Survey of Agricultural Pesticide Application Practices & Recommendations for Protecting Lower Mainland Riparian Habitat From Off - Target Pesticide Deposit

—a view to the future—

Discussion Paper
Prepared for:

Habitat Protection Branch
Ministry of the Environment, Lands & Parks
Province of B.C.

and

Commercial Chemicals Division
Environmental Protection
Environment Canada

Prepared by:

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Environment Canada
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Acknowledgments

This project was an interagency initiative with the British Columbia Ministry of Environment, Lands and Parks (MOELP), Environmental Canada, Environmental Protection (EP), Ministry of Agriculture Fisheries and Food (MAFF), and the British Columbia Federation of Agriculture (BCFA).

Amongst many contributors to the report, the following people are recognized as central to its administration and production: Sylvia von Schuckmann and Rob Adams (MOELP); Doug Wilson and Mike Wan (EP); Madeline Waring and Ted Van der Gulik (MAFF); and Margaret Crowley (BCFA).

John Elliot and Laurie Wilson of the Canadian Wildlife Service provided important information concerning pesticide use in the Lower Mainland.

Valuable comments were gratefully received from Glen Carlson, Bob Cox, Bruce Cox, Linda Gilkeson, Peter Lewis, Rod Silver and Irene Stuart of MOELP; Joe Kambeitz, Fred Mah, Bruce Reed, and Steve Samis of the Department of Fisheries and Oceans; Dave Melnychuk and Dave Sands of MAFF; and Bob Vernon of Agriculture Canada.

Special appreciation is also extended to the many agricultural producers and pesticide applicators who offered their experiences and opinions on pesticide drift.

EXECUTIVE SUMMARY

Riparian habitat occurs where aquatic and terrestrial systems converge, in the zone of wet soil along edges of streams and wetlands. The diverse vegetation of riparian areas offers a wider range of living spaces for wildlife than any other agricultural land form. These narrow corridors provide critical food, shelter and safe travel routes for extensive communities of fish, amphibians, birds, and mammals.

Sixty different insecticides, fungicides and herbicides are used for pest control on approximately 5,000 ha of berries, 8000 ha of vegetables and 31,000 ha of forage crops grown on the Lower Mainland of British Columbia. As watercourses flow across farmland, the habitat and food chains of wildlife in the riparian community can be affected by pesticides through off-target sprays, drift, and surface run-off.

The purpose of this survey is to assess the effectiveness of current pesticide use guidelines and practices in order to identify practical opportunities for improving riparian habitat protection.

Information on pesticide use guidelines, application technology, and protective land use strategies for riparian areas was collected by canvassing pesticide and habitat conservation specialists from Canada, U.S.A., the United Kingdom, the Netherlands and Denmark. Thirty B.C. Lower Mainland pesticide applicators were interviewed to derive local opinions on resources needed by the farming community to better protect riparian areas from off-target pesticide deposit.

The findings include discussions of:

- current pesticide application systems
- the limitations of existing pesticide use guidelines
- technology and practices that could help applicators prevent off-target pesticide deposit
- means of filling gaps in our knowledge on the potential impact of agricultural pesticides in specific locations

A bibliography pertaining to riparian protection and sustainability is appended.

Recommendations for protection of the riparian zone involve four components:

I. Assessment of environmental risks of off-target pesticide deposit

II. Enhancement of applicator education

III. Provision of field based technical assistance to growers

IV. Development of grower / community / government partnerships for riparian conservation

This report makes eighteen recommendations for addressing these components.

Recommendations:

I Assess environmental risks of off-target pesticide deposit by:

i) identifying riparian areas; assessing zones of pesticide influence by monitoring drift and residues in riparian areas; auditing impact using indicator organisms.

ii) assessing pesticide use patterns over precise geographic areas;

iii) combining thematic maps of biotic resources from various agencies (DFO, Agriculture Canada, MOELP, CDC, AEPC) with i) and ii) for import into a common GIS platform (see IV-xiv; IV-viii) for analysis.

II Enhance educational resources by:

iv) providing pesticide impact models to offer methods of selecting pesticides based on potential environmental impact as well as cost and effectiveness;

v) providing rationale for pesticide use guidelines through information on causes and consequences of riparian contamination; routes of contamination of selected species, sub-lethal and cumulative physiological effects upon fish and wildlife and long term effects on land values;

vi) providing information on the drift potential of pesticide formulations considering droplet sizes, weather conditions and delivery systems to allow field estimates of appropriate buffer zones required to protect habitat and / or "pesticide free" zones;

vii) scheduling pesticide applicators courses in the spring to allow attendance by seasonal employees; designing competence testing that evaluates candidates' ability to rate the potential environmental impact of various active ingredients and formulations;

viii) including environmental danger signs, and drift reducing methods on pesticide labels;

ix) providing video based minority language pest management training outlining pest identification, pest lifecycles and means of making spray decisions; time-sensitive information through voice messaging systems, fax-back systems or computer bulletin boards where necessary.

III Provide field based technical assistance through:

x) farm based workshops to assess sprayer calibration, demonstrate drift, and research adequate buffer zones for various crops and conditions;

xi) conducting cost / benefit studies on: drift reducing application technology; the use of hedgerows to protect water bodies from contamination while providing a source of natural biological pest control agents;

xii) supporting research on monitoring techniques and economic damage thresholds for pests in crops where pest monitoring programs are not well developed.

IV Develop partnership programs for riparian protection by:

xiii) initiating grower / government / community conservation projects designed to: assess farm habitat and its potential for supporting food chains, identify run-off flow patterns, determine naturally occurring conditions that reduce or increase the risk of off-target pesticide deposit, enumerate species indicative of quality fish and wildlife habitat, track species diversity / richness over time;

xiv) developing standardized habitat audit workbooks, usable by conservation groups or growers to map habitat information; mapped information could be digitized for use in GIS risk assessments (as in I-iii above).

xv) furnishing a convenient central source of information on: best management practices, conservation perspectives, results of research into pesticide impact and mitigation strategies, sources of financial or technical assistance for developing drift reduction plans;

xvi) emphasizing the benefits of using drift reducing strategies through production of literature or video based case histories in cooperation with chemical supply companies, IPM service or supply companies and agricultural support organizations;

xvii) developing farmer supportive public relations tools to promote stewardship, in co-operation with stakeholders that support riparian sustainability;

xviii) linking GIS habitat assessment maps with consultant-run IPM decision support systems, to provide subscribing growers with dynamic, least risk spray recommendations on a field specific basis.

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1.0 INTRODUCTION

1.1 Background

Fertile soils, long growing seasons, and proximity to large markets have made the Lower Mainland region one of the most intensively managed commercial agricultural areas in British Columbia. There are approximately 5,000 hectares of berries, 8,000 hectares of vegetables and 31,000 hectares of forage crops grown in the Lower Fraser River basin.

Producers rely upon agricultural pesticides to ensure harvests of high quality crops that meet consumer demands.

Areas of wet soils that connect fully aquatic and terrestrial environments, are found parallel to watercourses flowing across agricultural land. This highly productive, riparian zone supplies food, shelter and escape terrain for fish and wildlife communities throughout the year.

The diverse plant life along riparian corridors maintains water quality by stabilizing banks, filtering run-off and providing shade that protects organisms from damaging ultraviolet radiation and high water temperatures (Gregory et. al., 1991). Organic litter and insects dropping from riparian vegetation provide nutrients that sustain the productivity and diversity of stream communities.

Narrow watercourses and adjacent land occupy relatively small proportions of farms. This marginal land may not be recognized by farm managers as essential habitat for fish, song birds, waterfowl, and mammals.

If unprotected, plants and animals within critical wildlife food chains may suffer incidental or chronic impacts from pesticide drift or runoff.

Although the extent and impact of riparian contamination by pesticides is unknown, organophosphate insecticide residues have been detected in water from selected farm ditches flowing to Lower Mainland rivers (Wan et. al., 1995). One organochlorine insecticide recognized as hazardous to aquatic organisms (Ernst et al., 1991) has been detected in sediments of ditches (Wan, 1994).

In the interest of sustaining the quality of riparian habitat, Environment Canada and the B.C. Ministry of Environment, Lands and Parks funded this project to identify strategies for minimizing off-target deposit of agricultural pesticides. The interagency committee that provided terms of reference for this project also included representatives from Ministry of Agriculture Fisheries and Food and the B.C. Federation of Agriculture.

1.2 Objectives

A survey was undertaken to compile information on:

- methods of treating raspberry, strawberry, blueberry, vegetable and forage crops with pesticides, and their potential for off-target deposit.
- existing guidelines for pesticide use within Canada, USA and Europe and the suitability of B.C. guidelines for adequate protection of riparian areas.
- information and resources needed by pesticide users to assist them in the protection of riparian habitat and waterbodies.
- land use strategies or practices used elsewhere that may be applicable to the protection of riparian areas on Lower Mainland farms.
- The feasibility of developing joint riparian protection strategies with stakeholders and government agencies.

1.3 Scope

This survey reviewed pesticide use guidelines, and drift control methods used both within and outside of British Columbia. Growers, pesticide applicators and technical agriculturalists were canvassed for their opinions on existing approaches to minimizing off target pesticide deposits. This report includes recommendations for additions to applicator training materials, the investigation of low-drift application systems, and the assessment of environmental risks associated with pesticide use.

1.4 Methodology

Information for the report was compiled from January 1 - March 31, 1994. Details of pesticide guidelines, land use practices and application technology were collected by canvassing academic and government pesticide management specialists across Canada, USA, the United Kingdom, the Netherlands and Denmark. A contact list is appended.

Information on Canadian pesticide labelling statements for products under the Pest Control Products Act was abstracted from microfiche files at the Ministry of Agriculture, Fisheries and Food, Cloverdale, B.C.

Local opinions on pesticide application methods and needs for additional tools and information were derived from interviews with 30 Lower Mainland stakeholders. The contact group consisted of both growers and commercial pesticide applicators. Certain information collected in interviews was given in confidence, therefore sources are not provided.

2.0 FINDINGS

About 60 pesticides are recommended for pest control on berry, vegetable and forage crops in the Lower Mainland.

Table 1. lists numbers of farms and areas of selected berry, vegetable and forage crops cultivated in the Lower Mainland along with estimates of areas under Integrated Pest Management programs (IPM). Numbers of pesticide active ingredients available for use on each commodity are listed.

High acreage vegetable crops with less developed IPM programs such as peas, sweet corn and bush beans do not receive high amounts of insecticides compared to other crops listed.

2.1 Overview of Current Approaches to Pest Control

2.1.2 Pesticide Application Methods

Most commercial agricultural acreage in the Lower Mainland receives pesticide via boom sprayers mounted on tractors, trucks or trailers.

Aerial pesticide applications in the Fraser valley have been reduced in recent years. High cost, inferior plant coverage with low volume aerial formulations and urban growth adjacent to farmland have made ground based spraying a more practical alternative for most farms.

Airblast or air carried systems that pump liquid formulations into air blasts from high speed fans are sometimes used for treating berry bushes because of their effective coverage of pests in plants with dense foliage.

In drift sensitive situations, close to crops, weeds are wiped with "hockey stick" wick applicators or sprayed under low pressure through hand held wands connected to tractor pulled tanks and pumps.

Backpack sprayers are used for spot treatments or on small plots of crops.

