

Year	Suspected W.E.E. Reservosir Host	Number tested	Percent positive at screen
1976	Gophers	3	0
1977	Richardson squirrels	19	10.5
	Pigeons	11	0
1981	Turkeys	21	19.0
1982	Garter snakes	18	0
	Ground squirrels	16	24.1
	Frogs	20	15.0
	Rats	6	0
	Pigeons	4	0
1983	Community domestic chickens	152	2.6
	Geese/pheasants/turkeys	15	20.0
	Miscellaneous wild birds	97	0

Table 7: Serological testing performed on suspected equine cases, 1975 - 1991.

Year	Number Tested	Number of serologically confirmed cases	Date of first confirmation	Date of first report of ≥ 6 cases/week
*1975	261	139	†N/A	N/A
1976	19	10	N/A	N/A
*1977	80	53	N/A	N/A
1978	5	1	N/A	-
1979	6	0	-	-
1980	11	1	N/A	-
*1981	182	123	July 14	July 21
1982	16	1	N/A	-
*1983	46	23	August 2	August 10-17
1984	8	0	-	-
1985	9	0	-	-
1986	11	1	N/A	-
1987	10	1	N/A	-
1988	29	12	July 14	N/A
1989	3	0	-	-
1990	9	0	-	-
1991	10	2	August 7	-

* Epidemic Years

† Information is not available

Table 8. Serosurveys for W.E.E. on human sera submitted to the Cadham Provincial Laboratory, 1968 - 1985.

Year	Number Tested	Percent Positive
1968	1863	5.2
1975	492	0.8
1981	250	8.6
1982	277	9.0
1983	130	3.8
1984	142	2.8
1985	172	1.7

Table 9. Serological testing done on suspected human cases, 1975 - 1991.

Year	Number Tested	Number Positive
*1975	196	14
1976	111	0
*1977	256	5
1978	14	0
1979	54	0
1980	87	0
*1981	586	25
1982	231	0
*1983	855	†18
1984	159	0
1985	51	0
1986	87	0
1987	18	0
1988	55	0
1989	60	0
1990	28	0
1991	111	0

* Epidemic Years
† 2 deaths

Table 10. A summary of the warning signals used to predict an epidemic of Western Equine Encephalitis by members of the Manitoba Arbovirus Surveillance Committee.

I. **Mosquito data**

More than 50 female mosquitoes/standard New Jersey-style light trap/night for 3 consecutive nights.

Large population of mosquitoes with **Culex tarsalis** representing 25% of the mosquitoes trapped.

Early (late June/Early July) build up of **Culex tarsalis** populations.

W.E.E. virus isolation in ≥2% of the mosquitoes trapped, particularly in the week of July 8-15.

II. **Sentinel chicken flocks data**

A sustained seroconversion of 15%-20%, particularly in the month of July.

III. **Equine data**

The confirmation of W.E.E. infections in ≥6 equine cases/week, particularly if they occur in the month of July.

A COST BENEFIT ANALYSIS OF MANITOBA'S INTEGRATED DUTCH ELM DISEASE MANAGEMENT PROGRAM 1975 - 1990

WESTWOOD, A.R., Forestry Branch, Manitoba Natural Resources, 300-530 Kenaston Blvd., Winnipeg, MB. R3N 1Z4

ABSTRACT

Since the discovery of Dutch elm disease in Manitoba in 1975, the average annual elm loss rate in rural communities has been 2.4%. The value of the urban elm forests within these communities and the City of Winnipeg exceeds $1.1 billion. In 1990 the Province of Manitoba spent $2,063,000 to manage Dutch elm disease within an area of 100,000 km^2. This expenditure represents approximately 0.2% of the value of the urban elm trees currently in the provincial inventory. An average annual rate of expenditure of approximately $1.5 million by the Province of Manitoba since 1981 has kept annual elm losses in Manitoba communities to less than 2.5%. An increase of the annual loss rate by a few percentage points would translate directly into costs of $22,300,000 for elm removal, $21,000,000 for replacement trees, a decline in real estate values and a near complete loss of the urban forests in many towns and cities. These costs would be condensed into a 5 to 10 year period. The Province of Manitoba has realized a minimum savings of $5,010,000 since 1981 by managing Dutch elm disease. An expenditure of approximately $10 million since 1981 has conserved $276,204,000 worth of elm trees in 35 rural communities. Implementation of buffer zones around selected communities has significantly reduced urban elm losses. The present program has been successful in spreading the costs of DED management over many years and more importantly, provided protection for the elm resource until a "cure" is found or more effective management techniques are developed. In terms of the economic cost-benefit, the integrated Dutch elm disease management program conducted by the Province of Manitoba and Cities of Brandon and Winnipeg has been a worthwhile investment.

