Survey of Pesticide Use in British Columbia: 1999

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Executive Summary

The survey of pesticide sales and use in British Columbia during 1999 is the third in a series of surveys conducted for the British Columbia Ministry of Environment, Lands and Parks (MELP) and Environment Canada. The long-term objective of these surveys is to determine trends in pesticide sales and use. The first survey was commissioned after MELP began to encourage and promote the adoption of Integrated Pest Management (IPM) to reduce reliance on pesticides and eliminate unnecessary pesticide uses. In addition to assessing changes in pesticide use, the 1999 survey was conducted as part of the Georgia Basin Ecosystem Initiative (GBEI).

Under the GBEI, Environment Canada plans to develop management strategies for the toxic chemicals of greatest concern. In order to determine management needs, Environment Canada is compiling an inventory of a limited number of priority toxic substances and quantifying their loadings to the environment. To begin the source inventory of toxic substances, Environment Canada produced the "1998 Nominating List of Toxic Substances in the Lower Fraser/Georgia Basin." This list of 44 substances emphasizes suspected endocrine-disrupting chemicals and includes 14 pesticide active ingredients or groups of active ingredients. The development of management strategies for pesticides requires an understanding of pesticide use patterns within the Georgia Basin.

The objectives of the 1999 pesticide sales and use survey were to:

- obtain pesticide sales records for 1999, including veterinary and commercial pesticides;
- obtain pesticide use data for 1999 for anti-sapstain chemicals and wood preservatives;
- obtain pesticide use records for the Lower Mainland Region from annual summaries of use submitted by pest control services renewing licenses in the agriculture and landscape use categories;
- incorporate the results of a separate survey of domestic pesticide use in the Greater Victoria conducted by the Georgia Strait Alliance;
- compile the information into databases and summary tables so that the data could be compared to the results from previous two surveys; and
- provide separate tabulations to show patterns of pesticide use within the Georgia Basin.

The study included data gathering and data analysis. The data were compiled from existing sources, including the Annual Summary of Reportable Pesticide Sales by

licensed vendors and the Annual Summary of Pesticide Use by pest control service licensees. Data also were acquired through vendor and user surveys.

As in the previous two studies, the survey included an evaluation of data quality. Errors and irregularities on both the sales and use reports were identified and summarized. In order to evaluate the accuracy of the data reported a survey was conducted to determine the methods used by service licensees to calculate annual pesticide use.

The study results showed that in 1999, British Columbians purchased or used 8,102,384 kg of pesticide active ingredients. This value excludes most Domestic label products, but does include Domestic products sold by veterinarians. Of this total, 7,010,944 kg (86.5%) were anti-microbial chemicals, consisting primarily of commercially applied wood preservatives and anti-sapstain chemicals. Insecticides (including biological insecticides) accounted for 394,534 kg (4.9%) of the total pesticides, while 335,059 kg (4.1%) were herbicides and 269,363 kg (3.3%) were fungicides. The remaining pesticides included fumigants, plant growth regulators, insect growth regulators, molluscicides, vertebrate control products, adjuvants and surfactants.

The total, province wide pesticide use included 286 active ingredients. Twenty of these active ingredients accounted for 95% of the pesticides sold or used during 1999. Creosote alone accounted for 66.5% of the pesticide use in the province. The wood preservatives chromated copper arsenate (CCA) and didecyl dimethyl ammonium chloride (DDAC) accounted for 11.4% and 3.8% of all pesticides used, respectively. Other important active ingredients included mineral oil (insecticidal or adjuvant), representing 3.2%; the wood preservative pentachlorophenol, representing 2.5%; borax[1], representing 1.9%; and the herbicide glyphosate (isopropylamine form), representing 1.3% of the pesticides used.

The Georgia Strait Alliance interviewed 409 Victoria-area residents, 87% of whom reported using some type of pesticide. The most commonly used category of pesticides was insect repellents, which were used by 37% of the people surveyed. Use of weed killers (herbicides), insecticides and fungicides was reported by 34% of the survey respondents. At least 25% of the respondents used cockroach and ant control products, herbicide-fertilizers and/or slug and snail baits.

Thirteen (possibly fourteen[2]) pesticide active ingredients included in the "1998 Nominating List of Toxic Substances" were sold in the Georgia Basin during 1999. Sales of these products amounted to over 41,000 kg or approximately 8.2% of the pesticides sold in the basin. Only two of the nominated toxic substances, atrazine and malathion, were among the top twenty pesticides sold in the Georgia Basin.

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[1] Includes all forms of borate and borax, which are primarily used as anti-sapstains, but excludes sodium metaborate tetrahydrate (a herbicide)

[2] The PMRA database does not indicate whether the "surfactant blends" include non-ionic surfactants, one of the nominated toxic substances.

Lower Mainland pest control services licensed in both the agriculture and landscape categories applied some pesticide active ingredients that were included in the "1998 Nominating List of Toxic Substances". Services licensed in the agriculture category applied almost 10,000 kg of 12 active ingredients included on the "Nominating List." These active ingredients amounted to approximately 12% of the pesticides applied by agriculture services in 1999. Landscape services in the Lower Mainland used nine pesticide active ingredients that were included on the "Nominating List." Applications of these chemicals totalled 123 kg or 1.4% of the pesticides applied by landscape services.

The long-term objective of the British Columbia pesticide surveys is to determine trends in pesticide sales and use. The 1999 survey provides three data points for most categories of pesticides, which is the minimum amount of data required to detect a trend. However, three data points provide minimal statistical power. The major changes in pesticide sales and use from 1991 to 1999 were as follows:

- The total quantity of reportable pesticides sold increased by about 19%.
- Active ingredients that showed consistent and substantial sales increases (>10,000 kg) from 1991 to 1999 included mineral oil (insecticidal or adjuvant), the fungicides chlorothalonil and formaldehyde, and the biological insecticides *Bacillus thuringiensis*, Serotype H-14 (used for mosquito control) and *Bacillus thuringiensis* Berliner ssp. *kurstaki* (used for caterpillar control).
- During the same period, sales of ethalfluralin and atrazine declined by over 10,000 kg (90% and 50% decreases, respectively).
- Six active ingredients remained among the top seven reportable pesticides sold in all three years. These active ingredients were mineral oil (insecticidal or adjuvant) and glyphosate (isopropylamine), which were numbers one and two respectively in all three years, plus mancozeb, sulphur, mineral oil (herbicidal or adjuvant) and captan.
- The sales of federally-labelled Restricted pesticides decreased from 1991 to 1999. Major decreases (over 7,000 kg each) occurred for methyl bromide, azinphos-methyl and dinoseb.
- The quantities of flea control products sold by veterinarians declined by 78% due to a change in flea control technology (replacement of pesticides with a product administered orally or by injection).
- There was a major change in the pesticide active ingredients used for flea control. Imidacloprid, which was not used in 1991 or 1995, comprised 62% of the externally applied flea control products used in 1999. Chlorpyrifos, which amounted to 17% of the flea control pesticides applied by veterinarians in 1991, was not used in 1999.
- The use of pesticides by landscape services in the Lower Mainland decreased by 40% (6083 kg).

- Landscape services' use of sodium metaborate tetrahydrate, sodium chlorate and glyphosate isopropylamine decreased by over 1000 kg each (45% to 96%). In addition, the use of paraquat decreased by over 600 kg (97%).
- The use by landscape services of insecticidal soap increased by 717 kg (227%). In addition, the use of chlorothalonil increased 1200% from 28.5 kg in 1991 to 371 kg in 1999. The use of quintozene increased by 326 kg (70%).
- Anti-sapstain chemical use by lumber mills declined by over 40%, and the decrease was statistically significant at the 1% level.

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1.0 INTRODUCTION

1.1 Background

The survey of pesticide sales and use in British Columbia during 1999 is the third in a series of surveys conducted for the British Columbia Ministry of Environment, Lands and Parks (MELP) and Environment Canada. The long-term objective of these surveys is to determine trends in pesticide sales and use. In addition to assessing changes in pesticide use, the 1999 survey was conducted as part of the Georgia Basin Ecosystem Initiative (GBEI). Under this initiative, Environment Canada plans to develop management strategies for the toxic chemicals, including pesticides. The development of management strategies for pesticides requires an understanding of pesticide use patterns within the Georgia Basin.

1.1.1 Ministry of Environment, Lands and Parks Pesticide Surveys

In 1991, the British Columbia Ministry of Environment, Lands and Parks (MELP) established the objective of encouraging and promoting adoption of Integrated Pest Management (IPM). IPM methods reduce reliance on pesticides and eliminate unnecessary pesticide uses.

In 1992, MELP commissioned the first survey of pesticide sales and use records in British Columbia, using data from 1991 (Norecol Environmental Consultants 1993). A second survey of pesticide use was completed using data from 1995, and the results were compared with the 1991 study results (Norecol, Dames & Moore 1997). MELP's intention was that additional surveys would be conducted periodically to document changes in pesticide use.

The 1991 and 1995 surveys included the following data sources:

- pesticide sales and use information filed as part of the licence application requirements for retail pesticide vendors and licensed pest control services;
- a survey of wholesalers of Domestic-label pesticides, whose sales are exempted from the reporting requirements;
- a survey of wood preservative plants; and
- a survey of anti-sapstain chemicals.

The 1995 study was somewhat more limited in scope than the survey of 1991, as only pest control services located in the Lower Mainland and licensed in the landscape category were included. In the 1991 survey pest control services from all MELP regions were included. As well, a broader range of Domestic label pesticides were analyzed in

the 1991 survey than in the 1995 study, which only analyzed the Domestic pesticides sold by veterinarians. Slimicides (biocides used in cooling towers and paper making) were included in the 1991 survey but absent from the 1995 survey. With the exception of these omissions, the 1995 survey provided the first opportunity to monitor changes in pesticide use patterns.

The 1999 survey is similar in scope to the 1995 survey, except that it incorporates the results of a separate survey of domestic pesticide use in the Capital Regional District (CRD). The elements of the 1999 survey are discussed in Section 1.2.

1.1.2 Georgia Basin Ecosystem Initiative

As part of the GBEI, Environment Canada plans to develop management strategies for the toxic chemicals of greatest concern. In order to determine management needs, Environment Canada is compiling an inventory of a limited number of priority toxic substances and quantifying their loadings to the environment. To begin the source inventory of toxic substances, Environment Canada produced the "1998 Nominating List of Toxic Substances in the Lower Fraser/Georgia Basin". This list of 44 substances emphasizes suspected endocrine-disrupting chemicals and includes the following 15 pesticides or groups of pesticides:

- Atrazine
- Chlorinated phenols (including pentachlorophenol);
- Didecyl dimethyl ammonium chloride (DDAC)
- 3-iodo-2-propynyl-butyl carbamate (IPBC or iodocarb)
- Dinoseb
- Endosulphan
- Lindane (gamma-hexachlorocyclohexane or gamma-BHC)
- Malathion
- Methoxychlor
- Metolachlor
- Non-ionic surfactants (including nonyl- and octylphenolethoxylates, which are used as adjuvants)
- Organotins (including fenbutatin oxide)
- Parathion
- Simazine
- Trifluralin.

The "1998 Nominating List" also includes several substances that are components of wood preservatives. These substances (and the corresponding wood preservatives) are:

- Polycyclic aromatic hydrocarbons (constituents of creosote); and
- Chromium, copper and arsenic (constituents of chromated copper arsenate and ammoniacal copper zinc arsenate).

The inventory of pesticide sales and use will provide an estimate of the loadings of these substances to the environment of the Georgia Basin.

1.2 Study Objectives

The major objectives of the 1999 survey were to:

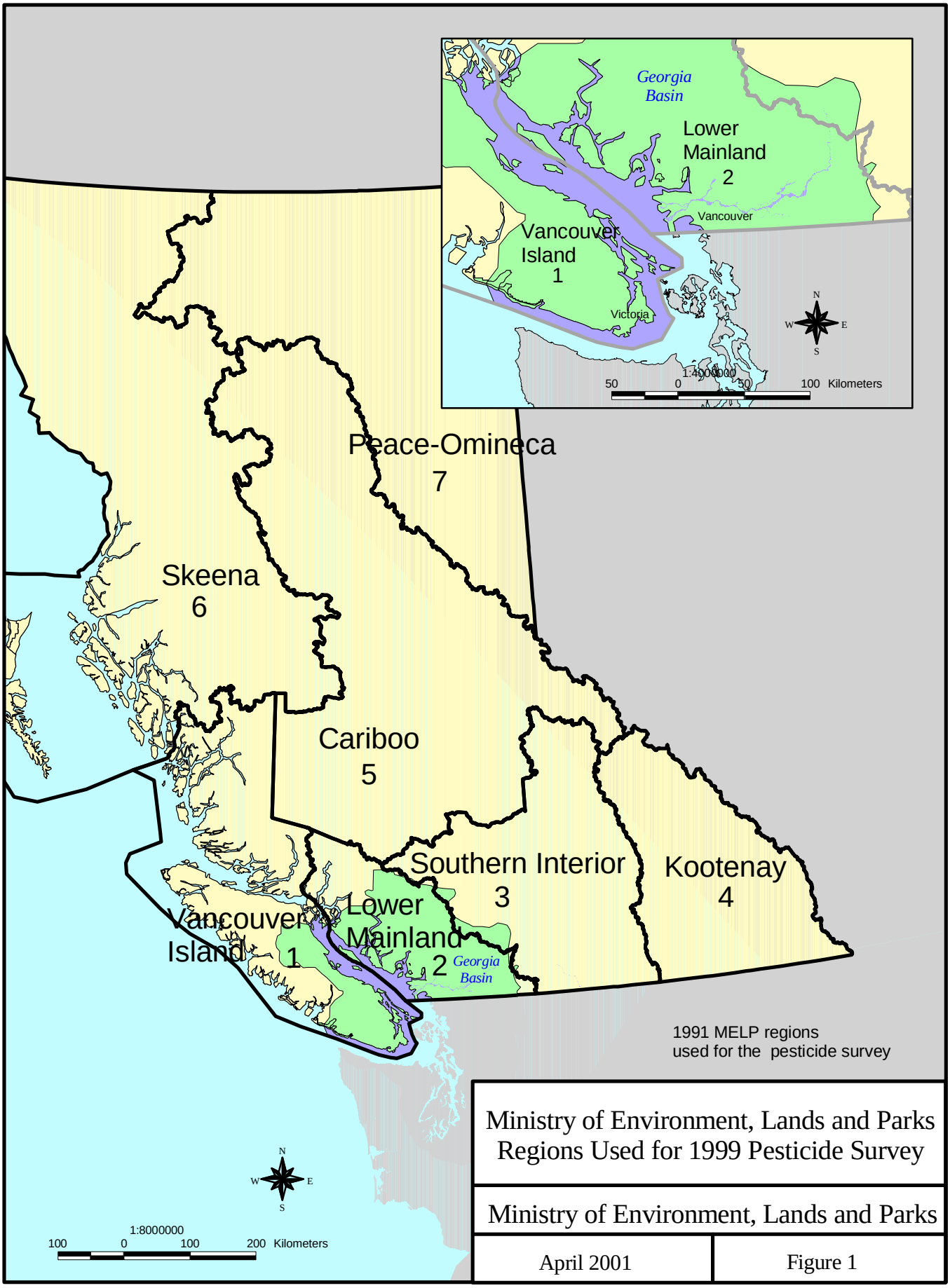
- obtain pesticide sales records for 1999, including veterinary and commercial pesticides;
- obtain pesticide use data for 1999 for anti-sapstain chemicals and wood preservatives;
- obtain pesticide use records for the Lower Mainland Region from annual summaries of use submitted by pest control services renewing licenses in the agriculture and landscape use categories;
- incorporate the results of a separate survey of domestic pesticide use in the CRD conducted by the Georgia Strait Alliance;
- compile the information into databases and summary tables so that the data can be compared to the results from previous two surveys (Table 1); and
- provide separate tabulations to show patterns of pesticide use within the Georgia Basin.

Table 1 Comparison of 1991, 1995 and 1999 Pesticide Survey Components

1991	1995	1999
Reportable Pesticide Sales	Reportable Pesticide Sales	Reportable Pesticide Sales
Anti-Saptain Chemicals	Anti-Saptain Chemicals	Anti-Saptain Chemicals
Wood Preservatives	Wood Preservatives	Wood Preservatives
Slimicides	--	--
Domestic Pesticide Sales	Domestic Pesticide Sales (Veterinary pesticides only)	Veterinary pesticides sales Domestic Pesticide Use (CRD only)
Pesticide Applications by Licensed Services (All categories, all regions)	Pesticide Applications by Licensed Services (Landscape category, Lower Mainland only)	Pesticide Applications by Licensed Services (Agriculture and landscape categories, Lower Mainland only)

This report presents detailed information on pesticide sales and use for British Columbia as a whole and for seven geographical regions[3] (Figure 1). It discusses the data quality and includes a comparison between the 1991, 1995 and 1999 data sets. It also discusses pesticide sales and use patterns within the Georgia Basin (MELP Region 2 and most of Region 1).

[3] For administrative purposes, MELP has divided the province into eight regions. Data from two of these regions (5 and 8) have been combined to correspond with the regions used for the 1991 pesticide survey.



Ministry of Environment, Lands and Parks
Regions Used for 1999 Pesticide Survey

Ministry of Environment, Lands and Parks

April 2001 | Figure 1

2.0 SURVEY METHODS

2.1 Approach

The characterization of 1999 pesticide use in British Columbia involved data gathering and data analysis. This chapter describes the tasks associated with data gathering and the evaluation of data quality.

The study included two primary types of data gathering:

- acquisition and compilation of information from existing data sources; and
- acquisition of new data through vendor or user surveys.

The existing data sources used were the Annual Summary of Reportable Pesticide Sales by licensed vendors and the Annual Summary of Pesticide Use by pest control services licensees. Data obtained in whole or in part from surveys of pesticide users included heavy-duty wood preservatives, anti-sapstain chemicals, domestic flea control products sold through veterinarians and domestic pesticides used in the CRD (domestic pesticide use survey conducted by the Georgia Strait Alliance). The following sections describe the methods of acquiring and compiling data from these sources.

2.2 Annual Pesticide Sales and Use Summaries

2.2.1 Background

Each year, a pesticide vendor is required to file a summary of pesticide sales over the past year in order to renew a licence. The annual summary lists all "Reportable" pesticides, that is products having a Restricted or Commercial use label. The vendor reports the product name and formulation, quantity of pesticide sold and the federal Pest Control Products Act registration number (PCP number). This reporting is intended to apply only to products sold to end users (not for resale).

In order to keep track of pesticide sales, the vendor is expected to maintain a register that records the product, amount sold, and purchaser for each Reportable pesticide sale. The vendor may compile the Annual Summary from the purchase register or from business records. The purchase register does not have to be submitted with the licence application, but it must be available for review by MELP staff upon request.

Similarly, holders of pest control service licences must report summaries of their pesticide use annually when they apply for licence renewal. They also must keep daily use records, which include information on the purpose for which the pesticide was applied.

Pest control service licensees may apply pesticides in one or more designated categories. The licence categories include agriculture, aquatic weed control, forestry, forest nurseries and seed orchards, predator control (restricted to MELP staff), industrial vegetation control, industrial vegetation-pavers, landscape, mosquito and biting fly control, noxious weed control, product fumigation, structural, and structural-wood preservation. These categories provide information on the purposes for which the pesticides were applied.

The 1999 survey included obtaining and summarizing the annual reports for all pesticide vendors plus pest control services licensees in the agriculture and landscape categories from the Lower Mainland (Region 2) only.

2.2.2 Data Acquisition and Database Entry

MELP regional offices provided annual sales summaries from 182 vendors; reports indicating nil sales of Reportable pesticides were excluded. The Lower Mainland regional office also provided annual use summaries from 200 agriculture and landscape pest control service licensees. ENKON entered all data from the summary forms into two computer databases (one for vendors and one for service licensees). The information recorded included the region, vendor or user identification (licence number, name, city and postal code), product name and formulation, PCP number and quantity sold. As in the previous surveys, sales by several vendors in Dawson Creek (Region 7) were reduced by 5 to 45% based on the licensees' estimates of the proportion of their sales purchased by Alberta residents.

Seven pest control services were licensed in more than one category. In order to limit the survey to agriculture and landscape use only, ENKON telephoned all multiple-category licensees and requested that they indicate the amounts of pesticides applied for agriculture and landscaping (and separate the amounts, if they were licensed in both categories). All except one of the licensees provided either exact quantities or estimates of quantities used for agriculture and landscaping. The exception was a college, which was licensed in the agriculture, landscape and forest nursery categories. The license categories reflected the fact that the college grew the bedding plants and shrubs used to landscape the campus. Thus, the separation of categories was unclear. The uses were assigned to the agriculture and landscape categories based on discussions with the college’s pesticide applicator and the interviewer's best judgement.

2.2.3 Data Analysis and Presentation

The Pest Management Regulatory Agency of Health Canada (PMRA) provided a computer database (the "PCP database") of active ingredients and percent guarantees for all pesticides that were registered in 1999 and 2000. This database also included

information on the type of pesticide[4] and whether the product was for restricted, commercial, domestic, manufacturing or technical use.

The PCP database was used to search for the PCP numbers contained in the vendor and service licensee databases. The PCP number was used to identify the pesticide active ingredient and "percent guarantee", which is the formulated product concentration. The active ingredient(s), percent guarantee, licensed use and pesticide type of each product were copied from the PMRA database into the vendor and service licensee databases. The percent guarantees were then used to calculate the quantities of active ingredients sold by vendors and used by service licensees.

For the 1995 survey, PMRA also had provided lists of active ingredients and percent guarantees for pesticide/fertilizer combinations that are registered under the Fertilizer Act. As the fertilizer database was undergoing redesign in 2000, information on pesticide/fertilizer combinations was unavailable. Thus, for the 1999 survey ENKON used the 1995 pesticide/fertilizer formulation data plus any apparently accurate information provided on the annual report forms. Active ingredients and percent guarantees for pesticide/fertilizer combinations were entered manually into the sales and use databases.

In approximately 14% of the individual pesticide records, the recorder either failed to report a PCP number or reported a number that was clearly wrong. For example, a product described as Amitrol was reported with the PCP number for Lorsban (chlorpyrifos), or the PCP number reported was a technical or manufacturing product. ENKON screened the database for these instances and identified the probable PCP number based on the product name and formulation.

In some instances where the recorder provided no formulation data (e.g., simply listed diazinon), the product could have had several possible formulations. These records were assigned a formulation (active ingredient and percent guarantee) based on proportional representation of the different formulations of that active ingredient in the database. For example, if approximately 80% of the reported diazinon was formulation 50W and 20% was formulation 5G, then 80% of the products reported as diazinon but lacking a valid PCP number were assigned the formulation for Diazinon 50W. The remaining 20% were assigned the formulation for Diazinon 5G. Where only single records existed, the record was assigned the formulation that predominated in the region that the particular record represented.

Some products were reported with PCP numbers that did not appear in the PMRA database. Not all of these records involved incorrect PCP numbers. Rather, some were from products that are not currently registered, but that had been registered at some time in the past. ENKON used the 1991 and 1995 PCP databases to identify the formulations

[4] The database included a detailed list of pesticide types which ENKON edited and reduced to the following: adjuvant, biological insecticide, fumigant, fungicide, herbicide, insect growth regulator, insecticide, anti-microbial, molluscicide, plant growth regulator and vertebrate control product.

of products not currently registered. The outdated PCP numbers so identified included several products that were also identified as outdated registrations during the 1991 and 1995 surveys.

Sales and use data for most formulated products as reported by the vendors or service licensees were converted to kilograms of active ingredient(s) by multiplying the volume sold by the percent guarantee. For example, 1 kg of a 25% concentrate product equals 0.25 kg of active ingredient. Since the method of reporting the percent guarantee varies to some extent among products, different approaches were used as follows:

- If the guarantee was reported as a percent for solid products (those sold in kilogram or milligram sizes) or in grams per litre (g/L) for liquid products (those sold in litre or millilitre sizes), the number of kilograms of active ingredient was calculated directly using the appropriate multiplication.

- Some products sold as liquids have the guarantee given as percent (e.g., Sevin XLR insecticide, Clean Crop Diazinon 500). For these products one litre was assumed to equal one kilogram. This method is the standard recommended by MELP for reporting pesticide use under permit requirements.

- A few products have the percent guarantee reported in non-standard units. The most important of these products is the biological pesticide *Bacillus thuringiensis* (BT), which is measured in bioactive units (btu or itu) per litre or per kilogram. For pesticide permit reporting, MELP suggests that BT be reported as total litres or kilograms of product applied, without calculation of the active agent. The present study used this approach, which was also used for the 1991 and 1995 surveys (Norecol 1993, Norecol, Dames & Moore 1997).

- The other major products for which the percent guarantee is reported in non-standard units are certain fumigants. For products such as Plant-Fume, the guarantee is reported as grams or percent in smoke. The quantity of these products sold was also considered equivalent to the active ingredient.

Following calculation of the quantities of active ingredients, the data were summarized and tabulated in the following manner:

- reportable pesticide sales data were totalled to provide quantities of each active ingredient sold in each of the seven geographical regions and the total quantity sold in the province; and

- the pesticide control service data (agriculture and landscape use data) were totalled to provide quantities of each active ingredient applied and the total quantity used (for each purpose) in the Lower Mainland region.

2.3 Domestic Pesticide (Veterinary Flea Control Products) Vendors Survey

2.3.1 Identification of Wholesale Vendors

Vendors of Domestic label pesticides are not required to report their sales on an annual summary form. For the 1995 pesticide use survey Norecol, Dames & Moore (1997) surveyed wholesale distributors of flea control products distributed through veterinarians. The wholesale distributors were identified through an initial survey of 10 Lower Mainland veterinary clinics.

To determine whether there had been significant changes in the wholesale distributors since 1995, ENKON contacted the British Columbia Veterinary Association and five Lower Mainland veterinary clinics. ENKON obtained additional information from the major wholesale distributors surveyed in 1995.

Based on the veterinarians' responses, ENKON identified three veterinary product suppliers. Discussions with these suppliers identified additional three wholesale distributors. One more supplier was identified through the manufacturer's newspaper advertisement. Thus, survey letters were sent to a total of seven distributors. The letters explained the purpose of the survey, indicated the information required (pesticide name, formulation, PCP number, and quantity sold by region of the province), and requested cooperation. Letters were followed up with telephone calls.

2.3.2 Data Acquisition and Database Entry

ENKON contacted seven wholesale vendors (or reported vendors) of flea control products, and four of these distributors provided data. One distributor responded that the company did not sell flea control products. Another responded that the company had discontinued sales of flea control products, selling the last of their stock in 1999. However, they had archived their sales records and were unable to provide any data. The company indicated that their sales of flea control products in 1999 were minimal. The seventh distributor did not respond to the survey letter or return ENKON's telephone calls. This distributor was one identified late in the survey process who had not supplied information for either the 1991 or 1995 survey.