Table 1: Farms Cultivating Selected Berry, Vegetable & Forage Crops in the Lower Mainland: Ha Cultivated, Ha Grown Under IPM Programs and Number of Pesticide Active Ingredients Recommended for each Commodity.

CROP	Farms Reported 1991 §	Ha 1991 §	Ha under IPM 1993 §§	No. Optional Herbicides §§§	No. Optional Insecticides	No. Optional Disease Controls
BERRIES						
Blueberries	413	1834	149	6	3	3
Strawberries	168	746	159	9	8	4
Raspberries	441	2296	122	6	5	6
VEGETABLES	Total:782	Total:7834*	1365	-	-	-
Potatoes	154	1882*	918	16	15	8
Peas	157	1551*	-	7	6	0
Sweet Corn	237	1268*	-	12	9	0
Bush Beans	133	567*	-	9	5	3
Broccoli	79	547*	-	3	16	3
Brussel Sprouts	28	364*	45	3	16	3
Lettuce	144	283*	121	3	11	2
Cauliflower	88	255*	22	3	15	3
Carrots	130	180	122	6	3	0
Onions	146	165	88	8	5	6
FORAGE CROPS		§				
Corn for Silage	469	6097	-	19	9	4
Alfalfa & Mixtures	76	1113	-	14	13	0
Tame hay	1689	23,972	-	8	15	0

Sources: § Statistics Canada, 1992 ; §§ Gilkeson, 1992 update; §§§ BCMAFF, 1993a ,b, c ; * BCMAFF, 1992.

Blueberries

Peat soils in Richmond, are often too wet to support heavy spray machinery during the critical periods for disease and insect control in early spring. In addition, part-time growers managing small acreages sometimes lack the equipment, time, or detailed knowledge of pest biology required to correctly schedule pesticide sprays.

As a solution, several growers from Richmond, Coquitlam and Pitt Meadows cooperatively contract aerial applicators to treat several farms on a given date. This approach can be inefficient if pest development varies between farms or weather conditions delay the timing of applications.

The potential for pesticide drift during aerial applications is generally recognized by applicators and precautions are taken to minimize off target deposition.

Growers who are able, use ground based boom and air blast equipment. Given similar pressures and spray volumes, airblast systems that direct pesticide droplets upward and horizontally produce finer sprays than boom configurations. Fine sprays are more easily carried off-target by wind.

A Finnish designed *Jonas* picking machine has been used locally as a shroud to contain, recover and reuse pesticide drift and drip. However, the practice is not considered practical by most growers. Other picking machine designs are not as easily modified for spraying and their use would make spraying too slow for all but the smallest farms.

Herbicides are often applied with hand held wands attached to a tractor pulled tank and pump.

Strawberries and Raspberries

Horizontal and vertical open booms are commonly used for chemical application in strawberries and raspberries respectively.

Raspberry canes can exceed 6 feet in height making sprays targeting upper areas of plants susceptible to float and drift. Modified vertical booms that straddle rows of raspberry canes (Rears Mfg., Eugene, Oregon) apply spray from both sides towards the centre, providing more even coverage. The convergence of spray streams results in larger droplets, potentially reducing drift over the unidirectional models.

If post-emergent herbicides are applied during the growing season, extreme care is taken to limit drift and avoid damage to the crop. The majority of growers till, rotovate, mow, or use manual hoes for weed control.

Vegetables

Although most horticultural crop producers operate their own spray booms, contract sprayers are employed if the height of mature crops precludes the use of small scale equipment.

Modern, low volume boom sprayers equipped with computerized on board pesticide injection systems (Appendix I) are used by a small number of applicators in the Lower Mainland. Although not directly influencing over-spray or drift to non-target areas, these systems calibrate output to tractor speed, guaranteeing accurate mixing and even pesticide distribution. This reduces risks associated with disposal of excess pesticide and contributes to more reliable pest control, potentially reducing spraying frequency.

The small, intensively cultivated plots of miscellaneous and ethnic specialty vegetables grown in Burnaby along the north shore of the Fraser River are often sprayed with back-pack sprayers. This is the most practical, least wasteful means of spraying these small mixed crop acreages with staggered pest control periods.

Forage Crops

Pesticides are generally applied to forage crops (grasses, forage legumes, silage corn) with ground boom equipment by growers or contract sprayers.

2.1.3 Drift Associated with Pesticide Application Methods

Monitoring to determine the influence of application equipment on pesticide drift, Wan (1983) showed that aerial sprays resulted in most off-target contamination. Drift from test plot boundaries exceeded 150 meters with fixed wing aircraft and 75 meters by helicopter. Wan (1983) reported that pesticide drift during helicopter spraying is more controllable due to slower airspeed and reduced propeller wake. With liquid formulations, ground based spray booms and backpack sprayers produced drift of over 5 meters resulting in suggested buffer zones of 15 m (5 m wider than agricultural guidelines) (Table 2). Placing nozzles closer to the ground was shown to reduce drift.

Few data are available on drift associated with specific configurations of sprayers used in the Lower Mainland (i.e. nozzle type, boom height, tractor speed).

2.1.4 Integrated Pest Management

Integrated Pest Management programs use biological (e.g. parasites, predators), cultural (e.g. rotation, pruning), physical (e.g. mulches, traps) or sanitary (e.g. destroying plant trash harbouring pests) approaches to pest suppression with a strong emphasis on monitoring pest populations. Good monitoring data leads to the elimination of redundant pesticide applications. Sprays are used only when necessary and timed for effective control.

IPM has had a positive impact on B.C. grown crops in the last 15 years. Most participating growers enjoy net economic gains through reduced chemical and labor costs.

Approximately 8% of the hectarage of strawberries, raspberries and blueberries and 17% of the total Lower Mainland vegetable hectarage was grown under IPM programs in 1991 (Gilkeson, 1992). These numbers omit acreage monitored through extension projects, research, or growers cooperatives.

Large proportions of particular vegetables—carrots (66%), onions (74%), potatoes (42%)—and small acreages of strawberries and blueberries

Table 2. Drift Associated with Selected Pesticide Application Methods

Spray Equipment	Height of Nozzle Above Ground (m)	Drift from Plot Boundary	Suggested Minimum Buffer Zone from Sensitive Wetland Areas (m)
Boom: Fixed Wing	20 - 25	150 +	200
Boom: Helicopter	20 - 25	75 +	100
Boom: Truck	0. 45	5+	15
Backpack Sprayer	1-3	5+	15

(Source: Wan, 1983)

were grown under integrated pest management programs in 1991.

Overall, amounts of pesticides used to manage 15 insect and mite pests on 9 vegetable and berry crops were reduced on over 50% of the area monitored. For 7 of these pests, pesticide use was reduced on the entire area monitored.

Insecticide use for control of carrot rust fly (carrots) onion maggot and onion thrips (onions) was reduced on over 80% of the area monitored.

In potatoes, IPM techniques resulted in reductions of insecticide use for control of tuber flea beetle on 81.8 % of areas monitored. Reductions in insecticide use for aphid control occurred on 73% of the area monitored.

Monitoring provided early identification of disease outbreaks in vegetables, but generally did not reduce pesticide use for their control.

The use of IPM increased from 1991- 1993 in strawberries, blueberries, raspberries and 6 vegetables (Gilkeson, 1992, and unpublished update).

Control methods used in IPM programs include the following:

Biological Controls

Biological controls from commercial sources are used in blueberries (*Hippodamia sp.* against aphids), and potatoes *(Bacillus thuringiensis* against caterpillars). The biological control agent *Aphidius matricariae* is being evaluated for use on potatoes against green peach aphids.

Native biological control agents provide significant levels of pest suppression for spider mites in raspberries and aphids in potatoes.

Parasitic wasps (*Trichogramma sp.*) are being researched for the management of cutworms and other caterpillars in berry crops.

To date, 40 biological agents have been tested against 15 different noxious weeds in B.C. However, further research is required prior to their widespread adoption for weed management (MAFFBC,1993a).

Cultural Controls

Cultural approaches to pest management in vegetables include crop rotation to suppress tuber flea beetle in potatoes, and the clipping of carrot tops and flowers to manage carrot rust fly populations.

In forage grasses, cultural weed control involves out competing weeds with companion crops that are removed early for silage or hay, and clipping weeds prior to seed set.

In corn, delayed planting allows control of early weeds by cultivation. Extensive mid-row cultivation controls weeds until the crop is established.

Industry standards for blueberry cultivation include planting ground cover in between rows to out-compete weeds while reducing the leaching of pesticides and nutrients. Grasses needing mowing only once or twice per season can potentially reduce labour and herbicide input.

Clover is being tested in Delta for use as ground cover to fix nitrogen while suppressing weeds.

Some raspberry growers plant barley as temporary ground cover. The barley dies back in the winter to provide mulch the following season.

Geographic Information Systems (GIS)

The development of computer aided expert systems using geographic information in potato fields from Delta and Cloverdale has helped to identify areas with chronic insect and disease problems. These efforts, begun in 1992, have reduced monitoring costs and increased the effectiveness of pest management strategies (B. Vernon, pers. comm.).

GIS's are capable of spatially relating locations predisposed to pest infestation and highest pesticide input, with riparian areas. Sampling programs designed to identify areas of off-target pesticide deposit, could be combined with such databases to assess risk near sensitive areas.

Outlook
Research by Agriculture Canada and private pest management companies is increasing the viability of IPM practices in the Lower Fraser Valley. Successful programs have fostered grower interest in environmentally compatible pest control.

2.1.5 Drift Reducing Technology

Several pesticide application systems have been developed to reduce off-target drift of pesticide sprays.

Spray Shrouds
Spray boom shrouds fabricated as metal shields, canvass curtains or conical nozzle covers protect pesticide sprays from the wind (Appendix I). Shrouding can reduce drift while increasing coverage and cost effectiveness of pesticide applications.

Most Fraser Valley growers contacted in this study were not familiar with shrouded spray booms. However, at least one berry grower and one contract vegetable sprayer use farm fabricated shrouds to minimize the drifting of herbicide sprays onto crops.

Electrostatic Sprayers
Electrotrostatic systems can reduce wind drift, and increase on-target deposit while reducing amounts of chemicals applied.

Electrostatic systems pass spray streams across electrodes where droplets of formulation become negatively charged. The charged droplets are attracted to positive charges and float along electrical lines of force that wrap around leaves and stems of plants. Forces of static electricity are strong enough to pull spray droplets against gravity, allowing coverage of undersides of leaves. The advantages of electrostatic systems are especially noticable in crops where deep, dense canopies have many layers of leaves.

A British Columbian prototype, (Electromist Sprayer) tested at the Ohio Agricultural Research and Development Centre resulted in 20 fold increases in leaf coverage over levels typically designated as acceptable (B. Bleasdale, pers. comm.).

Over 70 new, energy efficient "turbulent air assisted" electrostatic units powered by 12 volt batteries (Electrostatic Sprayer Systems Ltd., Watkinsville Georgia) have been tested at several American experimental stations on crops of broccoli and strawberries. They are currently used for a variety of commercial vegetable row crops in the United States. This patented system is able to reduce off-target pesticide deposit by over 50% (J. Patrick, pers. comm.)(Appendix I).

Evaluations of electrostatic sprayers are planned for 1994 by the Horticulture Dept., University of Wisconsin (B. Hughes, pers. comm.).