INTRODUCTION

Dutch elm disease was first discovered in American elm trees (*Ulmus americana* L.) in Manitoba in 1975. In anticipation of its introduction, forestry personnel of the Province of Manitoba and Cities of Winnipeg and Brandon followed the progress of Dutch elm disease through eastern North America and in the early 1960's initiated measures to lessen the impact of the disease in Manitoba. These early measures were primarily aimed at maintaining a healthy elm population and encouraging planting of alternate tree species. Following the introduction of the disease into Manitoba in 1975, an aggressive province-wide Dutch elm disease management program was implemented. This program has undergone constant evolution and continues to embrace the goals and objectives that were set over a decade ago. The Manitoba program has

developed into a truly integrated pest management program utilizing insect vector, pathogen and host biology in a multifaceted approach to manage the elm resource. The purpose of this analysis is to assess the benefits provided by the provincial Dutch elm disease program, 15 years after its inception. In simplest terms, an economic benefit assessment of this type attempts to determine if it makes financial sense to implement control programs (Stemeroff 1991). This synopsis will briefly describe the biology and history of Dutch elm disease in Manitoba, components of the Dutch elm disease management program and will present a cost-benefit analysis for the program.

BIOLOGY OF DUTCH ELM DISEASE

Detailed information on the biology and bionomics of Dutch elm disease in North America has been published by Sinclair and Campana (1978), Strobel and Lanier (1981) and Hiratsuka (1987). The following is a brief summary of this published information. The causal agent of Dutch elm disease is *Ceratocytis ulmi* (Buis.) C. Moreau (=*Ophiostoma ulmi* (Buis.) Nannf.). Once introduced into the tree, the fungus quickly spreads through the xylem vessels and surrounding cells, inhibiting the transportation of nutrients and water through the tree (Hiratsuka 1987).

The first external symptom of Dutch elm disease is leaf wilting. Usually wilting starts at the site of infection, and spreads rapidly throughout the canopy. Leaves turn brown, but may not fall for some months after the tree has died. The rate of spread of the fungus through an elm tree is dependent on a number of factors, including overall health of the tree, virulence of the fungal pathogen, and time of the year when the tree is initially infected (Hubbes and Jeng 1981; Hubbes 1988). Elm trees generally succumb to Dutch elm disease much faster when under environmental stress (e.g. drought, heat stress, frost damage, etc.). Stress leads to losses of carbohydrate reserves that further increases susceptibility to Dutch elm disease. Healthy, vigorous trees located in favourable sites can withstand infections for some years (Hildahl and Jeffrey 1980; Stipes and Campana 1981).

Dutch elm disease is transmitted between elm trees by bark beetles. Beginning in the spring, adult bark beetles feed and mate in the crotches of twigs in the tree canopy. After mating, female beetles construct brood galleries within the cambium and lay eggs. Brood galleries may be constructed in the canopy or lower down on main branches or the trunk of the tree. Larvae feed and develop within these galleries and eventually pupate within specially constructed pupal chambers (Hiratsuka 1987). During summer, newly emerged adults move to healthy uninfected trees to feed. In late summer and fall, the beetles move to the bases of infected or healthy trees to overwinter (Kondo *et al.* 1981). The following spring, the overwintered beetles move from the bases of trees to the canopy to feed and mate. If the fungus was present in the brood galleries bark beetles will carry the sticky spores of *C. ulmi* from tree to tree.

In North America the vectors of Dutch elm disease include the Native elm bark beetle, *Hylurgopinus rufipes* (Eichh.), and the introduced European Elm Bark beetle, *Scolytus multistriatus* (Marsh.). While the Native elm bark beetle currently comprises approximately 99% of the Manitoba vector population, occasional European elm bark beetles are found every year at various locations (Westwood 1991). The biology of these species is similar, but the European

elm bark beetle is considered to be a more effective vector of Dutch elm disease because the adults often feed at more sites in the tree canopy than do adult Native elm bark beetles.

The condition of the host tree affects the attractiveness to bark beetles; stressed or overmature trees attract more beetles than young vigorously growing trees (Hiratsuka 1987).

The primary host of *C. ulmi* in Manitoba is the American elm. The Siberian elm (*Ulmus pumila* L.) is fairly widespread in the province and has shown minor levels of susceptibility to Dutch elm disease.

HISTORY OF DUTCH ELM DISEASE IN MANITOBA

Prior to the occurrence of Dutch elm disease the natural elm population in south and central portions of Manitoba was approximately 20 million trees of 10 cm dbh (diameter at breast height) or greater (Jeffrey 1981). In addition, several million elms have been planted in urban areas and shelterbelts. In 1975, Dutch elm disease was first detected in Manitoba in Selkirk, Brandon and Winnipeg. These mutual outbreaks were most likely linked to campers carrying infected elm firewood from infected areas outside of the province. From 1975 to 1980, Dutch elm disease spread steadily throughout the southern portion of the province south of the Trans-Canada highway. During the 1980's the disease moved northward to the Whiteshell Provincial Park, the Interlake area and to Dauphin. In 1990 the disease was found in southeastern Saskatchewan and along the Saskatchewan River in eastern Saskatchewan near the Manitoba border. Currently at the time of writing, the disease extends from the eastern Manitoba-Ontario border across the province north to Fisher Branch in the Interlake, to slightly north of Dauphin in western Manitoba and westward across the Manitoba-Saskatchewan border and southward into North Dakota.