2.3.3 Data Analysis and Presentation

Total quantities of pesticide active ingredients sold by veterinarians in British Columbia were calculated in the same manner used to calculate sales of reportable pesticide active ingredients. Data for total active ingredient sales in British Columbia were tabulated.

2.4 Wood Preservative Plant Survey

Data on use of heavy-duty wood preservatives were obtained by surveying the 16 wood preservative plants in the province. A list of wood preservative plants was obtained from Environment Canada. The plant managers were contacted by letter and telephone to

request cooperation. Each received a survey form asking them to list all wood preservative chemicals used, with their PCP numbers and amounts used during 1999. Non-responses were followed up with phone calls.

Fourteen of the 16 companies contacted provided use data. The remaining two companies refused to provide any information, although they had participated in the survey in 1995.

Data obtained were entered into a database with a structure similar to that described in Section 2.2.2. Data were summarized by chemical and by region.

2.5 Anti-Sapstain Use Data

Environment Canada usually conducts an annual survey of lumber mills that includes onsite inspections and compilation of chemical use data. Environment Canada did not conduct this survey in 1999. Therefore, an anti-sapstain chemical use survey was included in the 1999 pesticide survey.

Environment Canada (D. Wilson 2000) provided a list of lumber mills and their histories of chemical use. ENKON contacted the managers of the 46 lumber mills that had used anti-sapstains in 1998. The survey methods were identical to the wood preservative plant survey methods.

ENKON encountered difficulty in obtaining cooperation from many of the mills. One company indicated that they were required to report their chemical use (including anti-sapstains) to the Greater Vancouver Regional District (GVRD) as part of their air quality permits. Therefore, Environment Canada and ENKON contacted the GVRD, which provided data for four plants within its jurisdiction (including information that one plant was not using anti-sapstains). Four mills outside the GVRD refused to provide data. Since they were not required to report their chemical use to any local government, data for these mills could not be included in the survey.

Some supplemental information on anti-sapstain chemicals was obtained from the survey of reportable pesticide sales. Two anti-sapstain vendors filed Annual Sales Summary forms. The reported sales volume of one chemical was used to estimate use by one mill that refused to provide chemical use data.

2.6 Quality Assurance/Quality Control

The survey methods included procedures to ensure a high degree of data accuracy (quality assurance) and protocols to evaluate data quality (quality control). Quality assurance procedures included:

- checking to ensure that reports from large volume vendors (based on previous surveys) were received;

- where possible, identifying errors or irregularities before data were entered into the databases (e.g., missing PCP numbers, missing quantities or quantities reported in non-standard units such as "cases" or "pieces");

- checking databases for data entry errors;

- sorting the data by PCP number and checking to see that product names and PCP numbers corresponded;

- checking again for correspondence between PCP number and product name after linking with the database of PCP numbers (Section 2.2.3);

- screening calculated quantities of active ingredients for outliers, with follow up to determine whether outliers reflect data entry or reporting errors; and

- re-checking entries and reported quantities for all active ingredients whose total quantities were substantially higher than those found during the previous surveys.

ENKON checked the reports received to ensure that all potential large volume vendors had reported. When missing reports were identified, the MELP regional office followed up and supplied the missing forms.

Significant errors or potential errors were followed up with phone calls to the vendors or service licensees. Missing quantities, units not quantifiable in kilograms or litres (e.g., "cases") and unusually large quantities were considered significant and were followed up. Missing or incorrect PCP numbers were not considered significant unless a particular vendor had a large number of incorrect PCP numbers, and the correct numbers could not be readily identified from the product names. Database entries were corrected based on information supplied by the vendor or licensee.

Data quality was evaluated by keeping a record of all errors identified. The errors were divided into categories (e.g., missing/incorrect PCP number, quantity error). These records were kept separately for sales and service licence reports. The total number of errors in each category was calculated and expressed as a percentage of the total data entries. The percentages of vendors and service licensees who had made errors were also calculated.

In addition, ENKON contacted 10% of agriculture and landscape services by telephone to discuss their methods of calculating the quantities provided on the reporting forms[5]. This question was asked of all licensees contacted with other questions. Additional service licensees required to make up the 10% were selected at random. Because ENKON had

[5] For the 1995 study, vendors were also surveyed regarding their calculation methods. It was determined that most of the large volume vendors maintained computerized sales records. Due to a change in the certification of pesticide warehouses by the Crop Protection Institute, sales of Reportable pesticides since 1995 have been confined primarily to a few large volume vendors. Therefore, the telephone survey of vendors was not repeated for the current study.

observed that some licensees (and retail vendors) were reporting PCP numbers that were outdated in 1991, the licensees surveyed were asked how they determined PCP numbers.

The licensees were asked the following questions:

- Did you calculate your annual use from computerized records?
- Did you calculate your annual use from the Daily Use Record? If so, how do you ensure that this record is accurate?
- Did you calculate your annual use by subtracting pesticides on hand from annual purchases?
- Do you use some other method of calculating annual sales? If so, please describe.
- Did you report amounts used as diluted volumes or concentrate?
- Do you determine PCP numbers by reading them off the product label, from a list that you maintain or by some other method (describe)?

The responses were tabulated and the percentages of respondents giving each type of responses were calculated.

2.7 Domestic Pesticide Use Survey

The Georgia Strait Alliance (GSA) conducted a telephone survey to determine pesticide use patterns in the Greater Victoria area. The survey was conducted as part of GSA's "ToxicSmart" [6] program funded from the Georgia Basin Ecosystem Initiative. The GSA pesticide survey and related "ToxicSmart" program included:

1. conducting a random survey of residential use of pesticides in Victoria and the Saanich Peninsula;
2. offering survey participants a choice of free educational materials or in-home visits by a ToxicSmart team to help them learn how to reduce their use of pesticides and other toxic household chemicals; and
3. doing a follow-up survey to measure changes in toxic chemical use among participants that accepted the educational materials or in-home visit.

The initial survey phase of the program was completed during the summer of 2000. The GSA, with input from MELP, Environment Canada, the CRD and ENKON, developed a set of questions for the telephone survey (Appendix A). The survey questions addressed the purpose of pesticide use, types of pesticides used, frequency of use, precautions taken, methods of storing and dealing with leftover pesticides, and attitudes toward pesticide use. The GSA completed the survey with 409 people and provided ENKON

[6] Modelled after BC Hydro's PowerSmart program

with a database of their responses. ENKON summarized the data to provide information on domestic pesticide use, including percentage of households using pesticides, percentage of respondents applying pesticides for selected purposes and numbers of respondents using specific pesticides. To provide consistency with the approach of the 1999 pesticide survey, the specific pesticides were identified by their active ingredients.

3.0 DATA QUALITY

3.1 Annual Pesticide Sales and Use Summaries

3.1.1 Errors and Irregularities on Sales Reports

The following types of errors and irregularities were identified on the annual summaries of reportable pesticide sales:

- missing or incorrect PCP numbers. Incorrect numbers include those that corresponded to different active ingredients and/or formulations than those listed on the report and numbers that were not recorded in the current or historical PMRA database;
- PCP numbers that had been registered historically but were outdated in 1995 or even in 1991;
- more than one PCP number reported for the same product (i.e., two or more products with identical or similar formulations were combined);
- quantity errors or irregularities (non-standard units such as cases or jugs, missing units, missing quantities);
- unclear reporting of pesticides sold by "concept packaging" in which two or more components of a tank mix, such as an herbicide and an adjuvant or two herbicides, are sold in a single package, often with only one component of the package reported; and
- other errors (including reporting sales for a period other than the calendar year 1999, illegible handwriting and failure to include the vendor's name on the report form).

Of the 180 Reportable Sales Summaries received, 39% contained at least one error. Two significant irregularities were identified. One vendor from the Okanagan (Region 3) reported sales from December 1, 1998 through October 31, 1999. Another vendor from the Okanagan reported products sold for resale in addition to sales to end-users. This vendor corrected the Annual Summary at ENKON's request.

As in the previous surveys, the majority of errors on the Annual Summary forms involved missing or incorrect PCP numbers. One vendor filed a report that contained no PCP numbers. Over 14% of the total data entries (lines on the reporting forms) contained PCP number errors. These errors included 27 products (0.7% of the total entries) that could not be identified in the PCP database. It is likely that some (perhaps most) of these products are not pesticides.

In addition, 5% of the entries contained quantity errors or irregularities. Products sold for resale and non-standard units accounted for 3% of the erroneous entries, while an additional 2% of the errors related to the“concept” packaging of two or more products. Only two annual summary forms contained reporting errors that were identified by screening the data for outliers. One of these forms was filed by the vendor who included products sold for resale. The other error, affecting only one entry, involved a product sold in 50-pound bags that was reported as being sold in 50-kg bags.

3.1.2 Errors and Irregularities on Use Reports

The following types of errors and irregularities were identified on the annual summaries of pesticide use by service licensees:

- missing or incorrect PCP numbers;
- unit irregularities (e.g., reporting of quantities in "tablespoons" or fluid ounces);
- quantities reported as applied (i.e., diluted); and
- quantity errors related to concept packaging.

Of the 200 Service Licence Use Summaries, 45% contained at least one error, and 16% (205) of the total data entries contained errors. As observed for the sales reports, the majority of errors involved missing or incorrect PCP numbers. Over 8% of the total data entries contained PCP number errors. Missing registration numbers for fertilizer-pesticide combinations were also common but usually were not included in the error summary as fertilizers do not have actual PCP numbers. However, 2 of the 205 errors identified entailed reporting PCP numbers of commercial or technical pesticides for fertilizer/pesticide combinations. These entries were recorded as quantity errors, as using the PCP percent guarantees with the fertilizer volumes would have resulted in significant overestimates of the active ingredients applied. The only other quantity errors were the reporting of diluted pesticides, which occurred in 2% of the total data entries.

3.1.3 Methods of Calculating Pesticide Use

Twenty-four service licensees were surveyed by telephone. Of these, 20 (87%) used the Daily Use Record to calculate total pesticide use for the year. Two of the licensees used computerized methods of tracking use, including entering daily use into a spreadsheet or using a computerized injector to measure pesticide volumes. Only one licensee (4% of those surveyed) used an inventory method of calculating use. An agriculture service licensee (an aerial applicator) said that he was required to file a report of planned spray volumes with the Ministry of Agriculture and Food two days before spraying and indicated that he used these reports to compile his annual summary.

Four of the licensees questioned initially (17%, all licensed in the landscape category) indicated that they had reported diluted pesticide volumes. These individuals had been selected non-randomly based on the unexpectedly large volumes they had reported. To determine whether their response was representative, ten landscape licensees were selected at random and asked whether they had reported diluted volumes or concentrate.

All ten replied that they had reported concentrate. Thus, it appears that screening the data for outliers was able to identify the licensees reporting diluted volumes. Also, the practice of reporting diluted volumes is not as common as the initial survey suggested.

The service licensees contacted by telephone also were asked how they determined the PCP numbers that they reported. Fourteen respondents (61%) said that they read the PCP numbers from the product labels (but some of these had listed incorrect PCP numbers). Eight respondents (35%) said they used a list of PCP numbers supplied by MELP or Ministry of Agriculture and Food. It appears that some of these licensees were using outdated lists, as some of the PCP numbers they reported had been outdated for four to eight years.

The accuracy of the service license data depends upon the accuracy with which the companies maintained their Daily Use Records and their understanding of the reporting requirements (whether they reported concentrate or diluted pesticide volumes). It appears from responses to the survey that the level of accuracy may vary considerably from one licensee to another. Overall, the service licensee use records are likely to be less accurate than the sales records due to this variability.

3.2 Other Survey Components

There is little or no basis with which to estimate the data accuracy of the other survey components. There was no attempt to determine how the wood treatment plant operators, lumber mill operators or veterinary pesticide wholesalers calculated the quantities they reported. The only inaccuracies apparent on their reports involved PCP numbers of wood preservatives and anti-sapstains. The veterinary product wholesalers accurately reported PCP numbers.

Some inaccuracy is likely in the wood preservative survey data, as most of the treatment plant operators did not know the PCP numbers of the products they used. Lack of a PCP number potentially affects chromated copper arsenate (CCA), which is available in several formulations. In both the current survey and the previous two surveys, respondents reported using either 50% or 60% formulations. The majority of those who gave either a valid PCP number or the formulation used the 50% formulation. Thus, where both the PCP number and formulation were missing, the 50% formulation was assumed.

4.0 SURVEY RESULTS

4.1 Overall Pesticide Sales And Use

The study results showed that in 1999, British Columbians purchased or used 8,102,480 kg of pesticide active ingredients. This value excludes most Domestic label products, but does include Domestic products sold by veterinarians. Of this total, 7,010,944 kg (86.5%) were anti-microbial chemicals, consisting primarily of commercially applied wood preservatives and anti-sapstain chemicals (Figure 2, Table 2). Insecticides (including biological insecticides) accounted for 394,630 kg (4.9%) of the total pesticides, while 335,057 kg (4.1%) were herbicides and 269,363 kg (3.3%) were fungicides. The remaining pesticides included fumigants, plant growth regulators, insect growth regulators, molluscicides, vertebrate control products, adjuvants and surfactants.