Electrostatic systems have not been tested locally to determine advantages for various crops or optimal rates of pesticide application.

Electronic Pesticide Injector
Pesticide injector systems that mix pesticide as needed during spraying are available from the USA. These systems, now being studied in the UK (A. Ferguson, pers. comm.) are expected to reduce risks associated with overmixing and accidental spills of pesticides (Appendix I).

Pesticide Disposal Systems
A batch treatment system, suitable for both suspended solids and dissolved chemicals from container rinsings and sprayers is currently being tested in Canada (Appendix II).

2.2 Pesticide Use Guidelines

2.2.1 Label Statements on Pesticide Products

The primary consideration in classifying a pest control product is the use for which the product is intended. "Use Precaution" statements on product labels provide on-site references for pesticide use and are critically important for minimizing exposure to operators, farm workers, and the environment.

Data requirements supporting pesticide registration may vary depending of the nature of the product, but include information on toxicological and environmental criteria (Agric. and Agrif. Canada, 1994).

Safety criteria for *commercial* products rate poison hazards according to acute oral LD50 and acute dermal LD50's. Standardized symbols combined with written warnings are used to designate levels of danger concerning poisoning, flammability, explosiveness, corrosiveness and irritancy.

Pesticides in the *restricted* classification have additional use limitations specified on the label if there are safety concerns for plants, animals, the environment or when used in environmentally sensitive areas.

Standardized label templates issued February 1994 for "Commercial" and "Restricted" products under the Pest Control Products Act state conventions for label structure and format (Appendix III).

Use Restrictions

Pesticide sales records from 1991 showed that of 693,176 kg used, 23 products represented 75.5% of the agricultural pesticides used in B.C. (Pesticide Management Program, 1993). This list, combined with information on pesticides applied by 57 Fraser Valley vegetable growers during 1991 (Appendix IV) was used to identify 33 locally important insecticide, herbicide and fungicide active ingredients. Representative "Use Restrictions" designed to confer protection to wildlife habitat and sensitive aquatic areas were reviewed from labels of end use products (Appendix V).

Labels of products whose use poses high environmental risks (e.g. pyrethroids) generally indicate potential hazards to fish, wildlife and aquatic environments. They include dimensions of buffer zones to be maintained adjacent to water bodies. There is no explanation of the ambiguity that although *relative oral* toxicity may be only slight or moderate, risks to aquatic environments remain very high.

Labelling statements designed to avoid contamination of watercourses often do not:

- explicitly define drift,
- indicate how to measure drift
- suggest how to eliminate drift

Precautions on pesticide labels are in small type size and:

- appear in English and French only
- do not include standardized precautionary symbols that indicate wildlife communities known to be affected or general risks associated with use near environmentally sensitive areas.

Drift prediction models are being developed by the Pesticides division, Commercial Chemicals Branch, Environment Canada (Fortin et. al., 1990, unpublished; I. Nicholson, pers. comm.), that will generate data on the environmental significance of drift from particular products. Information on expected environmental concentrations will then be integrated into the pesticide registration process and used to develop improved use instructions for pesticide labels. This level of information is not presently available.

2.2.2 Domestic and Foreign Pesticide Use Guidelines

In some jurisdictions, guidelines for the safe use of pesticides are provided to growers to supplement precautionary information on product packaging and labels.

For example, Alberta growers are sometimes provided with abstracts of pesticide legislation delivered as fact sheets. These memoranda reenforce the importance of following instructions for pesticide safe use to mitigate environmental risk. Ontario, Quebec, The State of Maine, and the UK also offer growers interpretative "best practice" guidelines (Appendix VI).

In addition to practical information on pesticide handling and use, both forestry and agricultural guidance notes typically recommend buffer zones along watercourses (Table 3). Buffer strips resist chemical contamination of species rich areas by maintaining safe distances between spray zones and watercourses, ensuring stream bank integrity, and assimilating excess nutrients from runoff. Although buffer zone dimensions are seldom based on rigorous scientific experimentation, and recommended widths vary, they may be the most easily understood, practical guideline for protecting riparian environments from disturbance.

British Columbia Guidelines

The B.C. Environmental Guidelines for Berry Producers (MAFF (draft), 1993) provide as much guidance on limiting pesticide contamination of water bodies as any of those reviewed. Techniques to control runoff, control spray and minimize drift are included. The guidelines describe methods contributing to drift control, and the safest atmospheric conditions for spraying. The use of low volatility pesticides and low volume sprayers with 10 and 30 meter untreated buffer zones along streams and wells respectively, are recommended. Aerial application is discouraged. An appreciation of drift distances associated with fixed wing and helicopter pesticide applications would be enhanced through the inclusion of data collected during actual crop treatments.

B.C. Instructional Material

The B.C. Pesticide Applicators Course for Agricultural Producers (Adams et. al., 1990) dedicates 46 pages to personal and environmental safety. It considers pesticide handling, and the consequences of contaminating bodies of water, fish, wildlife, beneficial insects and non - target plants. The course re-enforces buffer zone concepts and describes recommended 10 meter wide buffer zones along fish bearing waters and 30 meter wide buffer zones around wells when using field boom sprayers. Students are instructed to consult pesticide labels for warning statements such as "Toxic to Fish or Birds."

The Handbook for Pesticide Applicators and Dispensers (Adams, 1992) similiarly emphasizes hazards of pesticides to non-target organisms. The handbook teaches that permits are required for the use of non-exempt pesticides on public or private land used for forestry, public utility, or transportation and the rationale for 10 meter pesticide free zones (PFZ) adjacent to water bodies. PFZ's must, in turn, be protected by discretionary buffer zones. Recommended minimum widths of buffer zones for protection of PFZ's and fishery sensitive areas when using mist blowers (5 m), truck (5 m) and aerial (100 m for helicopter; 200 m for fixed wing) boom sprayers are provided, based on the research of Wan (1983). It is noted that the applicator assumes responsibility for determining adequate buffer zone widths at the time of application, considering the type of equipment used, speed of travel, terrain, soil conditions and weather. The toxicities of common pesticides to fish, birds and mammals are listed, with locations, numbers of animals affected and pesticides responsible for accidents that occurred between 1956 and 1982. Adams (1992) offers the most comprehensive educational information concerning effects of pesticides on fish and wildlife of those received. However, thorough discussions of riparian ecological functions and values are omitted.

Table 3. Recommended Widths of Buffer Strips for Riparian Protection Quoted in Forestry and Agricultural Land Management Guidelines

SOURCE	WIDTH	PURPOSE
MAFFBC Guide/Berry Prod. (1993 draft)	10 m around streams for boom sprayers 30 m around wells used for drinking	-agricultural pesticides
Alta. Env. Fact Sheet (undated)	30 m "spray free" zone adjacent to water and wells	-agricultural pesticides
New. Brunswick (S. Perly pers. comm.)	dependent on product; generally 15 m 65 m aerial	-agricultural pesticides
Haycock et al. (1993) (Europe and Scandinavia)	10 m - 150 m.; 10 m minimum	-for nutrient reduction -agriculture
Mander (1985) (Estonia)	10 m	- "woodland" NO^3 yields -purify polluted surface flow
Forestry Commission (1991) (UK)	>5 m or 2 - 3X width of stream -	-multiple protection -forestry
Stevens and Reynolds (1993) (UK)	wetland "riparian strip" could beneficially be widened to include additional 10 - 20 m of adjoining slope with more absorbent soils	-conifer harvesting & water quality, habitat protection
Maitland et al. (1990) (UK)	10X width of stream up to max 50 m	-conservation of forest streams
National Rivers Authority (1992) (UK)	2 m for small ditches 10 m for upland streams 100 m. for large floodplain rivers	-mechanical destruction of banks -nature conservation -pollution control
NFLD. Dept. Env / Lands (1994) (draft)	100 m from waterbody or well 25 m from waterbody or well 30 m from waterbody [<20% slope] 50 m from waterbody [>20% slope]	-forestry : Ambush -Roadsides: Roundup -roadsides: Tordon
Adams, (1992)	Pesticide Free Zone (PFZ) plus these recommended buffer zones between PFZ and the treatment area 5 m individual tree treatment 5 m Backpack / truckmounted mistblower 50 m aerial granular spreader 5 m truck mounted boom 100 m helicopter mounted boom 200 m fixed wing mounted boom	-streamside protection during pesticide application
Samis et.al. (1992)	10 m PFZ protected by buffer zones that vary in size depending on equipment and current conditions. Buffer zones are the responsibility of the applicator.	-forestry herbicides -fish and fish habitat

Minority Language Versions in B.C.
Information on the importance of preventing pesticides from entering water bodies and their toxicity to fish, birds, mammals and bees is offered through the Chinese edition of Pesticide Safety and Pest Management for Commercial Vegetable growers (BCMAFF, 1993c) but in less detail than in English documents.

The Punjabi language publication of Pesticide Safety and Pest Management for Commercial Berry and Cole Crop Farmers (BCMAFF, 1994b) briefly discusses means of reducing drift, pesticide toxicity to wildlife, the importance of avoiding runoff to water bodies and general instructions to avoid groundwater contamination. Buffer zones adjacent to water bodies are recommended, but dimensions are not indicated.

The effectiveness of these materials for riparian protection could be enhanced by including:

- additional field-based instructions on how to recognize drift prone field situations
- justifications for concern over habitat contamination; its vulnerability and role in the maintenance of agricultural sustainability.

B.C. Crop Production Guides
The Crop Production Guides (BCMAFF, 1993a, b, c; 1994a, b) provide tables identifying trade and common names as well as relative toxicities of pesticides registered for vegetables, berries and field crops. Conventional application equipment, use of adjuvants, and importance of correct calibration methods are discussed. Sections are dedicated to integrated pest management, safe pesticide use and precautions for protecting fish and wildlife. Recommended buffer zone dimensions are not included. Charts of relationships between particle size and drift are included under sections on aerial applications in the Field Crop edition. These documents could better orient growers towards conscientious habitat protection by offering examples of appropriate dimensions for buffer zones. The guides would benefit from a discussion of possible long term economic benefits resulting from the conscientious use of progressive drift reduction strategies.

Ontario Guidelines
Ontario Best Management Practices are packaged in 3 documents addressing practical solutions for soil and water problems pertaining to field crops, farm forestry habitat, and horticultural crops. IPM practices are incorporated into all three components. Unique to the field crop guideline is the inclusion of a table indicating potential loss of selected pesticides due to surface runnoff and leaching. Buffer strips of vegetation between crops and water bodies are recommended.

State of Maine Guidelines
The State of Maine is one of the few American states with management guidelines dedicated to reducing non-point source agricultural pollution (P. Ward, pers. comm.). The State of Maine Non-point Source Agricultural Task Force (1991) defined "best" practices as methods consistent with efficient, practical, technically and environmentally sound crop production that prevent, reduce or correct water pollution.

Recognizing that different farms may have unique sets of conditions, the task force developed management practices addressing general means of minimizing runoff and leaching of pesticides into water bodies. They support their recommendations with a list of technical publications and consulting organizations of interest to pesticide applicators.

The Maine Department of Agriculture, Food and Rural Resources (1988) encourages spray applicators to compile written drift management plans that map sensitive areas, widths of buffer zones and other routine drift preventive measures employed. Drift plans can help protect applicators from penalties in cases of unconsented exposure to pesticides.