MANITOBA'S DUTCH ELM DISEASE MANAGEMENT PROGRAM

When Dutch elm disease was first discovered, the Manitoba Department of Agriculture was responsible for surveillance and removal and disposal of diseased and hazard trees in Selkirk and assisting the cities of Brandon and Winnipeg. In 1980 the responsibility was transferred to Manitoba Natural Resources. The program was then expanded to provide focus for the entire province. It was necessary to enact a legal framework for the administration of a province-wide program and in 1981 the Dutch Elm Disease Act was passed. This act regulates all aspects of disease management in the province and enabled implementation of an effective Dutch elm disease program. During the 1980's the program was refined and additional resources were added to provide a fully integrated pest management effort that by 1990 encompassed 50 rural communities and the City of Winnipeg across an area of approximately 100,000 km^2.

The primary components of the current Dutch elm disease management program include site-specific inventory of trees within control areas, elm tree sanitation by pruning and removal, basal spraying with an insecticide to kill overwintering elm bark beetles, preventative and curative tree injections with fungicides, replacement of elms with alternate species, establishment of elm disposal sites, surveillance, research, education and public information and the community Elm Guard Program.

An integral part of the management program was the development of the Cost Sharing Agreement component, which was designed to share costs of activities such as basal spraying,

tree replacement and pruning, between Manitoba Natural Resources and communities. The result has been the development of close relationships between provincial forestry research, surveillance, enforcement and sanitation personnel and workers in the towns and cities throughout the province. The Cost Shared Agreement program has fostered significant investment by these towns, cities and municipalities in their rural and urban forests. The result has been a commitment by all government levels to manage Dutch elm disease.

ELM LOSSES AND PROGRAM COSTS

To measure the cost-effectiveness of Manitoba's Dutch elm disease program, requires measurement of elm loss rate due to Dutch elm disease, measurement of the value of the elm resource being protected, measurement of the cost of the program itself and a comparison of elm losses in the absence of Dutch elm disease management. Manitoba's Dutch elm disease program can be further divided into two program components, that of the Provincial forestry branch in 50 rural towns, cities and municipalities and that of the City of Winnipeg's forestry branch.

A) Dutch elm disease loss rate in rural Manitoba

For the purpose of this analysis, all areas outside of the City of Winnipeg are considered as part of the provincial Dutch elm disease rural program. Numbers of elm trees and numbers lost from all causes, including Dutch elm disease and hazard elm removals are accurately known for 28 of the 50 communities during the period 1975 to 1990 (Table 1). Hazard elms are those trees with more than 40% deadwood, and are highly attractive to elm bark beetles. These inventory data represent both public and privately owned elm trees greater than 10 cm dbh within town or city limits. The mean cumulative loss rate of elms in the 28 communities since the inventories were taken was 16.4% and the average annual loss rate was 2.4% (Table 1). This loss of 2.4% per annum is the best available measurement of overall elm loss in communities participating in the rural Dutch elm disease management program. Miner (1990) stated that in Winnipeg, mortality of elms to causes other than Dutch elm disease may be as high as 0.75%. Recent data on mortality of elms in an area without Dutch elm disease were obtained from Saskatchewan (D.A. Domke, personal commun. 1990). Both Regina and Saskatoon have significant elm populations. For example, in 1990, Saskatoon's elm inventory was approximately 50,000 boulevard trees. Based on current inventories and past losses the average annual mortality rate of elm in Regina and Saskatoon ranged from 0.25 to 0.35%. Using Saskatchewan data, a yearly mortality rate for elm of at least 0.25% from causes other than Dutch elm disease could be expected in the 28 Cost Shared Agreement communities, and so the average annual loss rate to Dutch elm disease in these communities is estimated to be 2.15%.

B) Buffer Zones

As part of the Cost Shared Agreement program, buffer zones have been established around certain towns or cities along rivers or creeks where there are large numbers of elm trees. Elsewhere in North America river or creek corridors with high densities of elm have been routes into communities for migrating Dutch elm disease carrying bark beetles (Strobel and Lanier

1981). Dutch elm disease tends to move along these corridors and, once within a town, the disease spreads outward from the watercourse into adjacent street and private property trees. Buffer zones were established outside of community boundaries within a number of Cost Shared Agreement areas in Manitoba to help regulate beetle movement. Various management components of the Dutch elm disease program such as basal spraying, sanitation and surveillance were practised within the buffer zone.

Table 2 shows the comparison of yearly elm loss rates between Cost Shared Agreement communities not located on a river or creek, those that have extensively elm lined rivers or creeks running through the community, but have no buffer zone, and finally those communities with buffer zones on rivers or creeks adjacent to town boundaries. Communities not located on a river or creek have experienced an average annual elm loss rate of 1.02% (sample size = 13 communities). Those on a river or creek with no buffer zone have experienced an annual average loss rate of 4.76% (10 communities). Towns or cities on a river or creek with a buffer zone have experienced an average annual elm loss rate of 1.46% (5 communities).