Figure 2 Percentages of Active Ingredients (by Chemical Class) of Pesticides Sold or Used in British Columbia, 1999

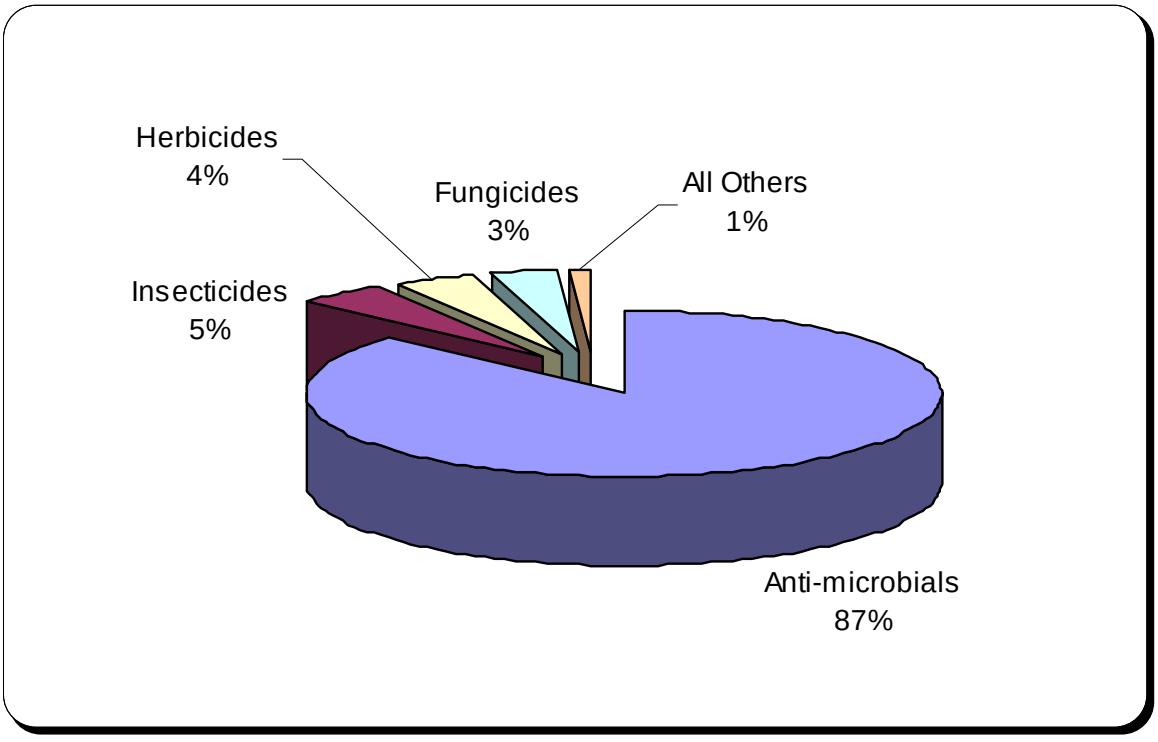


Table 2 Quantities of Active Ingredients (by Chemical Class) of Pesticides Sold or Used in British Columbia, 1999

Pesticide Type	Quantity (kg)
Anti-microbials	7,010,944
Insecticides	394,630
Herbicides	335,057
Fungicides	269,363
All Others	92,485

The total, province wide pesticide use included 280 active ingredients (Appendix B). Twenty of these active ingredients accounted for 95% of the pesticides sold or used during 1999 (Table 3). Creosote alone accounted for 66.5% of the pesticide use in the province. The wood preservatives chromated copper arsenate (CCA) and the anti-sapstain didecyl dimethyl ammonium chloride (DDAC) accounted for 11.4% and 3.8% of all pesticides used, respectively. Other important active ingredients included mineral oil (insecticidal or adjuvant), representing 3.2%; the wood preservative pentachlorophenol, representing 2.5%, borax[7], representing 1.8%; and the herbicide glyphosate (isopropylamine form), representing 1.3% of pesticides used.

4.2 Reportable Pesticides Sold

4.2.1 Province-Wide Pesticide Sales

In British Columbia, Reportable pesticides are all products that have a Restricted or Commercial use label. They include pesticides used for agriculture and industrial applications.

Reportable pesticides sold accounted for 13% of the total quantity of pesticide active ingredients included in the 1999 survey. Eleven active ingredients accounted for 59% of the Reportable pesticides sold. These active ingredients were insecticidal and herbicidal mineral oils; the herbicides glyphosate, isopropylamine and acid forms; the fungicides mancozeb, sulphur, captan, chlorothalonil and formaldehyde; the insecticide diazinon and the soil and wood fumigant metam (Figure 3).

[7] Includes all forms of borate and borax, which are primarily used as anti-sapstains, but excludes sodium metaborate tetrahydrate

Table 3 Quantities of the Top Twenty Pesticides Sold or Used in British Columbia, 1999 (Excluding Domestic Pesticides*)

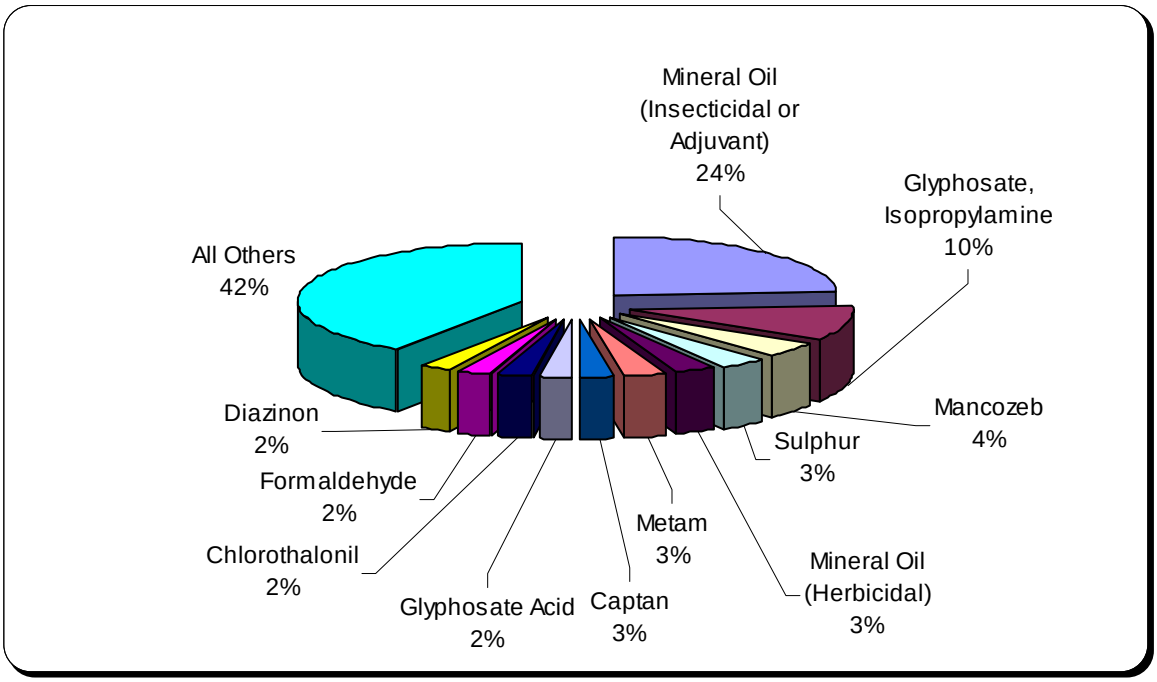
Active Ingredient	Quantity (kg)	Percent of Total
Creosote	5,387,761	66.5%
Chromated Copper Arsenate (CCA)	923,987	11.4%
Didecyl Dimethyl Ammonium Chloride (DDAC)	310,046	3.8%
Mineral Oil (Insecticidal or Adjuvant)	261,845	3.2%
Pentachlorophenol	201,642	2.5%
Borax, All Forms	142,578	1.8%
Glyphosate, Isopropylamine	108,763	1.3%
Mancozeb	44,682	0.6%
Sulphur	36,393	0.4%
Mineral Oil (Herbicidal or Plant Growth Regulator)	35,260	0.4%
Metam	30,855	0.4%
Captan	27,498	0.3%
Glyphosate Acid	26,810	0.3%
Chlorothalonil	26,640	0.3%
Iodocarb (IPBC)	26,569	0.3%
Formaldehyde	25,495	0.3%
Diazinon	24,563	0.3%
Metiram	23,890	0.3%
Bacillus thuringiensis, Serotype H-14	21,875	0.3%
Bacillus thuringiensis Berliner ssp. *kurstaki*	17,895	0.2%

* Domestic-label flea control products sold by veterinarians are included.

4.2.2 Regional Differences in Pesticide Sales

As the locations of all licensed pesticide vendors in British Columbia are known, the reportable pesticide sales data could be summarized by region. The complete summary is presented in Appendix C. The regional data must be viewed with some caution, however, as the 1995 pesticide survey identified that some vendors may sell to purchasers in other regions.

Figure 3 Percentages of Active Ingredients of Reportable Pesticides Sold or Used in British Columbia, 1999



The regional method of data tabulation showed some differences in pesticide sales that likely are related to regional differences in pesticide use. For example, insecticidal or adjuvant mineral oil accounted for over 50% of the pesticide active ingredient sales in the Okanagan and Kootenay regions, (Regions 3 and 4, respectively, Figure 1), where fruit trees are the major agricultural crops. It also was important in Vancouver Island and the Lower Mainland (Regions 1 and 2, respectively), but it was not sold in the rest of the province. Formaldehyde accounted for 5.4% of the reportable pesticide active ingredient sales in the Lower Mainland, where it is used as a fungicide/disinfectant in mushroom-growing operations. The herbicides glyphosate acid, glyphosate isopropylamine and MCPA ester accounted for 50% of the pesticide active ingredients sold in the Peace River area (Region 7), where grains are the major crop. These herbicides (particularly glyphosate isopropylamine) were sold widely in British Columbia. Three other herbicides, triallate, ethalfluralin and imazamethabenz were among the top 20 pesticides sold in Region 7, but sales of these products in the rest of the province were minimal. The only reportable pesticide sold in Region 6 (Skeena) was glyphosate isopropylamine, and its sales amounted to only 206 kg.

4.3 Wood Preservatives

The majority of pesticides used in British Columbia in 1999 were applied for wood preservation. Wood preservative chemicals are intended to provide long-term protection against fungi, insects, or marine borers for wood that will be used in exposed situations

(e.g., railway ties, patio decks). Wood preservation involves pressure or thermal impregnation of the preservative chemicals into the wood.

Table 4 presents the results of the wood preservative use survey. Only four types of wood preservatives were used in British Columbia in 1999. These products were creosote (which was applied alone or mixed in equal proportions with petroleum oil), chromated copper arsenate (CCA), pentachlorophenol, and ammoniacal copper zinc arsenate (ACZA). The majority of wood preservation facilities used only CCA. Three plants applied creosote, but the quantities applied were high enough to make creosote the most-used wood preservative in the province in terms of total kilograms (Figure 4). A single plant applied ACZA, which replaced the ammoniacal copper arsenate (ACA) used in 1991 and 1995. This chemical accounted for only 0.3% of total wood preservative use.

Since two plants failed to report their wood preservative use for 1999, the total amount of wood preservatives used (6,529,878 kg) is slightly underestimated. These plants, one located in Region 2 and the other in Region 3, accounted for only 0.6% of the total wood preservative use in British Columbia in 1995. However, they accounted for about 5% of the CCA used that year.

Figure 4 Percentages of Wood Preservative Active Ingredients Used in Wood Treatment Plants in British Columbia, 1999

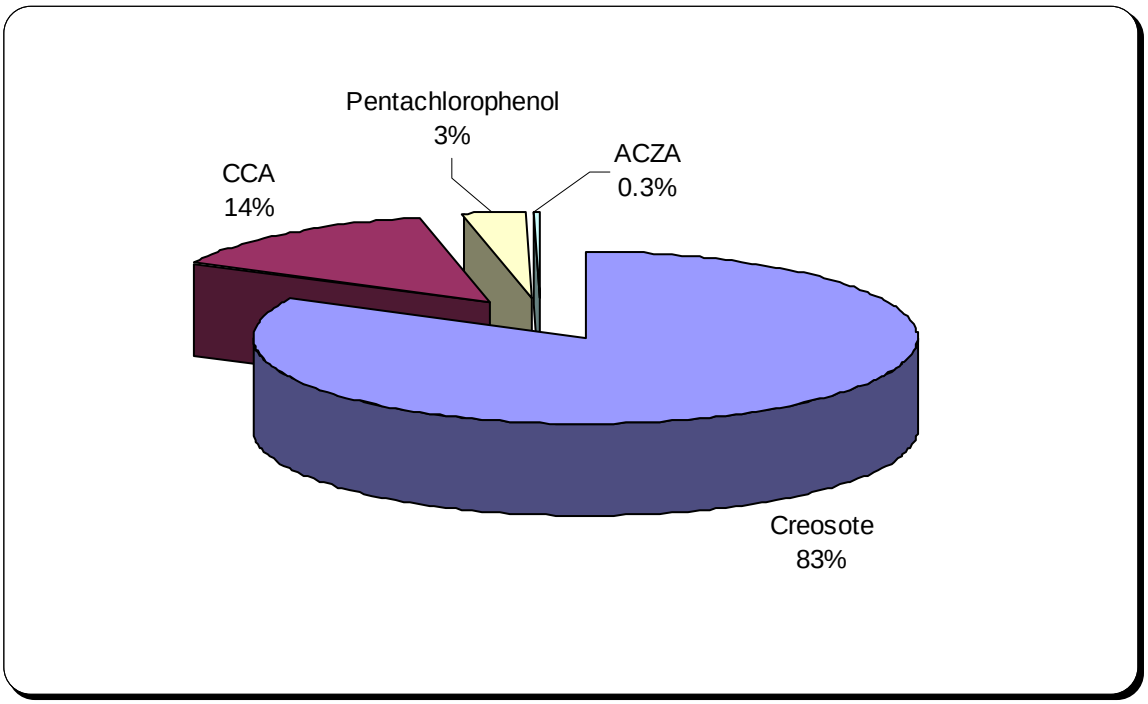


Table 4 Quantities of Wood Preservative Active Ingredients Used in Wood Treatment Plants in British Columbia, 1999

Preservative	Region					Total (kg)
	2	3	4	5	6	
Creosote	1,159,098	3,673,177	-	555,486	-	5,387,761
Chromated Copper Arsenate (CCA)	360,730	43,261	223,168	171,636	125,192	923,987
Pentachlorophenol	55,603	-	108,691	37,349	-	201,642
Ammoniacal Copper Zinc Arsenate (ACZA)	16,488	-	-	-	-	16,488
Total	1,591,920	3,716,438	331,858	764,470	125,192	6,529,878

Note: There are no wood preservation plants in Region 1 or Region 7.