United Kingdom Guidelines

The UK Ministry of Agriculture, Fisheries and Food produces two documents that discuss pesticide drift and briefly, wildlife: the Code of Good Agricultural Practice for the Protection of Water (MAFF, UK, 1991) and the Code for Safe Use of Pesticides on Farms and Holdings (MAFF, UK, 1990).

The Farming and Wildlife Advisory Group (FWAG), a large organization operating on charitable funds, works with chemical companies, the National Farmers' Union and the Ministry of Agriculture Food and Fisheries (TERF, undated) to produce guideline documents for safe pesticide use and habitat protection. FWAG recommends leaving 10 m wide grass or scrub buffer zones around sensitive (and uncommon) habitat, 6 m buffer zones around ponds, and grass strips 1 m wide between cropland and watercourses.

Guidelines for pesticide use from these jurisdictions are summarized in Appendix VI.

2.3 Growers Comments

Pesticide Applicators Training

The content of the Pesticide Applicators Course for Agricultural Producers is generally considered valuable by producers of all the commodities considered.

Growers remarked that:

- Seasonal farm workers are unavailable during winter months and training effectiveness is limited by the sheduling of courses. Training near the end of March, would be more accessible to returning farm staff.
- Raspberries, strawberries and cole crops are primarily grown by Indo-Canadians who may not be fluent in English. Educational materials in the first language of farmworkers are required.

Buffer Strips for Protection of Water Bodies

Fraser Valley growers operate on an expensive land base, with farms often comprised of several small, leased acreages. Where growers require 5 - 10 meter areas at field margins to turn machinery, watercourses bordering fields are protected by a buffer strip of uncultivated land.

However, in some situations maintaining 10 m setbacks from ditches would reduce cropped areas and reduce farm profits.

Some growers feel that:

- Loss of production related to mandatory uncultivated setbacks on leased land should be borne by landowners.
- Confusion arises for producers who must make distinctions between the environmental importance of natural fish bearing waters vs. non fish bearing ditches, and what is needed to protect each.

Pesticide Drift

The greatest pesticide related concern of growers, involves maintaining reliable pest control safely and at the least possible cost. Growers feel that enough calm days occur during spray periods that pesticides can be applied under low wind conditions.

However, interest was expressed in:

- greater availability of drift retarding additives.
- shrouded sprayer technology and the economic benefits of eliminating herbicide damage to crops.
- electrostatic spray technology and the economic benefits of reduced pesticide use and increased efficacy.
- greater reliability in certain equipment.

Leakage is common in couplings connecting hoses to wands and tanks of backpack sprayers.

Joint Riparian Protection Strategies
Although some growers expressed concerns over the need for environmental protection, frustration due to market restructuring (e.g.: North American Free Trade Agreement; Regulations for Occupational Health and Safety for Agriculture; amendments to the Labor Standards Act) has made farmers reluctant to consider joint protection strategies involving land use restrictions.

Even so, proposals for environmentally beneficial projects (requiring minimal financial and administrative burden) that would not interfere with farm operations may be considered by some landowners.

Growers would appreciate recognition for conscientious land stewardship efforts that they apply through day to day farming decisions.

3.0 Recommendations

In consideration of current approaches to pesticide use, information accessibility and gaps in risk assessment data, options for enhancing riparian protection are suggested within four mutually supportive areas:

- Education
- Technical assistance
- Impact evaluation
- Stakeholder Joint Efforts

3.1 Education

Training and Pesticide Use Guidelines
Applicators often select pesticides on the basis of efficacy or cost, rather than on their potential for environmental impact. Training material and guidelines should place additional emphasis upon the causes and consequences of riparian contamination with pesticides.

Although toxicological data exists for pesticides commonly used in the Lower Mainland, it is not organized within guidelines in a form suitable for field use. A model is currently available that considers many environmental parameters (including wildlife safety), calculates environmental impact quotients, and reduces hazard ratings to a single value (Kovach et al., 1992).

This, or similar information should be organized to provide pesticide applicators with a means of:

- *determining the potential environmental hazard of a given pesticide*
- *selecting lowest impact pesticides*

Also recommended is the inclusion of:

- *Numerical indices of drift potential, considering droplet or particle size, formulation, wind speed, temperature, and nozzle height.*

In addition, applicator competency tests should:

- *include components that use these interpretations to assess the student's ability to rate potential environmental impacts of various active ingredients and formulations.*

In the interest of developing an appreciation of the mobility of pesticide drift, training should:

- *include information on contamination routes for recognizable wildlife species. This would explain the rationale for considering risk parameters such as pesticide*

half - life, solubility or volatility.

It is important that all updated material be prepared in a format that can be easily incorporated into existing training manuals.

Pesticide Labelling
Growers are informed that pesticides are safe if used according to label instructions. In practice, label statements often leave actual use criteria to the subjective opinion of applicators. Consideration should be given to labelling improvements that would eliminate divergent interpretations of what constitutes high risk application procedures.

Suggested labelling improvements include:

- *use of precautionary statements describing practical consequences of off-target pesticide deposit*
- *recommended widths of buffer zones appropriate for various application methods and conditions*
- *placing conspicuous "danger to habitat" icons or signage on end-use packaging and labels.*

3.2 Technical Assistance

Growers uncertain of sprayer pressure / nozzle size combinations most likely to minimize drift during spraying may be indifferent to irregular or sub-optimal sprayer performance.

Both the calibration accuracy of farm based pesticide equipment and the need for further technical assistance could be determined through:

- *On - farm or centralized equipment clinics designed to ensure equipment reliability, use of correct pesticide application rates and efficient use of pesticides to reduce costs.*

A similar project was conducted by Engineering Extension and the Plant Industry Branch in Nova Scotia from 1989-1991. The idea was well received by growers and resulted in the servicing of 254 sprayers (Campbell, 1992).

This workshop approach could be used to demonstrate the existence of drift, visually or with sensors (e.g.: Kromekote cards, sensitive tape), and verify the potential waste associated with inefficient drift reduction practices.

Further,

- *a voluntary equipment evaluation program could be used to rate the efficacy of buffer dimensions specific to sprayer configuration, and crop habit.*

Cost : Benefit Reports on New Technology
Companies marketing spray shields and electrostatic systems state that a potential for minimizing drift while substantially reducing spray volume exists in most farm situations.

The applicability of novel technology in the Lower Mainland could be determined through:

- *an independent cost / benefit analysis for new spray technologies to determine their value in terms of increased environmental safety and reductions in chemical costs.*

Pest Management Information
Growers indicated that additional sources of practical pest management advice would assist them in managing pest populations.

Recommendations to consider are:

- *the use of telephone messaging systems, computer bulletin boards or fax back systems to alert growers of critical pest management periods;*

- *the use of video based grower training on pest identification, life cycles, scouting methods, decision making techniques, and factors to consider when planning sprays.*

- *the promotion of research into monitoring techniques and determination of economic pest thresholds for commodities without pest management consulting services.*

- *promoting the availability of private IPM consulting services.*

3.3 Impact Evaluation

Predictions of pesticide use patterns are complicated by crop rotations, periodic occurrences of pests, evolving pesticide preferences, and variations in phenology across geographic areas.

Examples of pesticide combinations, and frequencies of application for 12 vegetable crops during 1991 are provided in Appendix IV.

Data on the quantity and quality of environmentally sensitive areas on Fraser valley farmland are also incomplete.

Therefore, it is recommended that:

- *maps describing the overlap of habitat corridors with pesticide use be developed.*

Critical areas could then be selected for direct (during spraying) and indirect (residue detection) monitoring of drift. This would allow estimates of cumulative off-target deposit and tracking of riparian quality over time.

To that end, relative values of farm based habitat should be assessed through the compilation of data on:

- *distributions of riparian dependent species*

- *presence of endangered species*

- *soil types*

- *species diversity and richness*

Information should also be sought concerning:

- *patterns of pesticide use (e.g.: preferred chemicals, locations, frequency and rates of application)*

- *natural risk factors due to topography and soils at each receiving site,*

- *proximity of habitat to spray zones*

- *amounts of off-target pesticide drift and deposit; needs for "pesticide free zones"*

Determining Pesticide Use Patterns

Chemical Application Tracking Systems (CATS) (e.g.: available from DSD Systems, Hamilton, Michigan) are commonly used on American potato farms and blueberry plantations to determine chemical use patterns in combination with soil and water analyses. These systems (<$1000 CDN) detail rates and dates of pesticides applied, methods, and prevailing environmental factors over precise geographic locations (D. Bates, pers. comm.). This technology enables growers' associations, individual farms or government agencies to easily compile explicit pesticide use profiles.

Habitat Assessment

A quick, reliable system for numerically scoring the physical and biological condition of riparian habitat in agricultural landscapes has recently been developed (Peterson, 1992). Local "environmental audits" designed to inventory wildlife resources on each farm, could rate the value of habitat through:

- *the mapping of watercourses, their dimensions, and drainage routes,*

referencing the quality/diversity/productivity of existing streamside vegetation; soil types

Measuring Drift and Deposit

Levels of existing pesticide residue, if any, are necessary to determine the current state of riparian habitat in Fraser Valley farmland.

A system for measuring drift and deposit should include the selection of study sites:

- *for the assessment of current levels of impact,*
- *to estimate the environmental consequences of continued impact, (if any)*
- *to track progress toward mitigation objectives, where necessary*

3.4 Stakeholder Joint Efforts

The protection of riparian areas from pesticides can also be promoted through the development of stewardship programs for farmers.

Methods for introducing joint effort stewardship ideas to land owners have been pioneered and documented by Hilts and Reid (1993). Legal aspects of implementation have been researched locally (Findlay and Hillyar, 1994).

Several voluntary compliance programs have been successful in Canada. Hilts (1989) reported on Operation Burrowing Owl, in Saskatchewan and the Habitat Enhancement Land Use Program in Manitoba. Wadell (1989) describes The Islands Trust land owner contact program that supports private stewardship of wetlands in P.E.I.

The Natural Heritage League of Ontario has begun a project addressing a wide scope of environmental issues identified by The Ontario Farm Environmental Coalition, a group of four agricultural associations. 40,000 farm action plans are expected to be in place by the year 2000 (S. Hilts, pers. comm.). The project is funded by Agriculture Canada through the Green Plan.

Stewardship programs in B.C. include the Comox Valley Waterfowl Management Project; Greenfields, in Delta; the Delta Farmland and Wildlife Trust, and the Nature Trust grassland conservation project in the southern Okanagan.

3.4.1 Resource Inventories

It is recommended that:

- *a stewardship program involving the agricultural community be inititated as part of a plan to conserve riparian habitat while maintaining profitable farming enterprises.*

Aspects of habitat characterization (see 3.3) may be feasible through partnership projects involving the voluntary participation of community organizations and growers as well as government.

Documentation and interpretation of natural features on farmland would make growers more aware of sensitive areas. Knowledge of the value of water courses and buffer strips to fish and wildlife would provide farm specific rationale for avoiding pesticide drift while contributing to risk assessment data.

Acknowledgment of the connections between farms and habitat networks may encourage landowners to consider additional conservation projects. The results of resource inventories on private land could result in improvements of habitat that is presently of limited value to fish and wildlife.

Tracking of habitat quality over time could provide case histories documenting the value of integrated resource planning to farm operations.

Ultimately, farm-specific map based management plans would emerge that harmonize all management goals to meet grower's long term needs.