Towns not located on water courses were either infected through the introduction of disease carrying beetles on elm wood or from beetles moving into communities from adjacent farmland. The rate of infection is generally slower for communities without rivers or creeks in comparison to those areas where continuous elm cover leading into a community facilitates beetle movement.

The implementation of buffer zones around communities has reduced the expected average annual loss of elms by 3.3% versus non-buffered communities on rivers or creeks. The impact of this reduction in loss translates into significant savings in terms of Dutch elm disease management and conservation of the elm resource. For example, an additional 3.3% annual loss of elms in the City of Brandon over the last decade would have equalled 14,535 trees. The actual cost saving attributable to the buffer zone program (using Brandon and Winnipeg as examples) will be described in detail under Dutch elm disease program costs in the next section.

Statistical analysis (ANOVA and Duncan's Multiple Range Test) indicated there existed no significant difference ($p > 0.05$) between the average annual elm loss in communities without rivers or creeks or those with buffer zones on their rivers or creeks. Communities with rivers or creeks and no buffer zones lost significantly more ($p < 0.05$) elm trees than either of the other location types (Table 2).

C) Dutch elm disease loss rate in Winnipeg

Since the introduction of Dutch elm disease into Winnipeg, 34.4% of the cities elms have been removed (1975 - spring 1991) (Table 3). Strobel and Lanier (1981) noted that in many towns and cities in eastern North America where there was no significant effort made to manage Dutch elm disease, elm losses often reached 20% per annum. The removals in Winnipeg included 27% hazard trees and 7.4% infected with Dutch elm disease. The average annual loss rate of both hazard and Dutch elm disease infected trees was 2.59% over this period. The 1975 inventory for Winnipeg showed 275,000 elms (not including elms in some wild river bank areas), with the number of elms remaining in 1990 at 180,651. For comparative purposes, the City of Minneapolis, which also maintains a Dutch elm disease management program, lost 52.6% of its elms (4.91% per annum) during the period 1975 to 1989. In comparing the

Winnipeg and Minneapolis programs it is necessary to take into account differences in both geographical location (weather), tree growth and the biology of vectors and pathogen.

The 2.59% elm loss rate per annum for Winnipeg is misleading in comparison to rural loss rates for most Cost Shared Agreement communities. Data from the rural Cost Shared Agreement communities represent losses primarily from high value public, private and park trees as determined from the inventories. The loss rates reported from Winnipeg include a considerable number of elms from semi-wild and wild river bank areas throughout the city (some of which were never inventoried). The actual loss rate of higher value street, park and private elms is lower than 2.59% per year.

The provincial Dutch elm disease management program maintains a buffer zone around the City of Winnipeg. The average annual elm loss rate of 2.59% for Winnipeg is higher than the provincial average of 1.46% for towns and cities with buffer zones. This is probably because of the number of entry routes into Winnipeg for migrating bark beetles. There are only two entry routes into each of the five rural Cost Shared Agreement communities with buffer zones, because each community is located on only one river or creek. Winnipeg, on the other hand, has five potential invasion routes for bark beetles (the entry and exit points for the Red River and the entry points of the La Salle, Seine and Assiniboine Rivers which empty into the Red).

Winnipeg annual elm loss rates would have been considerably higher without the buffer zone, as illustrated by the annual loss rate of 4.76% in Cost Shared Agreement communities located on one or more rivers or creeks, but having no buffer zones (Table 2). The Winnipeg buffer zone appears to have potentially reduced Winnipeg's losses by at least 2.17% annually, about 95,480 elms during the period 1975-1990. This estimate of potential loss is conservative because the higher overall disease pressure from the surrounding areas would have reduced the effectiveness of the Winnipeg program.

D) Costs of the provincial program

The Dutch elm disease management program has cost Manitoba Natural Resources $14,497,000 or $1,449,000 per annum from 1981-1990 (Table 4). The sanitation and survey components also include expenditures for operational research into Dutch elm disease management techniques and basic research into curative and preventative measures. The actual costs of tree removals by provincial crews are shown in Table 4. The average cost for all types of removal combined is $85.35 per tree. These removals range from very large trees overhanging buildings or other property (which require expensive and sophisticated mechanical removal equipment and advanced training for staff) to smaller buffer zone or river bank trees growing in wild or semi-wild areas. Manitoba Natural Resources mechanical crews consist of at least three staff with an aerial bucket truck and a removal vehicle (picker truck) for movement of felled trees to disposal sites. Community Services and Provincial Corrections crews (ranging in size from 4 to 10 people) are supervised by Manitoba Natural Resources Dutch elm disease operational staff and require picker truck support if on site burning of cut elms is not practical.

The cost range for tree removal by Manitoba Natural Resource crews ($124.09 for large trees over buildings to $46.12 for riverbank trees) compares very favourably to removal by private contracting. Recent quotes by private contractors in the City of Winnipeg for removal

of "big bucket type trees" ranged from $150.00 to $300.00 per tree in 1990 (M. Allen personal commun. 1991).