4.4 Anti-Sapstain Use

Anti-sapstain chemicals are used by lumber mills to prevent fungal growth on, and staining of, cut lumber. They are intended to offer relatively short-term protection to lumber that will, when used in construction, be sealed, painted, stained, or otherwise protected from exposure to moisture and fungi.

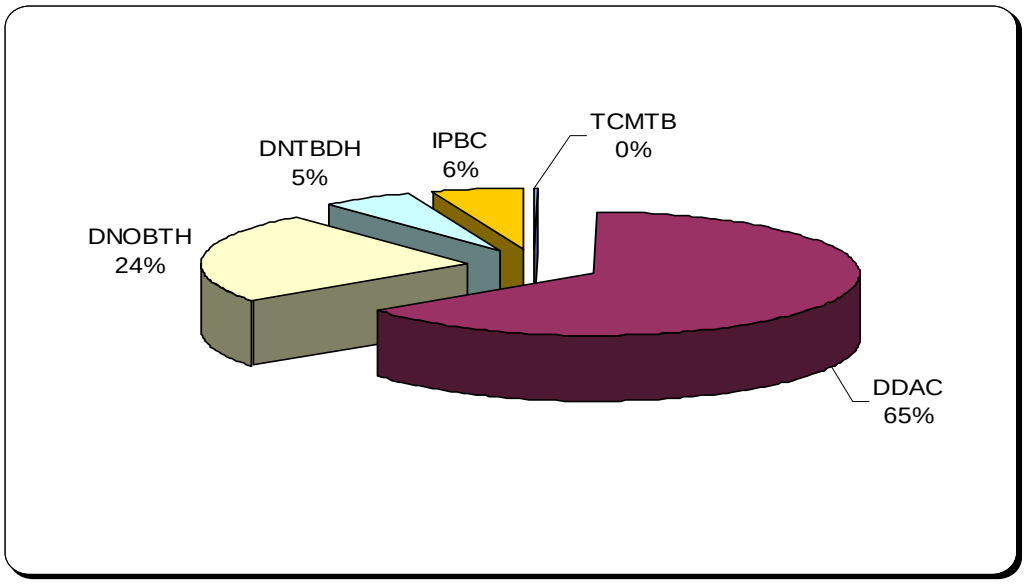
Table 5 and Figure 5 present the results of the anti-sapstain use survey. The total amount of anti-sapstain chemicals used (479,251 kg) is somewhat underestimated, as four mills failed to respond to ENKON's survey. These four mills used a total of 44,975 kg of anti-sapstain active ingredients in 1998, or about 8% of the total anti-sapstain use for that year.

The lumber mills responding to the survey reported using only five anti-sapstain active ingredients. The major anti-sapstain active ingredients identified were DDAC; two forms of borate, disodium octaborate tetrahydrate (DNOBTH) and disodium tetraborate decahydrate (DNTBDH); and 3-iodo-2-propynyl butyl carbamate (IPBC or Iodocarb). The active ingredient 2-(thiocyanomethylthio) benzothiazole (TCMTB) constituted a minor portion of the use. No mills reported using azaconazole in 1999, but the major user of this chemical in 1998 was one of the four mills that did not respond to ENKON's survey. A pesticide vendor, who filed an Annual Summary Report, sold 115 kg of azaconazole, which is about 4% of the total azaconazole used in 1998.

Table 5 Quantities of Anti-Sapstain Active Ingredients Used in British Columbia in 1999

Active Ingredient	Region				Total Used (kg)
	1	2	3	6	
2-(Thiocyanomethylthio)Benzothiazole (TCMTB)	1,134	--	--	--	1,134
Didecyl Dimethyl Ammonium Chloride (DDAC)	174,427	114,023	3,757	17,837	310,044
Disodium Octaborate Tetrahydrate	45,005	48,551	5,537	16,161	115,254
Disodium Tetraborate Decahydrate	--	26,250	--	--	26,250
3-iodo-2-propynyl butyl carbamate (IPBC)	16,938	9,297	--	334	26,569
Total	237,505	198,120	9,294	34,332	479,251

Figure 5 Percentages of Anti-Sapstain Active Ingredients Used in Wood Treatment Plants in British Columbia, 1999



4.5 Domestic Pesticides

4.5.1 Flea Control Products Sold by Veterinarians

Four suppliers of flea control pesticides sold to the public through veterinarians provided 1999 sales data. Based on these wholesale volumes, veterinarians sold approximately 156 kg of flea control product active ingredients in 1999 (Table 6). One active ingredient alone, imidacloprid, accounted for almost 62% of the sales. Three other active ingredients, piperonyl butoxide, n-octyl bicycloheptene dicarboximide and permethrin, accounted for an additional 29% of the pesticides sold by veterinarians for home use in dog and cat flea control. The insect growth regulator, methoprene, accounted for 4% of the total flea control product sales.

4.5.2 Domestic Pesticide Use in Greater Victoria

The Georgia Strait Alliance interviewed 409 Victoria-area residents[8], 357 (87%) of whom reported using some type of pesticide. Table 7 shows the percentage of respondents who reported using various categories of pesticides. The most commonly used category of pesticides was insect repellents, which were used by 37% of the people surveyed. Use of weed killers (herbicides), insecticides and fungicides was reported by 34% of the survey respondents. At least 25% of the respondents used cockroach and ant control products, herbicide-fertilizer combinations ("weed and feed" type products) and/or slug and snail baits.

[8] Based on this sample size, the 95% confidence interval for the responses is ±5%.

Table 6 Quantities of Active Ingredients in Flea Control Products Sold by Veterinarians in British Columbia, 1999

Active Ingredient	Total Sales (kg)
Imidacloprid	96.27
Piperonyl Butoxide	17.04
N-Octyl Bicycloheptene Dicarboximide	15.48
Permethrin	13.44
Methoprene	7.00
Pyrethrins	3.94
Tetrachlorvinphos	2.38
Amitraz	0.39
Propoxur	0.13
Total Veterinary Sales	156.06

Table 7 Types of Domestic Pesticides Used by Residents of the Greater Victoria Area Based on a Telephone Survey

Pesticide Category	Percent of Respondents
Insect Repellents	37%
Herbicides, Insecticides, Fungicides	34%
Cockroach and Ant Bait/Spray/Traps	33%
Herbicide-Fertilizer Combinations	32%
Slug and Snail Baits	25%
Wood Preservatives	17%
Rat and Other Rodent Poisons	16%
Flea and Tick Sprays, Powders, Pet Collars	15%
Head Lice Shampoos	10%
Mothballs	10%
Swimming Pool Chemicals	4%
Other	1%

The survey respondents who were willing to supply further information on their pesticide use (403 of the 409 respondents) were asked to list the pesticide products they used on lawns, gardens and hard surfaces and the frequency with which they applied these pesticides. Table 8 shows the numbers of survey respondents who reported use of each

product on each area (garden, lawn hard surfaces). The total number of uses is higher than the number of respondents as some individuals reported use of the same product on two or more areas. The product names have been replaced with their active ingredients to provide consistency with the other 1999 pesticide survey components. The reported use of these active ingredients should be viewed with some caution. Since the surveyors suggested a list of pesticide products (see Appendix A), the frequency of reporting specific products may be biased.

Table 8 Numbers of Telephone Survey Respondents Reporting Use of Specific Pesticide Products on Gardens, Lawns and Hard Surfaces

Active Ingredients	Area of Use			
	Garden	Lawn	Hard Surface	Total Uses
Herbicide-Fertilizer Combinations (likely 2,4-D Amine/Dicamba/Mecoprop Amine)		121	2	123
Glyphosate, Isopropylamine	5	15	58	78
Metaldehyde	76	2		78
Insecticidal Soap	41	1		42
Diazinon	28	1		29
Ferric Phosphate	27			27
2,4-D Amine/Dicamba/Mecoprop Amine		17	3	20
Sulphur/Zineb/Methoxychlor//Rotenone	17			17
Triforine	7			7
Pyrethrins	6			6
Ferrous Sulfate		5		5
Lime Sulphur	5			5
Mineral Oil (Insecticidal or Adjuvant)	4			4
Chlorpyrifos		2		2
MCPA Amine		1	1	2
Carbaryl/Dicofol/Oxydemeton-Methyl	1			1
Copper Oxychloride	1			1
Glufosinate Ammonium			1	1
Piperonyl Butoxide	1			1
Other	27	16	5	48
Total Number of Users	246	181	70	497

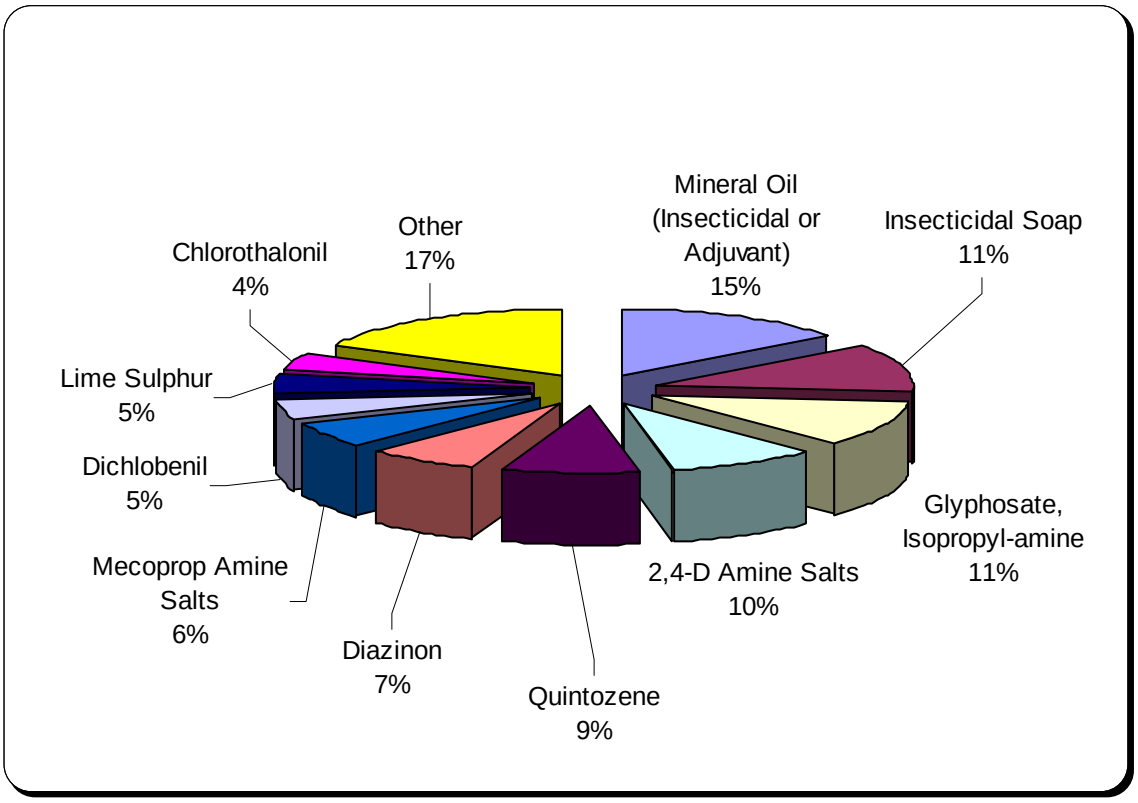
The most frequently used domestic pesticides were herbicide-fertilizer combinations applied to lawns. Other commonly used products were the herbicide glyphosate isopropylamine (used on gardens, lawns and surfaces) and the molluscicide (slug and snail bait) metaldehyde, which was used primarily on gardens. Insecticidal soap also was used frequently on gardens.

The survey respondents reported that they applied the products shown in Table 8 at frequencies ranging from less than once per year to 52 times per year (weekly use reported by one individual). Most of the respondents used pesticides relatively infrequently, with 18% applying pesticides less than once per year, 51% applying pesticides once or twice per year and 23% applying pesticides three to four times per year. Only 7% of the survey respondents used pesticides more frequently than four times per year.

4.6 Pesticide Use by Lower Mainland Service Licensees

The 1999 pesticide survey included a survey of pest control services in the Lower Mainland (Region 2) that were licensed to apply pesticides for the purposes of landscaping and agriculture. Quantities of all pesticides applied for agriculture and landscape are given in Appendix D.