Integration of Pesticide Application Data and Agricultural Resource Inventories Using Geographic Information Systems

The technology for linking digitized maps with numerical databases (Geographic Information Systems) exists within Ministry of Environment Lands and Parks, Department of Fisheries and Oceans and Agriculture Canada. However, implementation of a GIS integrating pesticide application data, and resource evaluations, to derive risk assessments would require commitment from several organizations.

Once agencies commit to the development of an integrated database, steps towards implementation would include:

- *Cross referencing existing mapping projects and remote sensing activities by agencies possessing resource databases, to establish a framework for cost-effective data sharing.*
- *Linking habitat assessment maps with consultant run IPM decision support systems to provide growers with dynamic, least risk spray recommendations.*

Contributors of Resource Information for a Geographic Information System

Interdisciplinary contributors to a GIS database may be university departments, Agriculture Canada, Provincial Ministries, the B.C. Conservation Data Centre, the Agricultural Environmental Protection Council, the Department of Fisheries and Oceans, stewardship organizations, and private companies.

Consideration should be given to the development of:

- *a self guiding work-book for documenting habitat characteristics, and natural features on farms. This would allow community based naturalist groups and farmers to contribute to resource inventories by verifying habitat quantity and quality.*
- *public relations mechanisms for acknowledging grower participation.*
- *a "Resource Audit Sponsorship Program" that would generate financial contributions to support specific auditing projects of non-governmental organizations.*

3.4.2 Hedgerows

Use of hedgerows on field margins can protect watercourses from pesticide drift. Hedgerow systems are well established and are promoted in the UK, primarily to provide habitat diversity, wind control and conserve moisture.

Economic benefits of shelter-belts have been researched by The Prairie Farm Rehabilitation Administration in Saskatchewan. Yield increases of over 50% in corn, 28% in canola and 23% in lentils have occurred primarily due to increased daily field temperatures. Most yield advantage is realized across areas 10 times the shelter belt height. (J. Kort, pers. comm.).

The benefits of hedgerows for B.C. Lower Mainland crops remain unresearched. It is recommended that hedgerows be evaluated for their:

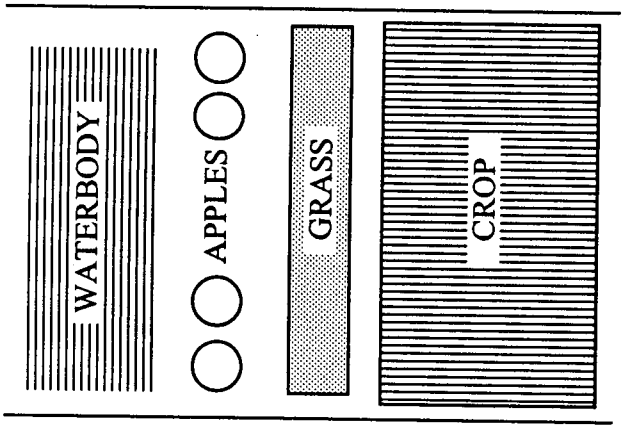
- *ability to protect riparian zones from pesticide drift,*
- *effects upon crop yields,*
- *influence upon species diversity, and the conservation of pesticide sensitive beneficial insects.*

Current Status of Hedgerows

Although some local growers currently support the use of field border vegetation for habitat protection, others have indicated that hedgerows can limit the manoeuvrability of machinery.

Growers are more likely to support hedgerow initiatives if they are composed of harvestable species. Hedgerows constructed with rows of scab resistant (cultivar "Liberty") apples adjacent to grass strips are currently being considered in Delta (Fig. 1).

Fig. 1. Schematic Design of a Harvestable Hedgerow



3.4.3 Information Dissemination

Some growers remarked that existing pesticide guidelines often referred to additional documents that were both difficult to read and obtain.

Improved riparian protection depends upon growers' awareness of the benefits of drift reducing management decisions. A comprehensive information program promoting appropriate pesticide use should encourage responsible practices and voluntary participation in stewardship programs.

It is recommended that:

- *a program of user-friendly communication be established to increase the accessibility of educational and extension information.*

Further, information transfer should be facilitated through:

- *an advertised centralized source for documentation, newsletters, and advice*

Interest in habitat protection strategies could be developed by offering:

- *case histories of farms operating as models of good conservation practice*
- *advance information on local demonstrations and IPM research*
- *opportunities for technical and financial assistance for conservation projects*
- *introductions to drift reducing technologies and successful IPM programs*
- *safe pesticide use guidelines; ongoing details on voluntary compliance programs*

Information regarding routine stewardship contributions that growers make should also be made available. Crediting the agricultural community for their contributions would reward and promote co-operation toward habitat conservation goals.

Information should be developed to:

- *educate neighbours and visitors to rural areas about farmers' past, present and planned stewardship efforts.*

Public relations tools that promote environmental guidelines are used to great advantage in the U.K. by the Farming and Wildlife Advisory Group.

One effective product used in the U.K. is a dual sided windshield sticker advocating the use of buffer strips on the publicly visible side, with the

side facing the vehicle operator displaying a reminder to use appropriate setbacks. (Appendix VII).

Similar communication tools for re-enforcing land stewardship ideals and IPM could be:

- *Practical, oversize farm calendars describing: safe spraying check-lists; benefits of using appropriate buffer strips; accomplishments of land stewardship organizations; IPM solutions*

Such tools could be produced in whole by, or in co-operation with agricultural support organizations such as:

- Growers' associations; chemical suppliers; IPM service and supply companies
- Federal and Provincial conservation agencies
- Green Plan participants (e.g.: The Farm Folk / City Folk Society of Vancouver)

4 Summary

About 60 different insecticides, fungicides and herbicides are used to manage pests in approximately 5,000 hectares of berries, 8,000 ha of vegetables and 31,000 hectares of forage crops grown on the Lower Mainland of B.C.

Ground based boom sprayers are the most common type of pesticide application equipment in the Lower Mainland, with airblast systems used to a limited extent. Aerial application has become less common due to urban development around farmland, expense and inferior plant coverage.

The use of IPM to manage crop pests has led to reductions in pesticide use on Lower Mainland farms. This trend is expected to continue as more IPM research is conducted.

Information on the influence of agricultural pesticides upon riparian habitat across the Lower Mainland is incomplete. Clarification of the complex and sometimes controversial relationship between farming and habitat stewardship depends upon better knowledge of both pesticide use patterns and the current condition of riparian habitat.

The following eighteen recommendations focus on coordinating and improving the availablity of information needed to ensure adequate agricultural pest control while minimizing movements of pesticides into waterbodies and riparian habitat.

Recommendations:

I Assess environmental risks of off-target pesticide deposit by:

i) identifying riparian areas; assessing zones of pesticide influence by monitoring drift and residues in riparian areas; auditing impact using indicator organisms;

ii) assessing pesticide use patterns over precise geographic areas;

iii) combining thematic maps of biotic resources from various agencies (DFO, Agriculture Canada, MOELP, CDC, AEPC) with i) and ii) for import into a common GIS platform (see IV-xiv; IV-viii) for analysis.

II Enhance educational resources by:

iv) providing pesticide impact models to offer methods of selecting pesticides based on potential environmental impact as well as cost and effectiveness;

v) providing rationale for pesticide use guidelines by making information available on causes and consequences of riparian contamination, routes of contamination for selected species, sub-lethal and cumulative physiological affects upon fish and wildlife; long term economic benefits to land owners such as tax deductions for maintenance of green belts, prevention of erosion and soil movement;

vi) providing information on the drift potential of pesticide formulations, droplet sizes, weather conditions and spray pressure to allow accurate field estimates of appropriate buffer zones required to protect habitat and /or "pesticide free" zones.

vii) scheduling pesticide applicators courses in spring to allow attendance by seasonal employees; designing competence testing that evaluates candidates' ability to rate the potential environmental impact of various active ingredients and formulations;

viii) including standardized environmental danger symbols, and drift reducing methods on pesticide labels;

ix) providing video based minority language pest management training outlining pest identification, pest lifecycles and means of making spray decisions; time-sensitive information through voice messaging systems, fax-back systems or computer bulletin boards where necessary.

III Provide field based technical assistance through:

x) farm based workshops to assess sprayer calibration, demonstrate drift, and research adequate widths of "pesticide free" and buffer zones for various crops and conditions;

xi) conducting cost/benefit studies on: drift reducing application technology; the use of hedge rows to protect water bodies from contamination and providing sources of natural biological pest controls;

xii) supporting research on monitoring techniques and economic damage thresholds of pests in crops where pest monitoring programs are not well developed.

IV Develop partnership programs for riparian protection by:

xiii) initiating grower / government / community conservation projects designed to: assess farm habitat and its potential for supporting food chains, identify run-off patterns, determine soil, slope and field margin characteristics influencing off-target pesticide deposit, enumerate species indicative of quality fish and wild life habitat, track species diversity and richness over time.

xiv) developing standardized habitat audit work books, usable by conservation groups or growers to map habitat information. Digitize mapped information for use in GIS risk assessment (as in I-iii above).

xv) furnishing a convenient central source of information on: best management practices, conservation perspectives, results of research into pesticide impact and mitigation strategies, sources of financial or technical assistance for developing drift reduction plans;

xvi) emphasizing the benefits of using drift reduc ing strategies through production of literature or video based case histories in cooperation with chemical supply companies, IPM service and supply companies, agricultural support organizations;

xvii) developing farmer supportive public relations tools to promote stewardship in co-operation with stakeholders that support riparian sustainability;

xviii) linking GIS habitat assessment maps with consultant run IPM decision support systems, to provide subscribing growers with dynamic, least risk spray recommendations on a field specific basis.

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APPENDIX I DRIFT REDUCING APPLICATION TECHNOLOGY FOR AGRICULTURAL PESTICIDES

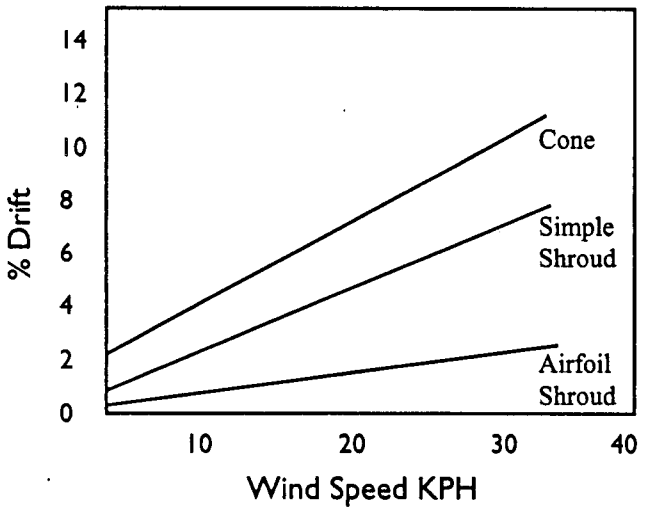
Ia Pesticide Injector Systems

MAFF in the United Kingdom is experimenting with tractor mounted in-line computer programmed injector systems that mix pesticide accurately (within 1oz. per acre) as it is needed, reducing risks associated with over-mixing, spills and worker exposure (A. Ferguson, pers. comm.). One model currently used in the Lower Mainland and available as the "Raven Chemical Injector" from Spray Center Electronics, South Dakota ~$10,000.