VALUE OF THE ELM RESOURCE VERSUS EXPENDITURES

A) Value of an individual elm in Manitoba.

The most recent assessment of the value of Manitoba's elm resource was provided by Miner (1990). The value of individual trees was calculated using a formula developed by the International Society of Arboriculture (Chadwick and Neely 1988). This formula is based on a cumulative point system and the inputs are updated on a continuous basis by the society. The formula is used widely in North America and provides for a variety of appraisal needs (e.g. property appraisers etc.). The formula used to appraise the City of Winnipeg's elm trees is:

APPRAISED VALUE = (BASIC) X (SPECIES) X (CONDITION) X (LOCATION)
where:

BASIC = the value of the tree based on replacement value given its current dbh and height. This BASIC calculation takes into account the initial investment of purchase of the tree and the annual accrued value, plus costs of maintenance over time. The BASIC calculation used for tree appraisal is similar to that used by the insurance industry in North America (e.g. Manitoba Public Insurance Corporation). The BASIC value of the average tree in Winnipeg (45 cm dbh) was calculated to be $8582.00 in 1990 (Miner 1990).

SPECIES = rating based on the durability, resistance to disease, life expectancy and aesthetic value. The species value for elms in North America ranges from 80 to 100% (Chadwick and Neely 1988). Although Winnipeg's elms are long living, have a desired growth shape and are well adapted to the local climate they were given the lowest rating of 80% due to susceptibility to Dutch elm disease.

CONDITION = state of decay of tree at time of appraisal. The condition factor ranges from 20 to 100%. Most of Manitoba's elms in towns and cities were judged to be in above average condition (excluding Dutch elm disease infected trees), showing little decay and were assigned a condition factor of 75% based on the formula criteria. (M. Allen personal commun. 1991).

LOCATION = the location factor was calculated based on real estate values for boulevard trees (valued for noise reduction and aesthetics) and park and private trees (valued for shade, wind brake, architectural effects, erosion reducing and air purifying qualities). The results for the different site types were then averaged to provide a location value of 70%.

The value of the average Winnipeg elm (45 cm dbh) was then calculated to be:

BASIC ($8582.00) X SPECIES (0.8) X CONDITION (0.75) X LOCATION (0.7) = $3604.44

The value of approximately $3600 for the average Winnipeg elm also applies to elms in most rural Cost Shared Agreement communities where the condition of the trees and general real estate values are similar. Considering that some of the rural Cost Shared Agreement communities do not have significant tree cover outside the town boundaries, the elms in these towns are probably of even greater value in enhancing the local environment than those in Winnipeg.

B) Value of the Provincial Elm Resource

Based upon the average value of $3600 per tree, the 1990 value of the elm inventory is $350,710,000 in the 28 Cost Shared Agreement towns and cities in Table 1 and $651,060,000 in the City of Winnipeg. The combined value for the inventoried elms within the 28 Cost Shared Agreement areas and Winnipeg is 1.0 billion dollars. Although original elm inventories do not exist for the remaining 22 Cost Shared Agreement communities, inventories were assessed in Gretna, Emerson, Riverton, Winnipeg Beach, Pinawa, Letellier and St. Jean during 1990 (total = 3246 trees). The value of the elms in 35 Cost Shared Agreement communities and Winnipeg exceeds $1.1 billion. To date accurate inventories have not been obtained for the remaining 15 Cost Shared Agreement communities in the Manitoba.

C) Value of elm losses

Winnipeg has lost an average of $25,639,200 worth of elm trees per year since the initial introduction of Dutch elm disease in 1975 and a cumulative loss of approximately $410,040,000.

Since 1975 the 28 Cost Shared Agreement communities have lost $10,062,000 worth of elms per year and a cumulative loss of $100,642,000. The incremental savings to the Province of Manitoba by keeping the elm loss rate to an average of 2.4% per annum is evident. A doubling of this loss rate in the provincial program to 4.8% per year would have equalled a loss of elms worth in excess of $200 million.

D) Cost of tree removal

There are several scenarios concerning tree removal that require discussion in a cost-benefit analysis of the Dutch elm disease program. Assuming an average cost to the province of $85.35 to remove a tree, the costs of discontinuing the provincial Dutch elm disease program can be estimated. If Dutch elm disease were allowed to run its' course in Manitoba, approximately 80% of all elms would be dead within 5-10 years, based on experience in many cities through eastern North America (Strobel and Lanier 1981). The cost to remove these elms in the 35 inventoried Cost Shared Agreement communities would be approximately $6.9 million (this does include trees in the remaining 15 Cost Shared Agreement communities without elm inventories). This cost projection is conservative, as many of the trees within communities fall into the "Big bucket", high risk category (see Table 5). The removal cost for all 50 rural Cost Shared Agreement communities would probably approach $10,000,000.