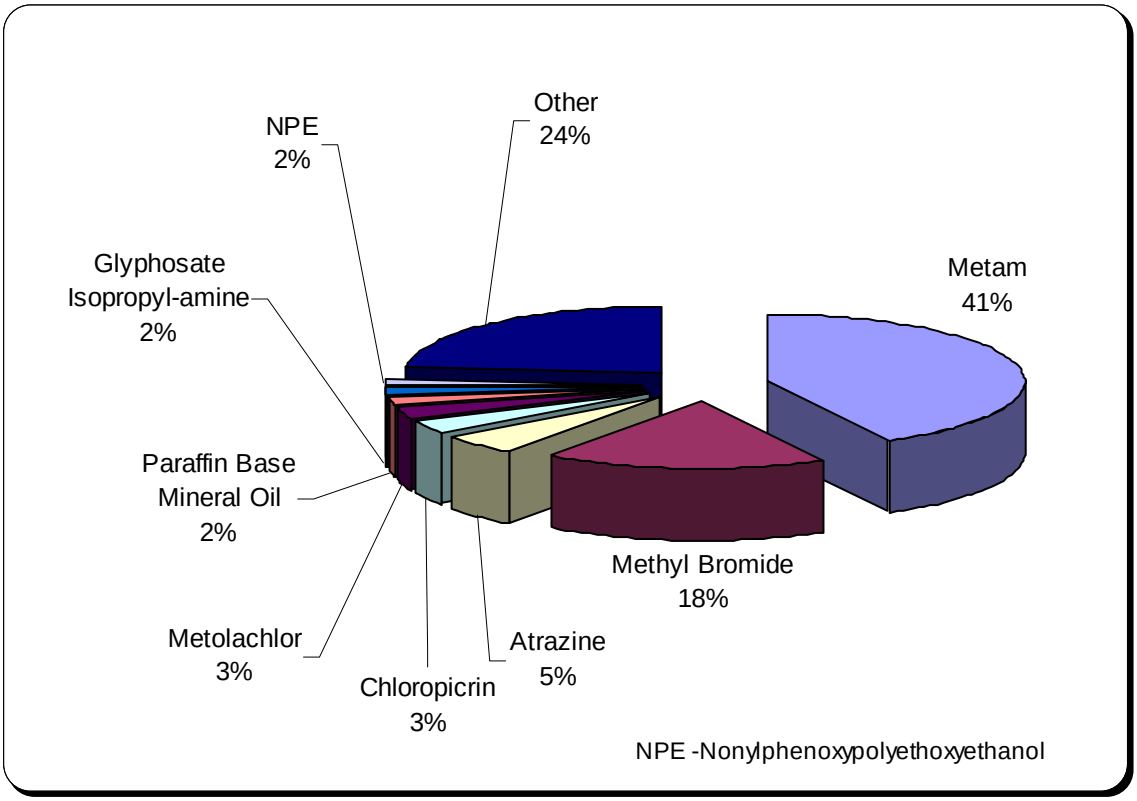
Figure 6 Percentages of Pesticide Active Ingredients Used by Licensed Landscape Services in the Lower Mainland Region, 1999



Landscape services in the Lower Mainland used 91 different active ingredients, of which 10 accounted for 87% of the pesticides applied (Figure 6). The most frequently used active ingredients were mineral oil (insecticidal or adjuvant), insecticidal soap and the herbicide glyphosate isopropylamine. These three active ingredients accounted for 37% of the total pesticide applied. The other major active ingredients used by landscape services included the herbicides 2,4-D amine salts, mecoprop amine salts and dichlobenil; the insecticide diazinon; and the fungicides quintozene, lime sulphur and chlorothalonil.

Lower Mainland agriculture services applied 86,565 kg of 101 different active ingredients during 1999. Two active ingredients, the fumigants metam and methyl bromide, accounted for 66% of the pesticides applied by agriculture services (Figure 7).

Figure 7 Percentages of Pesticide Active Ingredients Used by Licensed Agriculture Services in the Lower Mainland Region, 1999



5.0 COMPARISON WITH PREVIOUS SURVEYS

5.1 Objectives And Limitations

The long-term objective of the pesticide surveys begun in 1991 is to determine trends in pesticide sales and use. The 1999 survey provides three data points, which are the minimum required to suggest a trend. However, the statistical power associated with three data points is minimal, and therefore interpretation of results is limited. Furthermore, pesticide use can vary substantially from year to year in the absence of any overall changes in use patterns. Factors that affect pesticide sales and use include weather (e.g., wet weather promotes fungal growth, increasing the use of fungicides); outbreaks of particular insect pests; changes in crop prices, which may affect area of crops planted and therefore in the pesticides required; pesticide prices; and other economic factors, such as increases or decreases in highway construction, which may affect the amount of herbicides applied during paving.

Three years of data are not enough to characterize typical year-to-year variability in pesticide sales effectively. Thus, it is difficult to gauge the significance of increases or decreases in sales or use of most active ingredients. The one exception is the anti-sapstain data, which were available from Environment Canada for 1991 through 1998.

5.2 1991 and 1995 to 1999 Comparisons

The following comparisons were determined to be the most useful for the 1995 survey and are repeated for the 1999 survey:

- sales of all Reportable pesticide active ingredients;
- sales of the top 20 Reportable pesticides;
- sales of pesticides federally labelled as Restricted; this class of pesticides is the most strictly regulated in British Columbia, and changes in their sales are of particular interest;
- wood preservatives applied by wood treatment plants;
- anti-sapstains applied by lumber mills;
- flea control products sold by veterinarians, the only subset of Domestic pesticides for which comparable 1991, 1995 and 1999 data are available; and
- pesticides used by landscape services and agriculture services in Region 2.

5.2.1 Reportable Pesticides

Sales of all reportable pesticides for the years 1991, 1995 and 1999 are compared in Appendix E. Table 9 compares the sales of the top 20 reportable pesticides sold in 1991, 1995 and 1999.

Although there were changes in the total quantities sold, six active ingredients remained among the top seven sold in all three years (Table 9). These active ingredients were mineral oil (insecticidal or adjuvant) and glyphosate (isopropylamine), which were numbers one and two respectively in all three years, plus mancozeb, sulphur, mineral oil (herbicidal or adjuvant) and captan.

Two active ingredients that had not been sold in British Columbia during 1991 or 1995 appeared among the top twenty in 2000. These pesticides were the glyphosate acid, which was not registered for use in Canada in 1995, and the fungicide fosetyl-al.

Sales of several of 1999's top twenty pesticides have increased steadily since 1991. Active ingredients that showed consistent and substantial sales increases from 1991 to 1999 included mineral oil (insecticidal or adjuvant) plus two fungicides and two biological insecticides. The sales of insecticidal mineral oil increased from 162,245 kg in 1991 to 261,845 kg in 1999. Sales of the fungicide chlorothalonil increased from 3721 kg in 1991 to 26,640 kg in 1999, while formaldehyde sales increased from 3007 kg in 1991 to 25,495 kg in 1999. Sales of *Bacillus thuringiensis*, Serotype H-14 (used for mosquito control) increased from 3188 kg in 1991 to 21,875 kg in 1999. *Bacillus thuringiensis* Berliner ssp. *kurstaki* (used for caterpillar control) sales increased from 3095 kg to 17,895 kg during the same period. Consistent but smaller increases in sales occurred for mancozeb, MCPA Ester and diazinon (Table 9).

While increases in the use of insecticidal mineral oil, chlorothalonil and the two biological insecticides appear real, the increase in formaldehyde sales may be due, in part, to changes in pesticide registrations and labelling. In 1991 and 1995, most formaldehyde sales were listed with Transportation of Dangerous Goods codes in place of PCP numbers. In 1999, correct PCP numbers were reported for most products containing formaldehyde. It is possible that most of the formaldehyde sold in 1991 and 1995 was not a registered pesticide, and consequently some sales may not have been reported.

Sales of some pesticides that were among the top twenty in 1991 had decreased substantially by 1995. For example, sales of ethalfluralin declined from 26,917 kg to 2,289 kg, a decrease of over 90%. Atrazine sales declined from 22,898 kg to 9991 kg, a decrease of over 50%, although most of the change took place between 1991 and 1995 (Appendix E). In addition, the sales of the original form of glyphosate (isopropylamine) decreased by about 13% between 1995 and 1999, likely because some of the uses of this herbicide were replaced by newer forms of glyphosate (acid, trimethylsulfonium salt and mono-ammonium salt).

Table 9 Comparison of the Top 20 Reportable Pesticides Sold in British Columbia in 1999, 1995 and 1991

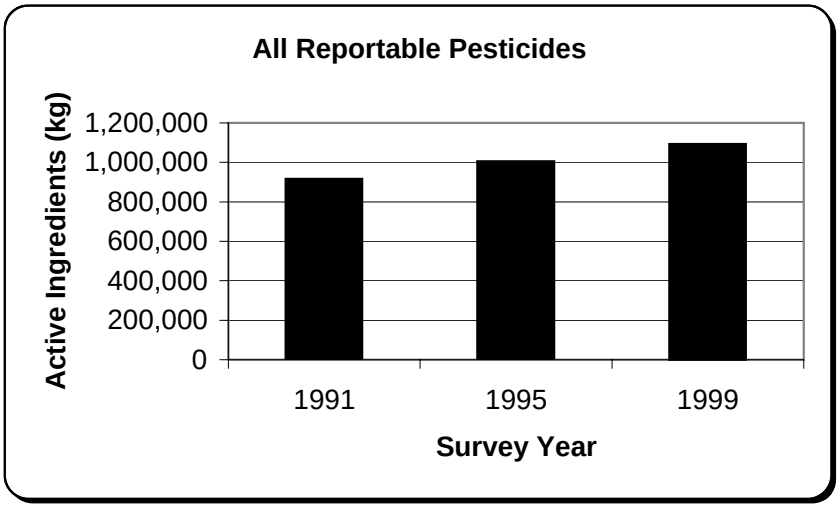
Active Ingredient	Total Sales (kg)			Rank		
	1999	**1995**	**1991**	**1999**	**1995**	**1991**
Mineral Oil (Insecticidal or Adjuvant)	261,845	206,440	162,245	1	1	1
Glyphosate, Isopropylamine	108,763	124,698	110,157	2	2	2
Mancozeb	44,682	41,907	29,511	3	3	4
Sulphur	36,393	26,319	28,101	4	6	6
Mineral Oil (Herbicidal or Plant Growth Regulator)	35,260	25,215	38,540	5	7	3
Metam	30,855	20,422	27,437	6	12	8
Captan	27,498	29,160	28,451	7	4	5
Glyphosate Acid	26,810	-	-	8	--	--
Chlorothalonil	26,640	15,871	3,721	9	14	44
Formaldehyde	25,495	14,342	3,007	10	16	52
Diazinon	24,563	22,552	19,643	11	8	13
Metiram	23,890	20,874	27,618	12	10	7
Bacillus thuringiensis, Serotype H-14	21,875	11,270	3,188	13	20	50
Bacillus thuringiensis Berliner ssp. *kurstaki*	17,895	12,283	3,095	14	19	51
Copper Oxychloride	14,699	16,316	10,202	15	13	20
Fosetyl-Al	14,451	-	-	16	--	--
2,4-D Amine	13,903	12,321	12,340	17	18	16
Lime Sulphur or Calcium Polysulphide	10,851	20,565	8,835	18	11	22
MCPA Ester	10,847	7,697	4,973	19	27	38
Azinphos-Methyl	10,595	21,804	17,820	20	9	14

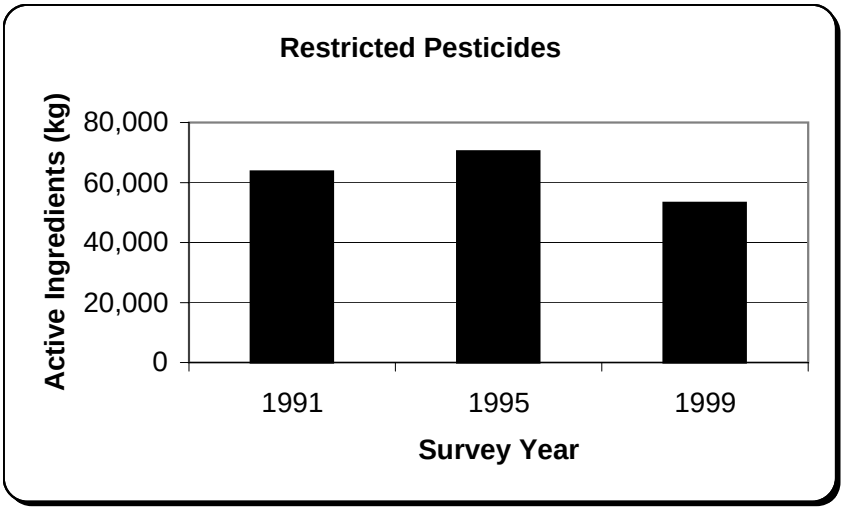
The total quantity of reportable pesticides sold in British Columbia increased from 916,707 kg in 1991 to 1,093,195 kg in 1999. However, the sales of federally-labelled Restricted pesticides declined during the same period (Figure 8, Table 10). Sales of one Restricted pesticide, *Bacillus thuringiensis*, Serotype H-14 (BT), increased substantially (almost 600%). This product is a biological insecticide used for mosquito control. Its use is restricted due to the manner in which it is applied (aerial application to water), not because of toxicity. Other products containing this active ingredient do not have a Restricted label. BT is not included in Table 10.