Ib Shrouded Sprayers

Innovative Equipment Inc, a subsidiary of Rogers engineering, Saskatoon, Sask, supplies spray boom shrouds covered with a downward deflecting windfoil for mechanical drift control. Spray is contained inside the shroud. The system allows use of smaller drop sizes, and less chemical while reducing spray floating and drift. Wind speed limitations are reduced beyond that supplied by cones or shrouds without windfoils.

Relative Effectiveness of Conical nozzle Covers, simple spray shrouds and shroud with windfoil.



Airfoil Shroud designed by Innovative Equipment Inc.

Source: Brochure; Innovative Equip. Inc., Saskatoon

Ic Electrostatic Spraying Systems

The concept of using electrostatic attraction to prevent spray drift is not new. Automobiles are painted with electrostatic systems around the world.

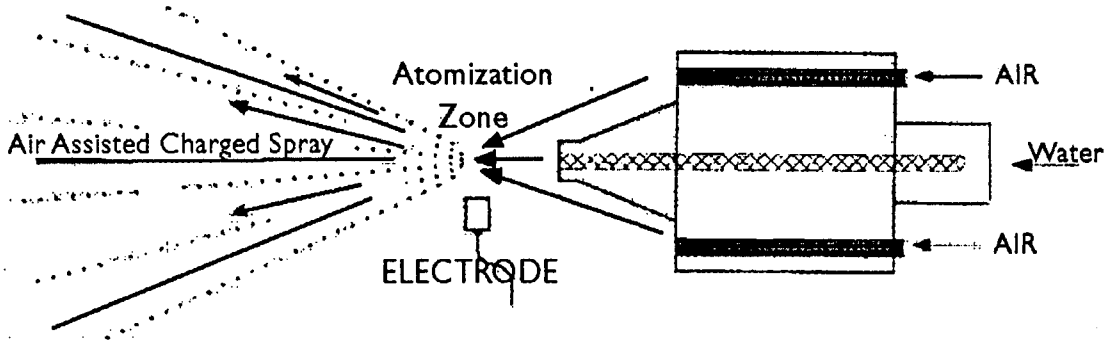
Electrostatic crop spraying systems are capable of increasing insect and disease control while reduc-

ing the amount of water and pesticides used. Static electricity with a force 40 times greater than that of gravity attracts spray to vegetation, reducing the amount passing through plant foliage or being carried off-target by wind. If better plant coverage and better pest control were shown in local trials, growers could reduce costs and use pesticides of lower toxicity.

Patented "turbulent air assisted" electrostatic spraying technology was introduced commercially by Electrostatic Spraying Systems Inc., Watkinsville Georgia (ESS) in 1989. 3 point hitch systems have recently been introduced for field crops.

Air and water enter separately at the rear of the nozzle. Air moves through the nozzle and intersects the liquid at the nozzle tip forming droplets of 30-60 microns in diameter. Air pressure required is 30-40 psi. and liquid pressure is below 15 psi. Equivalent atomization by a hydraulic sprayer would require nearly 3000 psi.

The ESS Air Atomizing Induction Charging Nozzle



As the spray is atomized, the droplets pass an electrode that charges each droplet. Droplets are propelled into the plant cover by a turbulent air stream. Charged droplets lose their electric charge when they contact plant surfaces.

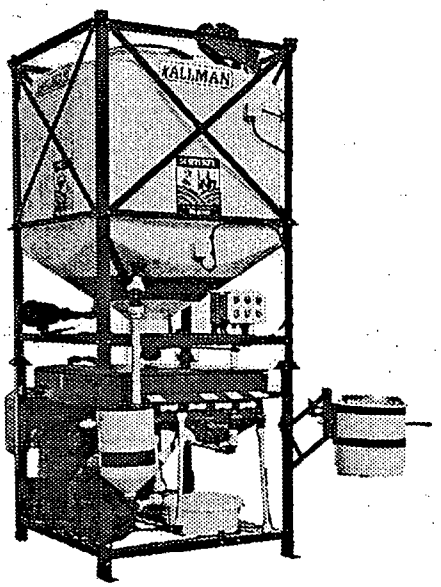
APPENDIX II RISK REDUCING DISPOSAL SYSTEMS FOR AGRICULTURAL PESTICIDES

Treatment of Spray Tank Rinsings

The ICI / Allman "Carbo Flo" water effluent treatment tested with permethrin, atrazine, and alachlor showed a 99% reduction in active ingredients in processed effluent compared to original spray water. Currently two units are being tested in Canada, one at Guelph and one at Forentek (UBC).

The system allows batch treatments of dilute agrochemicals from container rinsings and sprayers. Chemical induced flocculation settles suspended solids and filtration through activated carbon removes dissolved substances. Floc is ultimately disposed of as "special waste."

ICI / Allman "Sentinal"
Pesticide Waste Treatment System.



APPENDIX III PESTICIDE LABELLING TEMPLATES

Updated guidelines for data submitted in support of active ingredient registration (Dir93-01) and end use products (Dir93-03) under the Pest Control Products Act were issued February, 1993. The Pest Control Products registration handbook, released February, 1994 replaces 1986 directives for minimum label content associated with commercial and restricted pesticide products. Specifications considered here apply to agriculturally relevant products under the commercial, restricted and potentially restricted designations.

There is an ascending degree of hazard associated with product categories designated domestic (not described here) commercial, and restricted.

Commercial: (with acute oral LD_{50} over 50 mg/kg; acute dermal LD_{50} over 100 mg/kg.)

Commercial products are marketed for use and can be used safely in the activities specified on the label (e.g.: agricultural or industrial).

Restricted: (with acute oral LD_{50} less than 50 mg/kg; acute dermal LD_{50} less than 100 mg/kg., use associated with significant environmental risks or control products used in aquatic or forestry situations.

Registration is supported with toxico-kinetic studies on mammals, plants, birds, fish and non-target invertebrates) Additional limitations apply with respect to use or operator qualifications because of safety concerns for humans, plants, animals or the environment.

Potentially Restricted:

Some products with inherent characteristics which justify COMMERCIAL classification may have potentially restricted uses. Alternatives for labelling include:

i) Separate registration <u>or</u>

ii) Identification of the RESTRICTED use in a **box** on a secondary panel of a commercial product label with a description of the additional conditions which are imposed. A "nature of restriction" label statement must appear directly under the heading "Restricted Uses." Acceptability of this option is determined by the plant industry directorate.

Language: The language used on control product labels may be either English, French or both.

Products under jurisdiction of the PCP Act bear labels conforming to a specified format including:

i) A principal Display Panel bearing:
a) product name, **b)** class designation, **c)** precautionary symbols and "signal words" (i.e.: danger, warning, caution, flammable, corrosive, eye irritant), **d)** directions to read the label, **e)** guarantee statement, **f)** registration number, **g)** net contents, **h)** name and address of registrant.

ii) A secondary Display Panel bearing:
a) Directions for use (including applications rates), **b)** precautions (information relating to handling, storage display or distribution of the product, **c)** instruction on how to alleviate hazards and where necessary, decontamination methods **d)** any significant hazard relating to human health, wildlife or the environment that may result from the use of the product must be detailed with instructions on how to alleviate such hazards **e)** Disposal containing five standard statements for Commercial products **f)** toxicological information relating to people that have been poisoned **g)** notice to user indicating "product is only to be used in accordance with directions on the label" **h)** notice to buyer indicating a limitation of warranty.

SPECIAL LABEL REQUIREMENTS FOR RESTRICTED USES

Where a control product has Restricted uses on the label, the "Notice to User" statement appears predominantly at the top of the secondary label followed by:

A) "Nature of Restriction" statement.

e.g.: Storage / display / distribution limitations:

i) oral toxicity e.g.: "this product is to be stored apart from food and feed." This restriction is directed to the condition of storage and display and does not impose any additional limitations on the use of products.
ii) Inhalation and Percutaneous Toxicity e.g.: "this product is to be stored apart from lodging for humans, animal quarters, and normal work areas to avoid inadvertent exposure."

The "Nature of Restriction" statement varies with pesticide use, and is determined in consultation with the appropriate officers of the plant industry directorate.

B) Use limitations:
i) Aquatic, Forest or woodland uses: "This product is to be used only in the manner authorized; consult local pesticide regulatory authorities about use permits that may be required"

C) User limitations:
i) Government Agencies and Pest Control Operators
ii) Government Agencies only
iii) Signature required
iv) Veterinarian Use Only.

Label Template for Restricted Product

PRINCIPAL PANEL

Net Contents xx Liters
Liquid Aquatic Herbicide Solution
RESTRICTED
GUARANTEE: ACTIVE INGREDIENT X%
REGISTRATION NO.: XXXXXXX PEST CONTROL PRODUCTS ACT
READ THE LABEL BEFORE USING
Precautionary symbols and signal words (as required)

SECONDARY PANEL

Registrant Company
Full Address

NOTICE TO USER: This control product is to be used only in accordance with the directions on this label. It is an offence under the *Pest Control Products Act* to use a controlled product under unsafe conditions

NATURE OF RESTRICTION: This product is to be used only in the manner authorized; contact local pesticide regulatory authorities about use permits that may be required.

Restricted use

General information: Liquid Aquatic herbicide solution controls filamentous algae and certain other aquatic weeds in farm ponds, industrial ponds and lakes. Liquid Aquatic Herbicide Solution has no direct chemical action on aquatic vegetation. It filters wavelength of sunlight reducing the light intensity. The effect lasts as long as the water keeps its blue color. Additional liquid aquatic herbicide solution can be applied when the color of the water fades or a second complete treatment can be made later in the season when the first algae and weed growth is noticed.

It is recommended that the first treatment be made early in the growing season before algae and weed growth develops. When heavy vegetation is present at the time of the treatment the effect is slow and dead vegetation may be present until fully decayed.

SHAKE WELL BEFORE APPLICATION

METHOD OF APPLICATION: Apply 750 ml of liquid aquatic herbicide solution per 1,000 cubic meters of water or the equivalent of 75 ppm of product. For volumes of water in large tanks or other containers, use 7.5 ml / 10,000 litres. Treatment can be made from the shore without diluting however, water may be added if a larger volume is required. Wind and current action cause intermixing with the entire water area. Re-apply as needed. May be poured through the ice.

PRECAUTIONS: KEEP OUT OF THE REACH OF CHILDREN. Do not use in water where loss of product can occur by water exchange or overflow such as running streams or ponds with outlets.

FIRST AID: have patient lie in coolest spot available. If feverish, cool with cold compresses.

If Swallowed:	GET MEDICAL ATTENTION. Induce vomiting.
If Splashed in Eyes:	Immediately flush eyes with water for at least 15 minutes and get medical attention.
If Spilled on Skin:	Immediately remove contaminated clothing and wash skin with soap and water. Discard contaminated clothing and shoes or clean them thoroughly before re-use.

TOXICOLOGICAL INFORMATION: Active ingredient is a metabolic stimulant. Treat symptomatically.