The costs of removal of dead elms in the City of Winnipeg if the Dutch elm disease program were discontinued in 1990 would be conservatively estimated to exceed $12,300,000 if removal costs averaged $83.35, and 80% of the trees were removed. The cost of removal to

the City of Winnipeg in 1989 for large boulevard elms was estimated to range from $150.00 to $200.00 per tree (M. Allen personal commun. 1991). Most Winnipeg removals are "big" bucket types and therefore removal costs are greater than the provincial average.

E) Cost of buffer zones

Buffer zones dramatically reduce elm losses and the costs of tree removal in urban areas. Using Brandon as an example (see Elm Losses and Program Costs, Buffer zones), the implementation of the buffer zone prevented the loss of an additional 14,535 trees. The value of these trees is $52,326,000 and the cost to remove them would be $1,211,492. Winnipeg provides a more dramatic example of cost savings provided by buffer zones, where it is projected that an additional 95,480 trees would have been lost without implementation of buffer zones (based on a provincial rate of 4.76% for communities on rivers or creeks without buffer zones). The value of this loss based on provincial costs, would be $343,728,000 and the cost of removal $7,958,258.

F) Benefit of Dutch elm disease Management

The Province of Manitoba has spent $10,297,000 million on Dutch elm disease management since 1981 to manage Dutch elm disease in 50 rural communities (Table 4). In the absence of a Dutch elm disease program the costs of removal of 80% of the elms in the 28 Cost Shared Agreement communities in Table 1 during the period 1981-1990 is $7,765,000. The cost to replace an elm (purchase, transportation, labour and materials) with a three meter tree is approximately $75.00 (Slivitsky 1990). The cost to replace trees lost in the 28 Cost Shared Agreement communities if there had been no program since 1981 is $7,542,000. The Province of Manitoba has realized a saving of $5,010,000 since 1981 by managing Dutch elm disease. The actual saving is considerably greater if original inventory data for the remaining 22 communities existed and could be included in the estimate.

The Province of Manitoba has expended $10,297,000 on Dutch elm disease management since 1981 and lost 16.4% of the provincial inventory in the 28 Cost Shared Communities. In 1990 the remaining elm tree inventory in 35 Cost Shared communities is valued at $362,395,000. Without the Dutch elm disease program (assuming an cumulative 80% loss rate since 1981-1990) the elm inventory remaining in the 35 communities would be worth $86,191,000. An expenditure of approximately $10 million has conserved $276,204,000 worth of elm trees during the last decade.

CONCLUSION

Since the discovery of Dutch elm disease in Manitoba in 1975, the average annual elm loss rate in rural communities has been 2.4%. The value of the urban elm forests within the rural communities and the City of Winnipeg exceeds $1.1 billion. In 1990 the Province of Manitoba spent $2,063,000 to combat Dutch elm disease in 50 rural communities and the City of Winnipeg (Table 4). This represents is 0.2% of the value of the elm trees currently in the provincial inventory. The annual rate of provincial expenditure of approximately $1.5 million since 1981 has kept average annual elm losses to less than 2.5%. A partial reduction in Dutch

elm disease management that would allow even a doubling in the annual elm loss rate would mean a significant increase in expenditures. An increase of the annual loss rate by only a few percentage points would translate directly into costs of $22,300,000 for elm removal, $21,000,000 for replacement trees ($75.00 per 3.0 m tree), a decline in real estate values and a near complete loss of the urban forests in many towns and cities. These costs would be condensed into a 5 to 10 year period. The Province of Manitoba has realized a saving of over $5.0 million since 1981 by managing Dutch elm disease. An expenditure of approximately $10 million on Dutch elm disease management since 1981 has conserved $276,204,000 worth of elms in rural communities during the last decade.

The implementation of buffer zones around selected communities has significantly decreased the loss rate of elm in the urban forests.

The present program has been successful in spreading the costs of Dutch elm disease management over many years and more importantly, provided protection for the elm resource until a "cure" is found or more effective management techniques are developed. In terms of economic cost-benefit, the Provincial and Cities of Brandon and Winnipeg Dutch elm disease programs have been worthwhile.

The significance of Manitoba's urban forests is clearly evident when it is considered that 80% of the population of the province lives and works beneath this resource. The integrated Dutch elm disease management program is an example of how a multifaceted, integrated pest control effort can be developed to minimize an impact on a natural resource. The key component to the program is a commitment to all aspects of integrated management by several levels of government.

ACKNOWLEDGEMENTS

The author would like to acknowledge the helpful advice and comments provided by Mr. L. Matwee, Mr. K. Knowles and Mr. T. Boyce, Manitoba Department of Natural Resources, Forestry Branch, Winnipeg, Manitoba; Mr. K. Fosty, Manitoba Forestry Association, Winnipeg, Manitoba; Mr. M. Allen and Mr. P. Pines, City of Winnipeg, Forestry Branch, Winnipeg, Manitoba; Dr. E. Kondo, Forestry Canada, Forest Pest Management Institute, Sault Ste. Marie, Ont.; Dr. M. Hubbes, Faculty of Forestry, University of Toronto, Toronto, Ont.; Mr. G. Munro, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario; Dr. F. Baker, Department of Forest Resources, Utah State University, Logan, Utah; Dr. D. French, Department of Plant Pathology, University of Minnesota, St. Paul, Minnesota; and two anonymous reviewers from the Manitoba Entomological Society.