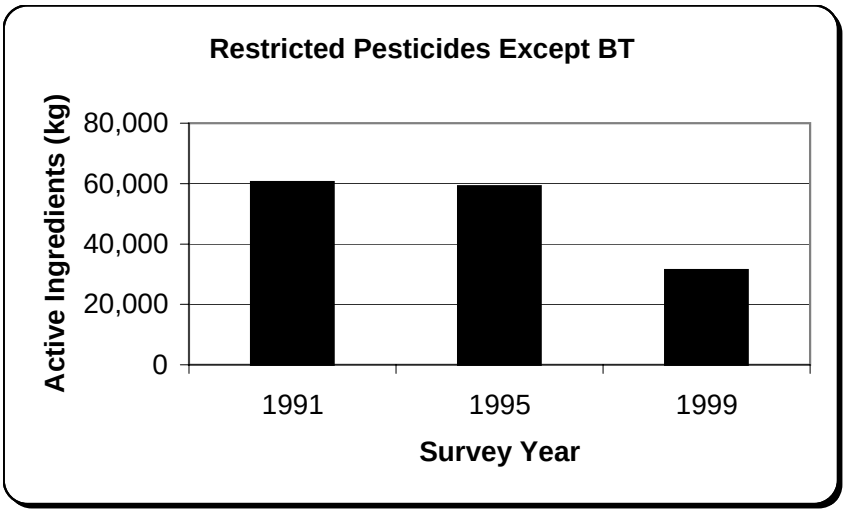
Table 10 Changes in Sales of Restricted Pesticides, 1991 to 1999

Active Ingredient	1991 Sales (kg)	1995 Sales (kg)	1999 Sales (kg)	Change from 1991 (kg)
4-Aminopyridine	0.07	0.21	0.47	+ 0.40
Aluminum Phosphide	200	736	151	- 50
Amitraz	-	69.3	32.66	+ 32.7
Azinphos-Methyl	17,820	21,804	10,595	- 7,225
Bendiocarb	346	216	118	- 229
Capsaicin			0.51	+ 1
Carbofuran	1,021	997	478	- 542.6
Copper Triethanolamine Complex	276	96.5	24.03	- 252
Dinoseb	7,233	6.0	48.00	- 7,185
Disulfoton	702	556	343.13	- 359
Fensulfothion	211	-	-	- 211
Formetanate Hydrochloride	14.7	59.3	55.20	+ 40.5
Methamidophos	2,947	1,910	1,500	- 1,447
Methyl Bromide	21,958	21,888	9,353	- 12,605
Oleoresin Capsicum	-	0.73	-	+ 0.00
Oxamyl	141	2,027	658	+ 517
Oxyfluorfen	184	234	180	- 4.2
Parathion	4,054	4,125	3,792	- 263
Phorate	878	-	-	- 878
Propetamphos	16.3	7.59	4.18	- 12.1
Pyrazophos	12.0	9.00	-	- 12.0
Strychnine	61.1	49.2	30.01	- 31.1
Sulfotep	2,131	3,665	1,593	- 538
Terbufos	143	585	2,405	+ 2,263
Triadimefon	13.5	-	-	- 13.5
Water Soluble Dyes	149	48.6	25.22	- 124
Total Sales	60,511	59,090	31,385	- 29,127

Figure 8
Changes in Quantities of Reportable and Restricted Pesticides Sold in British Columbia, 1991-1999







BT - *Bacillus thuringiensis*, Serotype H-14

5.2.2 Wood Preservatives

The use of wood preservatives was higher in 1999 than in 1991 but not as high as in 1995. The among-year differences were due primarily to changes in creosote use (Table 11). During the 1995 survey, the operator of one creosote treatment plant told the interviewer that a five-fold change from year to year was not unusual. The use of CCA increased from year to year despite the probable under-reporting of CCA use in 1999 (see Section 4.2.2). In addition, there was a change in the active ingredients used, with ammoniacal copper arsenate being replaced by ammoniacal copper zinc arsenate in 1999.

Table 11 Comparison of Wood Preservative Active Ingredients Used by Wood Treatment Plants, 1991 to 1999

Active Ingredient	1991 Use (kg)	1995 Use (kg)	1999 Use (kg)	Change from 1991 (kg)
Creosote	2,245,711	5,869,461	5,387,761	+ 3,142,050
Chromated Copper Arsenate (CCA)	651,134	912,392	923,987	+ 272,852
Pentachlorophenol	789,110	122,966	201,642	- 587,468
Ammoniacal Copper Arsenate (ACA)	500	909	-	- 500
Ammoniacal Copper Zinc Arsenate (ACZA)	-	-	16,488	+ 16,488
Total Used	3,685,955	6,905,728	6,529,878	+ 2,843,923

5.2.3 Anti-Sapstains

Nine years of data were available for anti-sapstain use (1991-1999). The total amount of anti-sapstain chemicals used annually declined steadily from 1994 through 1999 (Figure 9). Since there were enough data points for statistical analysis, a linear regression analysis was performed using the 1994-1998 data. The 1999 data point was omitted from the analysis because 1999 anti-sapstain use is underestimated by approximately 8% due to the non-reporting of four mills (Sections 4.4). The regression analysis showed that the decreasing trend in anti-sapstain use was statistically significant ($P<0.01$). The 1999 data point falls almost on the regression line (Figure 9). The actual 1999 anti-sapstain use was higher than the plotted data point. Thus, the decrease in anti-sapstain use between 1998 and 1999 does not appear to have been as steep as the decline from 1994 to 1998.

Figure 9 Changes in Total Use of Anti-Sapstain Chemical Active Ingredients in British Columbia, 1991 to 1999

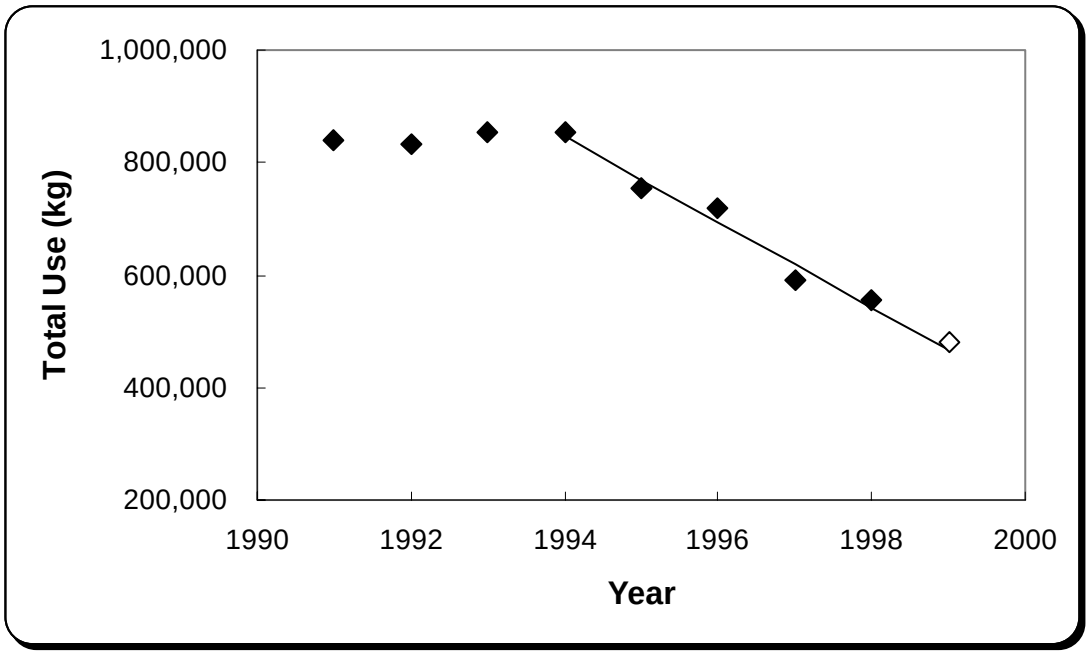


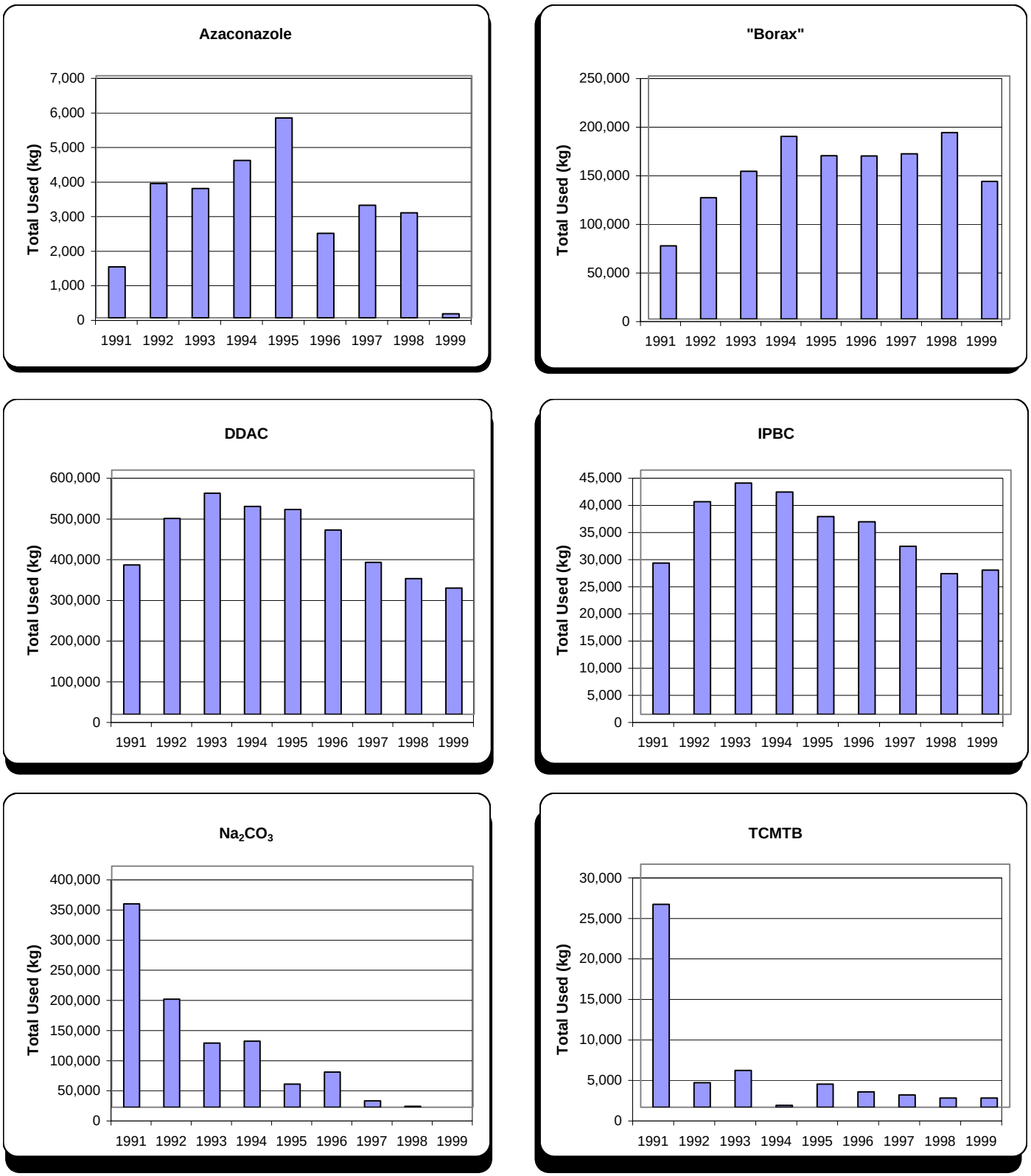
Figure 10 shows that the change in total anti-sapstain use from 1994 to 1999 is due largely to a decrease in the use of DDAC and IPBC plus a steep decline in the use of azaconazole after 1995. In addition, the use of sodium carbonate (Na_2CO_3, which was a component of a borax-based anti-sapstain) declined sharply between 1991 and 1993 and ceased altogether in 1998. The use of TCMTB also decreased sharply between 1991 and 1992, but a relatively small amount of this chemical (1000 to 1500 kg/year) was still being be used in 1999. Copper 8-quinolinolate (not shown on Figure 10) was used as an anti-sapstain in 1991 and 1992 but has not been used since 1992.

5.2.4 Flea Control Products

The total quantity of flea control products sold in 1999 was only 25% of the quantity sold in 1995 only 22% of the 1991 sales (Table 12). This change is real and is due to a change in flea control technology. During the 1999 survey, several vendors told ENKON that external flea control pesticides have been almost entirely replaced by a medication administered orally.

In addition, there has been a major change in the types of external flea control pesticides applied. Imidacloprid, which comprised 62% of the external flea control products used in 1999, was not used at all in 1991 or 1995. Chlorpyrifos, which amounted to 121 kg or 17% of the flea control pesticides applied by veterinarians in 1991, was not used in 1999.

Figure 10
Changes in Quantities of Anti-Sapstain Active Ingredients Used in British Columbia, 1991-1999



"Borax" = Disodium Octaborate Tetrahydrate + Disodium Tetraborate Decahydrate
Note: 1999 azaconazole use is estimated from sales data and does not appear in Table 5.

Table 12 Comparison of Flea Control Products Sold by Veterinarians in British Columbia, 1991 to 1999

Active Ingredient	1991 Sales (kg)	1995 Sales (kg)	1999 Sales (kg)	Change from 1991 (kg)
Amitraz	-	-	0.39	+0.39
Carbaryl	19.0	1.55	-	-19.0
Chlorpyrifos	121	23.3	-	-121
D-Trans Allethrin	0.18	0.26	-	-0.18
Di-N-Propyl Isocinchomeronate	-	1.13	-	-
Methoprene	40.0	34.8	7.0	-33.0
N-Octyl Bicycloheptene Dicarboximide	255	150	15	-240
Imidacloprid	-	-	96.3	+96.3
Permethrin	1.63	42.6	13.4	+11.8
Piperonyl Butoxide	210	307	17	-193
Propoxur	-	5.81	0.13	+0.13
Pyrethrins	70.2	56.1	3.9	-66.2
Tetrachlorvinphos	-	-	2.4	
Total Sales	718	622	156	-562

5.2.5 Landscape and Agriculture Services

Appendix F contains a complete comparison of the current (1999) and historical use of pesticide active ingredients by licensed pest control services in the Lower Mainland Region. Only 1991 and 1999 data are available for services licensed in the agriculture category, while 1991, 1995 and 1999 data are available for landscape services. The following sections discuss overall changes in pesticide use by licensed services and changes in active ingredient annual use greater than 1000 kg. Changes in specific active ingredients are discussed further in Section 6.0.