DISPOSAL:
1. Rinse the emptied container thoroughly and add the rinsings to the spray mixture in the tank.
2. Follow provincial instructions for any cleaning of container prior to its disposal.
3. Make the empty container unsuitable for future use.
4. Dispose of container in accordance with provincial requirements
5. For information on disposal of product and cleanup, contact the regional office of Environmental Protection, Environment Canada

Label Template for Commercial Product

PRINCIPAL PANEL

READY TO USE INSECTICIDAL CONTACT SPRAY
For use in xxxxxxxxx
COMMERCIAL
READ THE LABEL BEFORE USING
GUARANTEE: ACTIVE INGREDIENT X%
REGISTRATION NO.: XXXXXXX PEST CONTROL PRODUCTS ACT
READ THE LABEL BEFORE USING
Precautionary symbols and signal words (as required)
Net Contents xx litres

Registrant Company
Full Address

SECONDARY PANEL

DIRECTIONS:

Contact Spray: Kills crawling insects such as xxx in hog barns. Define equipment to be used. Spray on floors, walls ceilings and counters Use approximately x litres per 100 m^3. Insects must be contacted to be killed.

PRECAUTIONS: KEEP OUT OF THE REACH OF CHILDREN. Not for use on humans. Avoid inhalation of spray Avoid contact with skin eyes and clothing. Wash hands after use. Do not remain in treated areas. Ensure proper ventilation after sealed areas have been treated. Do not contaminate food or feed. Do not contaminate water troughs. Any surface that may contact food or feed products should be washed thoroughly with potable water after spraying and before reuse. Do not use in areas where bee-keeping equipment or supplies are stored. Product toxic to fish. Do not contaminate any body of water. FIRST AID: If on skin wash thoroughly with soap and water. If in eyes, flush with clean water. If irritation persists, obtain medical attention. If accidentally swallowed, obtain medical attention at once.

TOXICOLOGICAL INFORMATION: (as appropriate)

DISPOSAL: Do not reuse container. Follow provincial instructions for any cleaning of container prior to its disposal. Make the empty container unsuitable for use. Dispose of container in accordance with provincial requirements. For information on disposal of unused or unwanted product and cleanup of spoils, contact the regional office of Environmental Protection, Environment Canada.

NOTICE TO USER: This control product is to be used only in accordance with the directions on the label. It is an offence under the *Pest Control Products Act* to use a control product under unsafe conditions.

APPENDIX IV. Pesticides Used, Acreage Treated and Frequencies of Application to 12 Vegetable Commodities in the Lower Fraser Valley, 1991.

Pesticide Used	1991 SURVEY											
	Broccoli	Bruss. Sprts	Cabbage	Carrots	Caulifl	Chinese Veg.	Lettuce	Onion	Peas	Potatoes	Rad/Green On.	Turnip
Ambush	75 (1)	45 (1)	7 (1)		20 (1)					65 (1)		
Cymbush				35 (2)				38 (3)		620 (4)		
Dasanit			97 (3)		25 (1)							18 (2)
Decis	72 (2)	45 (1)	2 (1)		42 (2)							
Diazinon	2 (1)		7 (2)	45.5 (3)	57 (3)			55 (4)		68 (3)		20 (2)
Diazinon G				25 (1)	30 (1)						1 (1)	
Dimethoate							12 (2)		100 (1)			
Disyston							12 (1)					
Dyfonate G									55 (4)		20 (1)	
Furadan	6 (1)		15 (1)			2.5 (1)		2 (1)				
Lannate			7 (1)									
Lorsban			85 (2)		39 (2)							6 (2)
Metasystox R		45 (1)										
Monitor	151 (3)	45 (1)	100 (3)		99 (4)	2.5 (1)				375 (5)		
Parathion							12 (1)	2 (1)	360 (4)	5 (1)		
Piramor										40 (1)		
Sevin										65 (1)		
Thimet G										380 (2)		
Thiodan	6 (1)		27 (2)				7 (1)			453 (8)		
Acres Surveyed	153	45	121	112	131	2.5	-	75	330	1133	-	22
No. Growers	4	1	6	6	6	1	2	6	4	17	1	3

N = Acres Treated; (n) = Frequency of application during 1991;

Source: (L. Wilson and J. Elliot, unpublished)

APPENDIX V RELATIVE ORAL TOXICITY AND CAUTION STATEMENTS FROM PESTICIDE LABELS

Common / *Trade Name*	Oral Toxicity*	Environmental Cautions
Insecticides		
Azinphos-methyl / *Guthion*	Very	To protect wildlife, do not contaminate streams, lakes or ponds. Do not allow drift toward bee hives. This product in highly toxic.
Diazinon / *Diazinon*	Moderate	Toxic to fish and wildlife. Do not allow to contaminate irrigation or domestic water supplies, lakes ponds streams or rivers. Toxic to bees. Birds feeding may be killed.
Ambush / *Permethrin*	Slight	Do not apply with ground equipment within 15 m or 100 m aerial of water, especially productive fisheries water or water fowl habitat. Very toxic to fish. Do not contaminate ponds, lakes, streams or rivers.
Cymbush / *Cypermethrin*	Slight	Do not apply by ground within 15 m of productive fisheries water, waterfowl habitat or 100 m aerial. Untreated borders must be left around environmentally sensitive areas, ponds, streams, ditches, dugouts and wetlands. If 100 m cannot be used for aerial application must be by ground.
Ripcord / *Cypermethrin*	Moderate	Toxic to fish. Do not apply where streams lakes, ponds, water, may be contaminated, nor 15 m from fisheries productive waters. 15 m untreated border required during ground applications, aerial applications use 100 m untreated border around sloughs, streams rivers, dugouts and wetlands. Ripcord is very toxic to aquatic organisms and fish. Overspray or drift must be avoided. Toxic to bees and other beneficial insects.
Fensulphothion / *Dasanit*	Very	To protect fish and wildlife, do not contaminate streams, lakes or ponds. Highly toxic to birds.
Decis / *Deltamethrin*	Slight	Toxic to fish and aquatic organisms. Do not apply where stream, lakes, ponds or water may be contaminated. Untreated buffers should always be left around environmentally sensitive areas (e.g. wetlands, sloughs). Depth of buffer depends on method of application. Toxic to bees and beneficial insects. Drift of pesticide is not always visible to the eye. 100 m buffer required between edge of field; 15 m by ground. Overspray must be avoided.
Dimethoate / *Dimethoate*	Moderate	Birds and other wildlife may be harmed.
Fonophos / *Dyphonate G*	Very	This product is toxic to fish, birds and wildlife. Do not contaminate water sources.
Endosulfan / *Endosulfan*	Very	Do not allow to drift to areas occupied by unprotected persons and animals or streams lakes or ponds. THIS PRODUCT IS VERY TOXIC TO FISH

* Source: B.C. Crop Production Guides.

Note: Some highly *environmentally toxic products* may have only *slight or moderate* relative levels of *oral toxicity.*

APPENDIX V (continued)

Common / *Trade Name*	Oral Toxicity	Environmental Cautions
Furadan / Carbofuran	Very	Do not allow to drift onto areas occupied by beneficial animals. This product is highly toxic to waterfowl, birds, fish and other wildlife. Keep out of areas inhabited by birds, fish and wildlife. Waterfowl feeding on treated fields may be killed. Do not use on fields subject to flooding.
Chlopyrifos / *Lorsban*	Moderate	This product is toxic to fish, birds and wildlife.
Methamidophos / *Monitor*	Very	Toxic to fish and wildlife. Keep out of lakes, streams and ponds. Fish will be killed if their waters are contaminated with this product. Wildlife in contact with treated areas may be harmed. Highly toxic to birds
Pirimicarb / *Pirimor*	Moderate	Harmful to livestock. Avoid contamination of ponds, lakes and waterways.
Carbaryl / *Sevin*	Moderate	Avoid spraying when conditions favor drift from target.
Phorate / *Thimet g*	Very	Highly toxic to fish, birds and other wildlife. Do not contaminate any body of water.
Malathion / *Malathion*	Slight	Environmentally hazardous substance. Do not allow to drift to areas occupied by unprotected animals, streams lakes and ponds to protect wildlife
Fenvalerate / *Belmark*	Slight	This product is toxic to fish and aquatic organisms. Do not apply where streams, lakes, ponds or borders of water may be contam. Ground spray: Do not apply within 15m of fisheries productive water or waterfowl habitats. Do not contaminate any body of water during filling or rinsing. Aerial: Do not apply within 100m. of water. Spray at < 10 kph wind and note environmentally sensitive areas.
Fungicides		
Mancozeb / Ridomil	Slight	Avoid contamination of domestic or irrigation water supplies
Orthocide / *Captan*	Slight	Do not contaminate ponds streams or other bodies of water.
Maneb / *Dithane*	Slight	Do not allow to drift to streams, lakes and ponds to protect wildlife.
Mancozeb / *Manzate*	Slight	This product is toxic to fish. Do not dispose of this product near any body of water.
Copper oxychloride / *Fixed Copper*	Slight	Do not allow to drift to areas occupied by unprotected persons and animals or streams, lakes or ponds to protect wildlife.
Chlorothalonil / *Bravo*	Slight	This product is toxic to fish. Keep out of lakes, streams and ponds.

APPENDIX V (continued)

Common / *Trade Name*	Oral Toxicity	Environmental Cautions
Herbicides		
Agricultural Weed Killer (*Stoddards Solvent*)	Very	Do not allow spray, mist or visible vapours or air containing mist or vapours to contact plants other than those sprayed. Do not contaminate streams lakes and ponds.
Napropramide / *Devrinol*	Slight	Do not contaminate any body of water. Keep out of lakes streams and ponds. Do not contaminate water by cleaning equipment, or disposal of waste. Do not apply when weather conditions favour drift.
Ethalfluralin / *Edge G*	Slight	Direct contamination of any body of water with this product may kill fish. Do not contaminate water by direct application, cleaning of equipment or disposal of wastes.
Simazine / *Simazine*	Slight	Do not contaminate lakes, streams or ponds. RE algae control: Do not use water from treated ponds for human consumption. Although Simazine 80w has low toxicity for mammals, there is no residue tolerance established for fish. Fish from treated ponds should not be consumed. Treated water coming in contact with grass and vegetation may cause damage. Some damage may occur to trees or shrubs growing along margins of ponds.
Princep Nine-T / *Simazine*	Slight	Do not contaminate lakes, streams or ponds.
Lontrel / *Clopyralid*	Slight	Do not apply by air. To reduce drift: use coarse sprays at low pressure (200-275 kPa @ 100 - 200 l/ha; spray at winds less than 16 kph with nozzles that deliver high volume, coarse drops.
2,4-D Amine / *Amsol*	Moderate	Do not spray during high winds. Avoid drift to desirable vegetation. Avoid contamination of ponds, streams, rivers and other water courses. Coarse sprays are less likely to drift. Do not spray at high temperatures.
Vernolate / *Surpass*	Slight	Do not contaminate any body of water including irrigation water or water used for domestic purposes.
Dinoseb / *Dinoseb*	Very	This product is toxic to fish. Do not contaminate any water body in which desirable fish are found.