REFERENCES

Chadwick, L.C. and D. Neely. ed. 1988. Guide for establishing the values of trees and plants. Urbana, Illinois, International Society of Arboriculture.

Hildahl, V. and C.A. Jeffrey. 1980. The elm's enemy - Dutch elm Disease and its control in Manitoba. Dep. Nat. Resour., Winnipeg, Man.

Hiratsuka, Y. 1987. Forest tree diseases of the prairie provinces. Can. For. Serv., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-286.

Hubbes, M. 1988. Pathogen virulence and host reaction in Dutch elm disease. Naturaliste can. 115:157-161.

Hubbes, M. and R. Jeng. 1981. Aggressiveness of *Ceratocytis ulmi* strains and induction of resistance in *Ulmus americana*. J. of Forest Path. 11:257-264.

Jeffrey, C.A. 1981. Manitoba Dutch elm disease program development. Proceedings of the Dutch elm disease workshop and symposium. Manit. Dep. Nat. Resour. Winnipeg, Manitoba.

Kondo, E.S.; Hiratsuka, Y. and W.B.G. Denyer, editors. 1981. Proceedings of the Dutch elm disease workshop and symposium. Manit. Dep. Nat. Resour., Winnipeg, Manitoba.

Miner, R. 1990. Program evaluation of the City of Winnipeg Dutch elm disease program. Prepared for the Natural Resource Institute. U. of Manitoba. 1990. 20 pp.

Sinclair, W.A. and R.J. Campana, editors. 1978. Dutch elm disease - perspectives after 60 years. Search Agric. (Geneva, N.Y.) 8(5):1-52.

Slivitsky, M. 1990. Dutch elm disease tree replacement program - Winnipeg, Manitoba. Manitoba Natural Resources. Rpt. pp. 1-67.

Stemeroff, M. 1991. Economic Benefit Assessment of Spruce Budworm Control in Eastern Canada. Deloitte and Touche, Guelph, Ont. pp. 1-99.

Stipes, R.J. and R.J. Campana, 1981. Compendium of elm diseases. Am. Phytopathol. Soc., St. Paul, Minnesota.

Strobel, G.A. and G.N. Lanier. 1981. Dutch elm disease. Scientific American. 245:40-50.

Westwood, A.R. 1991. Report of the Eighteenth Annual Forest Pest Control Forum - November 1990. Forestry Canada, Ottawa, Ontario pp. 245-256.

Table 1: Elm losses for 28 Cost Shared Agreement communities in Manitoba 1975-1990.

Location	No.Elms (Year)	No. Elms 1990	% Loss Cumulative	% Loss Per Year	Site[1] Type
Altona	1186 (1982)	1029	1.5	1.6	No River
Boissevain	3140 (1982)	3045	3.0	0.4	No River
Brandon	43649 (1981)	39004	10.6	1.2	River/B
Carman	2346 (1980)	1561	33.4	3.7	River
Crystal City	724 (1982)	556	23.2	2.9	River
Dauphin	9673 (1981)	9309	3.8	0.4	River/B
Deloraine	2137 (1982)	1989	6.9	0.8	No River
Gimli	822 (1978)	708	13.8	1.2	No River
Gladstone	1448 (1981)	1244	14.0	1.6	River/B
Killarney	1321 (1981)	1287	2.6	0.3	No River
Lac du Bonnet	549 (1977)	174	68.3	7.9	River
Manitou	1548 (1981)	1514	2.2	0.3	No River
Minnedosa	1740 (1981)	1707	1.9	0.3	River
Morden	5673 (1982)	4696	17.2	2.1	River/B
Morris	2840 (1981)	2162	23.6	2.7	River
Neepawa	2635 (1981)	2557	3.0	0.3	No River
Pilot Mound	1194 (1982)	1138	4.7	0.6	No River
Pine Falls	755 (1976)	205	72.8	8.3	River
Portage	5777 (1981)	3453	40.2	5.1	River
Rivers	901 (1981)	837	7.1	0.7	River
Selkirk	3656 (1975)	1039	71.5	7.6	River
Souris	4713 (1982)	3896	17.3	2.0	River/B
Steinbach	2317 (1981)	2015	13.0	1.4	No River
Ste. Anne	2907 (1979)	1013	65.1	8.4	River
Stonewall	2017 (1977)	1843	11.0	0.7	No River
Teulon	894 (1976)	519	41.9	3.6	No River
Virden	3803 (1981)	3732	1.9	0.2	No River
Winkler	6051 (1982)	5082	16.0	1.9	No River
	116,460	97,314	16.4	2.42	

1. River = River/creek running through or adjacent to community - no buffer zone.
   River/B = River/creek and adjacent buffer zone.
   No River = No river/creek with significant elm population
2. $$\% \text{ Loss per year} = 100 \left(1 - \left[\left(\frac{\text{Final Inventory}}{\text{Initial Inventory}} \right) \right. \right. \left. \left. \text{(Years Elapsed)}^{\frac{1}{\text{(Years Elapsed)}}} \right] \right)$$

Table 2: Comparison of elm loss per year in Cost Shared Agreement communities with and without watercourses and buffer Zones.