APPENDIX VI
SUMMARY OF GUIDELINES FOR PESTICIDE USE FROM SELECTED JURISDICTIONS*

British Columbia Env. Guide. for Berry Producers (draft 1993)	Ontario (Source: Best Management Practices, 1993)
1. Environmentally Responsible Principles Use least toxic alternative at minimum effective rate, explanation of environmental and chemical conditions influencing off-target deposition	Includes explanation of insecticide resistance, impacts upon beneficial insects, depth of water table, weather limitations
2. Handling Applicator certification required, follow labelled instructions, storage, protective gear, calibration, hygiene, observe re-entry period.	Read labels; match rates to level of problem & soil type; calibrate sprayer carefully
3. Transport Transport only less than 500 kg of undamaged, labelled containers on absorbent material	No Guidelines Included
4. Storage Track quantities and types of pesticides stored on-site in original containers within a locked, ventilated, building bearing warning signs & separate from herbicides, protective clothing, and spill mitigation materials	No Guidelines Included
5. Mixing Avoid mixing by water course. Land should slope away from water, 10 m away from well, at a lower elevation than wells, protected with berm; use a backflow prevention valve when filling, have an organized spill plan	Never fill sprayer directly from well; avoid back siphoning; maintain air break between water and pesticide; never rinse or wash sprayer near a well
6. Spill Response Know emergency contacts, exclude people and animals from the area, use respirators, eye protection, prevent pesticide spread; bury contaminated material 50 cm deep, 30 m away from water course; decontaminate the surface; if spill lies beside a water course, remove soil and bury.	Establish an action plan in case of spill or poisoning
7. Disposal Drain pesticide containers into spray tank by holding vertically for 30 sec.; if containers are not triple or pressure rinsed immediately, treat them as special waste.	No Guidelines Included
8. Runoff Control Do not apply in a heavy rain, use minimum tillage, grade to reduce slopes; leave border of veg. around water courses to contain runoff.	Avoid spraying if heavy rain is forecast, maintain buffer strips of vegetation to reduce runoff into water. If control is good, reduce low end of registered rates; examples of % leach and runoff loss of selected pesticides are included
9. Drift Control Spray with low pressure, minimum boom height, proper nozzles, minimum spray angle; use low volatility chemicals, thickeners and low volume sprayers @ temps < 30C and wind < 8 kph. Buffer zones: 10 m using booms by streams, 30 m around wells	Maintain buffer strip of vegetation between surface water and cropped fields, use higher water volumes (50 gal./acre) and larger nozzles; consider using larger drops, low pressure, higher water volumes, (> 170 l. / ha), larger nozzles; delay spraying if wind > 8 kph.
10. Aerial Application Only as a last resort, pilot must have applicators cert., notify public prior to spraying; flag target areas; use ground observer; 500 meter buffer from schools.	No Guidelines Included

**Appendix VI includes summaries of all guidelines submitted by personnel in the contact list (Appendix IX).*

APPENDIX VI (CONT.)

Alberta (Source: Fact sheet, Alta. Environment, undated)	Maine (Source: NPS Ag. Task Force, 1991)
1. Environmentally Responsible Principles Use only as required, follow label instructions; solubility adsorption and degradation concepts described, consider implications of soil profile, composition and slope	Adopt biological controls as alternative to pesticides. Rotate Crops to reduce likelihood of using same pesticides continually. Match application rate to soil type, organic matter content and peat population
2. Handling "Use common sense," keep spray equipment calibrated	Become a certified applicator; calibrate equipment and avoid over application; read and follow label directions; Application techniques and amount of pesticides used should reflect the sensitivity of the site
3. Transport Water crossing locations must have solid bottoms and shallow water; booms, lines and pumps must remain out of water, with tanks securely attached, conc. pesticide in secondary containment	No Transport Guidelines Included
4. Storage Store in separate room away from water (min 30 m), with an impermeable floor & no drain	Consider risks of environmental contamination and provide safe, secure storage for pesticide containers
5. Mixing Use closed systems designed to eliminate spills for mixing and loading; not permitted within 30 m of open water; do not fill spray tanks directly from water source; air gap must be maintained; don't immerse spray equipment directly into open water	Protect waters from contamination when mixing, or rinsing containers; prevent spills of concentrates, mixtures and wastes, use rinsate on a treated field
6. Disposal Spray equipment should not be washed or transported in or through a water body; triple or pressure rinse prior to disposal at an Agri -chemical Container Collection site. Add rinsings to spray mixture.	Triple rinse containers and drain into spray tank. Follow Maines' returnable pesticide container law.
7. Spill Response No Guidelines Included	Make MSDS's available
8. Runoff Learn about pesticide mobility and persistence; assess the susceptibility of soil to pesticide leaching; consider location of wells water table and surface water. Check weather prior to spraying, do not irrigate sprayed areas creating runoff.	Develop record systems for the farm that identify soils, & watertable as risks for pesticide movement to water; avoid highly leachable chemicals on sensitive areas; avoid pesticide applications prior to significant rainfall. Be familiar with sensitive areas.
9. Drift Control Spray free zone 30 m adjacent to water and wells, use procedures that minimize drift; Approval by Alta Environment required for spraying within 30 m of open water bodies.	Follow label guidelines regarding wind speeds and equipment requirements. Be familiar with sensitive areas. Commit anti-drift plan to paper.
10. Aerial No Guidelines Included	No Guidelines Included

APPENDIX VI (Cont.)

	Denmark (Source: pers. comm Klause Hanson, Ministry of Environment)	United Kingdom (Source: Ministry of Agriculture Fisheries & Food, 1990, 1991)
1.	Environmentally Reponsible Principles	Establish what reasonable precautions are required to safeguard the environment; minimize drift to protect water, desirable plant communities and conserve wildlife, including beneficial insects; avoid drift or direct application to field margins
2.	Handling	Anyone using pesticides must hold certificates of competence in safe effective use. Pesticides should not be left unattended unless securely stored
3.	Transport	Emergency responses should be identified, do not ford rivers
4.	Storage ***Growers rely upon labelled information for usage guidelines. No additional guidelines prepared for distribution.***	Do not store where there is risk of polluting surface or ground water; small amounts may be held in fire resistant bin, chest or cabinet with sump large enough to contain leaks, door sills and impermeable flooring
5.	Mixing	Use contaminated water to mix additional pesticide if needed
6.	Disposal	Do not discharge into water, send unwanted containers to supplier or disposal contractor, fill and wash equipment in areas chosen and built for the purpose; rinse equip., do not damage labels; bury containers 80 cm. below levels of drains, keep records of type and amount buried. Apply contaminated water to crop or land of little wildlife value and able to absorb liquid without runoff to watercourses, groundwater, septic tanks or sewers
7.	Spill Response	Staff should be trained in emergency response; water should not be used for pesticide fires.
8.	Drift Control	Never apply where there is danger of drift onto water; avoid unnecessary use of fine spray droplets, avoid high temp. with low humidity; use correct nozzles, boom height; protect field margins near watercourses; consider wind speed / direction
9.	Aerial	Pilots require aerial applicators certification

APPENDIX VI (Cont.)

U.K.

(Source:British Agrochemical Assoc., 1993)

1. Environmentally Reponsible Principles

Use pesticides only when necessary; keep updated on latest pest control information

2. Handling

Use only as recommended on the label; all applicators must have proficiency certificate; never spray in high winds or if rain is expected, never apply over water courses, review your pest control program annually

3. Transport

Cross watercourses by bridge or tunnel; drive at a steady pace

4. Storage

Store in flood free areas away from drains, watercourses, ponds, surface waters, water supplies and groundwater catchment areas. Floors must be impermeable, cleanable, have no internal drains with raised sills on doors; keep inventory records; spill recovery materials must be available and labelled

5. Mixing

Check for damage to nozzles, hoses, and tanks; calibrate system and check for leaks; mix no more spray than is immediately required; never make a direct connection between a spray tank and water supply; all hose connections should be fitted with a syphon break device; never handle open pesticide containers near water supplies or watercourses. Use a sprayer that directly meters chemical concentrate into the spray line for dilution with clean water

6. Disposal

Order only enough product for immediate work; do not dispose into drains, watercourses or onto land; choose products and equipment that minimise or eliminate contaminated packaging, and reduce operator exposure (ie: water soluble bags, closed transfer systems, or chemical induction hoppers with container rinsing facilities; pressure rinse empty containers (whenever possible) and drain for a minimim of 30 sec. into the spray tank; solids: shake packs, read product label for specific instructions; puncture or crush containers and dispose at a licensed disposal site; unwanted products should be disposed of by a specialty contractor; bury only where there is no risk of water contamination a minimim of 80 cm. deep and below land drains; mark and inventory the area; only burn with approval of env. health office. Dispose of surplus spray on uncropped land (not fallow or stubble) of minimum wildlife value that is not liable to runoff

7. Spill Response

Have written contingency plans for spillage; contain spills with absorbents e.g.: sand or fullers earth, dispose of contaminants by a specialized waste disposal contractor

8, 9. Runoff and Drift Control

Minimize drift using the correct nozzles, pressure , boom height, speed and water volume, use non spray buffer strips along ditches and watercourses, use the most accurate spraying technique possible

APPENDIX VI (Cont.)

United Kingdom

Source: Farming and Wildlife Advisory Groupt

1. Environmentally Responsible Principles

Examples are given of beneficial insects (flies, beetles, mites, parasitic and predatory wasps, and spiders) that could be affected by insecticides used to kill aphids; examples of secondary effects of pesticides on bird species dependent upon weed seeds and insects whose decline is attributed to herbicide use (grey partridge and linnet); choose varieties of crops on disease resistance criteria, scout crop to assess the need for controls; ask supplier how pesticide might affect wildlife

2. Handling

Calibrate sprayer frequently, use correct equipment and spray accurately, seek expert help on threshold levels of pests, select product with least potential damage to natural environment with specific target action and short persistence. Use only approved chemicals in approved way by trained applicators, keep spray boom as low as possible consistent with an even spray pattern; if drift may occur use coarsest spray that product label will allow. Pesticides should never be used to kill crows, foxes or other predators

3. Mixing

Avoid making up surplus spray solution.

4. Disposal

Dispose of dilute pesticides using an approved soakway or a water effluent treatment plant; as a last resort apply to uncropped land of little wildlife value; spray last full tank at slightly reduced concentration, then use tank washings to spray same area with washing; dispose of containers at licensed landfill; bury containers .8 m deep on a marked site that will not result in water contamination; do not allow accumulation of surplus pesticides in an area where concentrations will build up.

5. Drift Control

10 m wide grass or scrub buffer zones should be established around sensitive or uncommon habitat; 6 m wide buffer zones around ponds; a grass strip of at least 1 m should be left uncultivated between edge of crop and boundary features (ditches, watercourses, hedge). Effort should be made to avoid pesticide drift; it is a specific requirement of pesticide regulations to contain sprays within target area: ensure breeze is blowing in a safe direction; safe means away from hedgerows, watercourses, ponds; when contractors are used, spray operators must be made aware of areas important to wildlife.

10. Aerial

No pyrethroids may be sprayed by air within 250 m of water; spraying any insecticide from the air should be avoided.

APPENDIX VII STEWARDSHIP PUBLIC RELATIONS TOOL USED IN THE UNITED KINGDOM

Two sides of a windshield sticker used by growers wishing to be seen as caring for the environment (size reduced Appx. 60%)

Caption on the back of the decal reads:

AVOID SPRAYING INTO THE HEDGEROW, TURN OFF NOZZLES.
UNITE WILDLIFE AND FARMING WITH HELP FROM FWAG.

SUPPORTED BY RHONE-POULENC AGRICULTURE-
PROTECTING YOUR FUTURE.

IF YOU CARE ABOUT HEDGES AND WISH TO BE SEEN AS CARING FOR THE ENVIRONMENT DISPLAY THIS STICKER IN YOUR TRACTOR CAB.

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