No River/Creek in community	1.02A	13
River/Creek - No Buffer Zone	4.76B	10
River/Creek - With Buffer Zones	1.46A	5

[1] Means followed by different letters are significantly different at the 5% level (Duncan's Multiple Range Test).

Table 3: American elm tree losses in the City of Winnipeg due to Dutch Elm Disease and hazard removals.

Year	No. Removals	% of Elms	Hazard Removals	Total Removals	% of Elms	No. of Elms[1] Remaining
1975	7	.003	---	7	.003	274,993
1976	74	.030	---	74	.030	274,919
1977	73	.030	--	73	.030	274,846
1978	53	.020	4,060	4,113	1.50	270,733
1979	93	.034	3,727	3,820	1.41	266,913
1980	315	.120	5,393	5,708	2.14	261,205
1981	757	.280	6,070	6,827	2.61	254,378
1982	1,100	.364	5,265	6,365	2.50	248,013
1983	1,569	.571	6,392	7,961	3.21	240,052
1984	1,866	.679	7,858	9,724	4.05	230,328
1985	2,219	.810	3,245	5,464	2.37	224,864
1986	1,290	.450	7,191	8,481	3.77	216,383
1987	1,644	.760	4,606	6,250	2.89	210,133
1988	1,426	.679	6,203	7,629	3.63	202,504
1989	3,859	1.906	6,875	10,734	5.30	191,770
1990	3,786	1.974	7,333	11,119	5.80[2]	180,651
Total	20,131		74,218	94,349	2.59[3]	

(M. Allen personal commun. 1991)

[1] Original number of elms was set at 275,000 based on survey.

[2] Since 1975, the American elm tree population has been reduced by 7.3% due to Dutch elm disease and by 27.0% due to hazard removal for a total of 34.4%.

[3] Mean.

Table 4: Summary of expenditures on Dutch elm disease by Manitoba Natural Resources 1981 - 1990 (thousands of dollars).

Year	Winnipeg CSA[1] $ (000's)	Rural CSA $ (000's)	Sanitation Program $ (000's)	Survey Program $ (000's)	CSA Program[2] $ (000's)
1981	350	100	500	70	50
1982	350	100	500	70	50
1983	350	100	500	80	50
1984	350	100	760	90	45
1985	350	100	825	90	45
1986	350	100	825	106	40
1987	350	100	791	106	40
1988	350	100	945	106	40
1989	700	100	1,145	125	40
1990	700	100	1,063	160	40
	4,200	1,000	7,854[3]y	1,003	440

EXPENDITURES (RURAL AND WPG.) 1981 - 1990 = $14,497,000 or $1,449,000 per year.

EXPENDITURES (RURAL ONLY) 1981 - 1990 = $10,297,000 or $1,029,700 per year.

[1] Cost Shared Agreement Program

[2] Costs in managing the province-wide Cost Shared Agreement program include all public advertising, Dutch elm disease literature, service calls, etc.

[3] Both sanitation and survey program costs from the period 1981 to 1983 are estimated as the Dutch elm disease budgets were included with other forest protection activities during this period.

Table 5. Costs to remove Dutch elm disease infected or hazard Elm trees in 1990 by Manitoba Natural Resources (MNR) sanitation crews.

Crew Type	Cost Per Tree $	+ Administration/ Capital Costs (Approximate)	Total $
Big Bucket[1]	104.09	20.00	124.09
Small Bucket[2]	94.00	20.00	114.60
DNR Labour Crews[3]	65.23	20.00	85.23
Community Services Crews[4]	36.71	20.00	56.71
Corrections Crews[5]	26.12	20.00	46.12

AVERAGE COST FOR ALL REMOVAL TYPES = $85.35

[1] Largest piece of removal equipment owned by MNR. Used on large trees around buildings, etc. High risk removal.

[2] Used for moderately sized trees around buildings, etc. High risk removal.

[3] DNR employed sanitation crews. Used on both private properties (around buildings, etc.) and within buffer zones. Moderate risk removals.

[4] Labour supplied by community services. Supervised by MNR staff. Low risk removals on public lands, buffer zones, riverbanks, etc.

[5] Labour supplied by Department of Corrections. Supervised and paid for by MNR. Low risk removal same as #4 above.

A word about herbicides and what you're raising on the farm

Responsible Partners

Herbicides are a growing concern. They should be – but not just among consumers. As concerned as farmers have always been, they must now handle herbicides more carefully than ever before. Otherwise, modern agricultural practices could be severely restricted. Then everyone will suffer. That's why Hoechst has established the program – Responsible Partners – to keep you informed about crop protection chemicals and how to reduce the risks of using them. Remember, the land is for life. Call toll free 1-800-667-5959 for details.

Hoechst