Landscape Services

There was a 40% decrease (6083 kg) in use of pesticide active ingredients by landscape services between 1991 and 1999. The greatest total decreases (2806 kg and 1265 kg, respectively) and among the highest percentage decreases (96% for each) were in the use of sodium metaborate tetrahydrate and sodium chlorate, two components of a single herbicide product (Table 13). The use of bromacil, a component of the same herbicide,

also decreased by 96% (Appendix F). The use of glyphosate isopropylamine and mineral oil (insecticidal or adjuvant) decreased by over 1000 kg (53% and 45%, respectively). The use of insecticidal mineral oil appears to vary substantially from year to year, as the use in 1995 was 71% greater than the use in 1991. Use of the other three active ingredients declined steadily between 1991 and 1999. In addition, the use of paraquat decreased by over 600 kg (97%).

The use of several active ingredients increased considerably between 1991 and 1999 (Table 13). For example, the use of insecticidal soap increased by 717 kg (227%) between 1991 and 1999. In addition, the use of chlorothalonil increased 1200% from 28.5 kg in 1991 to 371 kg in 1999. The use of quintozene increased by 326 kg (70%).

The reduction in pesticide use by landscape services is important, because MELP has been working to educate and promote Integrated Pest Management (IPM) in this sector. Both the overall reduction in pesticide use and the increase in use of "less toxic" active ingredients like insecticidal soaps are consistent with the implementation of IPM.

However, some of the reduction in pesticide use (a relatively small portion) may be related to a reduction in the number of pest control services licensed in the landscape category. The number of landscape licensees reporting pesticide use was about 6% lower in 1999 than in 1991 (Table 13). This change could have occurred for one of three reasons:

1. Many landscape services have pesticide service licenses but do not apply pesticides every year. It is possible that the total number of licensees did not actually change, but fewer licensees applied pesticides in 1999 than in 1991 because they had implemented IPM.
2. Only landscape services that want the option of using pesticides need to be licensed by MELP. Therefore, if a company decided to stop using pesticides altogether, it might not renew its license. Thus, a reduction in the total number of licensees could have resulted from companies' implementing IPM.
3. The number of licensed landscaped services might have changed for economic reasons. In this case, some of the apparent reduction in pesticide use would be an artifact of the lower number of licensees.

Agriculture Services

Since there are only two data points (1991 and 1999) for pesticide applications by services licensed in the agriculture category, statistical comparisons are not possible, and typical year to year variability is unknown. Nevertheless, some differences between the two years are apparent.

Table 13 Changes in the Top 20 Active Ingredients Used by Lower Mainland Pest Control Services Licensed in the Landscape Category, 1991-1999

Active Ingredient	1991 Rank	1995 Rank	1991 Use (kg)	1995 Use (kg)	1999 Use (kg)	Change from 1991
Mineral Oil (Insecticidal or Adjuvant)	2	1	2,443	4,183	1,342	- 1,101
Soap (Insecticidal)	--	9	-	359	1,031	+ 1,031
Glyphosate, Isopropylamine	3	5	2,145	1,068	1,016	- 1,129
2,4-D Amine Salts	5	3	921	1,088	863	- 58.0
Quintozene	10	11	468	371	794	+ 326
Diazinon	6	8	676	539	639	- 37.1
Mecoprop, Amine Salts	7	6	669	903	567	- 102
Dichlobenil	11	7	394	636	452	+ 57.9
Lime Sulphur	12	10	328	379	428	+ 100
Chlorothalonil	29	18	28.5	72.1	371	+ 342
Dicamba	14	12	140	204	129	- 10.7
Iprodione	24	21	50.4	61.8	128	+ 77.9
Sodium Metaborate Tetrahydrate	1	2	2,930	2,385	124	- 2,806
Thiram	--	83	-	0.1	89.6	+ 89.6
Simazine	26	15	41.4	93.6	76.7	+ 35.3
Copper Oxychloride	15	14	132	146	74.0	- 58.3
Mancozeb	9	13	559	157	70.0	- 489
Glyphosate Acid	--		-	-	67.9	+ 67.9
Fatty Acid	--	30	--	38.0	66.8	+ 66.8
MCPA Amine Salts	20	20	65.0	62.1	65.9	+ 0.83
Ferrous Sulfate	--	17	-	82.2	64.8	+ 64.8
Benomyl	16	32	111	30.7	59.3	- 51.5
Sodium Chlorate	4	4	1,321	1,076	55.8	- 1,265
Amitrole	18	26	91.1	46.6	43.8	- 47.2
Thiophanate-Methyl	17	29	93.4	39.5	30.1	- 63.4
Methoxychlor	22	19	58.6	67.3	21.4	- 37.3
Paraquat	8	33	622	29.4	16.8	- 605
Natural Gum Resins	19	42	87.4	11.7	7.95	- 79.4
Bromacil	21	16	65.0	84.4	2.79	- 62.2
Total	--	--	15,154	14,802	9,071	- 6,083
Number of Licensed Services	--	--	200	235	189	- 11

The total quantity of pesticide active ingredients applied by agriculture services increased more than 100% between 1991 and 1999 (Table 14, Appendix F). This change likely is due to a change in the Pesticide Control Act Regulation, as of January 1, 1992, which required anyone purchasing a Restricted pesticide to have an applicator certificate. Thus, as of 1992, farmers would have needed to obtain applicator certification or hire licensed services to apply Restricted pesticides.

The active ingredients that showed the greatest increases in terms of total kilograms were the soil fumigants metam (+37,730 kg), methyl bromide (+11,707 kg) and chloropicrin[9] (1922 kg). The use of adjuvants and surfactants also increased substantially, with use of nonylphenoxypolyethoxyethanol (NPE), paraffin base mineral oil and surfactant blends increasing by 944 kg to 1422 kg (Table 14).

Several active ingredients that were applied by agriculture services in quantities greater than 1000 kg in 1991 were not used in 1999. These active ingredients were the soil fumigant 1,3-dichloropropene, the fungicide folpet, and the herbicides vernolate and dinoseb. At 6711 kg applied, 1,3-dichloropropene was the number one active ingredient used by licensed agriculture services in 1991.

[9] Methyl bromide and chloropicrin are components of the same Restricted pesticide.

Table 14 Comparison of the Top 20 Active Ingredients Used by Lower Mainland Pest Control Services Licensed in the Agriculture Category, 1991 and 1999

Active Ingredient	1991 Rank	1999 Rank	1991 Use (kg)	1999 Use (kg)	Change from 1991
Metam	6	1	2,124	39,854	+ 37,730
Methyl Bromide	2	2	5,186	16,893	+ 11,707
Atrazine	3	3	4,647	4,840	+ 193
Chloropicrin	11	4	1,116	3,039	+ 1,922
Metolachlor	5	5	2,700	2,515	- 185
Paraffin Base Mineral Oil (Adjuvant)	12	6	887	2,035	+ 1,149
Glyphosate, Isopropylamine	7	7	1,719	1,706	- 13.1
Nonylphenoxypolyethoxyethanol	--	8	53.3	1,476	+ 1,422
Chlorothalonil	--	9	-	1,124	+ 1,124
Surfactant Blend	--	10	153	1,097	+ 944
EPTC	10	11	1,270	864	- 407
1,3-Dichloropropene	1	--	6,711	-	- 6,711
Folpet	4	--	2,798	-	- 2,798
Vernolate	8	--	1,562	-	- 1,562
Dinoseb	9	--	1,454	-	- 1,454
1,3-Dichloropropene	1		6,711	-	- 6,711
Folpet	4		2,798	-	- 2,798
Vernolate	8		1,562	-	- 1,562
Dinoseb	9		1,454	-	- 1,454
Dimethoate	13	25	880	266	- 614
Methyl Isothiocyanate	14		862	-	- 862
Dichlobenil	15	62	766	16.4	- 750
Tallow Fatty Acid	16		669	-	- 669
Dazomet	17		662	-	- 662
Ferbam	20		465	-	- 465
Total Active Ingredients Applied	--	--	42,083	86,565	+ 44,482
Number of Licensed Services	--	--	15	14	- 1

6.0 GEORGIA BASIN PESTICIDE SALES AND USE

6.1 Reportable Pesticide Sales

For all practical purposes, the Georgia Basin is equivalent to MELP Region 1 plus Region 2 (Figure 1). Table 15 shows quantities of the top twenty reportable pesticides sold in the Georgia Basin. Most of these active ingredients are also among the top twenty reportable pesticides for all of British Columbia. Exceptions include the soil fumigants methyl bromide and dazomet, the herbicides atrazine and napropimide, the fungicide cupric hydroxide and the insecticide malathion.

Table 15 Quantities of the Top Twenty Reportable Pesticide Active Ingredients Sold in the Georgia Basin in 1999

Active Ingredient	Rank	Quantity Sold (kg)	Percent Of Total
Glyphosate, Isopropylamine	1	70,494	14.0%
Mineral Oil (Herbicidal or Plant Growth Regulator)	2	35,260	7.0%
Mancozeb	3	27,882	5.5%
Formaldehyde	4	25,492	5.0%
Chlorothalonil	5	23,674	4.7%
Metam	6	23,034	4.6%
Bacillus thuringiensis, Serotype H-14	7	21,790	4.3%
Captan	8	21,172	4.2%
Mineral Oil (Insecticidal or Adjuvant)	9	17,896	3.5%
Diazinon	10	13,191	2.6%
Fosetyl-Al	11	11,777	2.3%
Copper Oxychloride	12	9,487	1.9%
Methyl Bromide	13	9,353	1.9%
Atrazine	14	9,002	1.8%
Dazomet	15	8,663	1.7%
Cupric Hydroxide	16	6,907	1.4%
Napropamide	17	6,402	1.3%
Bacillus thuringiensis Berliner ssp. *kurstaki*	18	6,266	1.2%
2,4-D Amine	19	6,253	1.2%
Malathion	20	5,941	1.2%

Pesticide active ingredients that were included on the Nominating List of Toxic Substances in the Lower Fraser/Georgia Basin" (Section 1.1.2) are of particular interest to Environment Canada, as sales provide a surrogate estimate of pesticide loadings to the environment. The sales data should be viewed with caution, however, because some of the large volume vendors in the Lower Mainland may sell pesticides to other areas of the province. For example, one Lower Mainland vendor was responsible for 95% of the *Bacillus thuringiensis*, Serotype H-14, a biological insecticide used for mosquito control, sold in British Columbia in 1999.

Thirteen (possibly fourteen[10]) pesticide active ingredients included in the "1998 Nominating List of Toxic Substances" were sold in the Georgia Basin during 1999 (Table 16). Sales of these products amounted to over 41,000 kg or approximately 8.2% of the pesticides sold in the basin. Only two of the nominated toxic substances, atrazine and malathion, were among the top twenty pesticides sold in Regions 1 and 2.

Table 16 Pesticide Active Ingredients from the "1998 Nominating List of Toxic Substances" Sold in the Georgia Basin in 1999

Active Ingredient	Quantity Sold (kg)	Rank	Percent of Total Sales
Atrazine	9,002	14	1.8%
Malathion	5,941	20	1.2%
Nonylphenoxypolyethoxyethanol	5,670	21	1.1%
Simazine	5,331	23	1.1%
Metolachlor	4,669	26	0.9%
Octylphenoxypolyethoxyethanol	3,950	30	0.8%
Parathion	3,751	32	0.7%
Trifluralin	1,572	51	0.3%
Endosulfan	1,076	60	0.2%
Lindane (Gamma-BHC)	103	124	0.0%
Fenbutatin Oxide	62	139	0.0%
Dinoseb	48	147	0.0%
Methoxychlor	38	153	0.0%
Total Nominated Toxic Substances Sold	41,212		8.2%
Possible Nominated Toxic Substance			
Surfactant Blend	1,117	59	0.2%

[10] The PMRA database does not indicate whether the "surfactant blends" include non-ionic surfactants.

6.1.1 Use by Pest Control Services

Agriculture Services

In 1999, Lower Mainland pest control services licensed in the agriculture category applied almost 10,000 kg of pesticide active ingredients that were included in the "1998 Nominating List of Toxic Substances" (Table 17). These 12 active ingredients amounted to approximately 12% of the pesticides applied by agriculture services in 1999. The total quantity of nominated toxic substances applied by agriculture services was 427 kg (about 4%) lower in 1999 than in 1991. However, if "surfactant blend" were included as a nominated toxic substance, then the use of these substances would be 670 kg (about 6%) higher in 1999 than in 1991.

Table 17 Quantities of Active Ingredients That Are "Nominated Toxic Substances" Used by Agriculture Services in the Lower Mainland, 1991 and 1999

Active Ingredient (AI)	1999 Rank	1991 Agriculture Use (kg)	1999 Agriculture Use (kg)	Change from 1991 (kg)
Atrazine	3	4,647	4,840	+ 193
Metolachlor	5	2,700	2,515	- 185
Nonylphenoxypolyethoxyethanol	8	53.3	1,476	+ 1,422
Trifluralin	15	567	595	+ 28
Octylphenoxypolyethoxyethanol	26	28.0	264	+ 236
Parathion	33	405	200	- 205
Endosulfan	55	92.0	35.8	- 56
Simazine	59	105	18.1	- 87
Malathion	61	336	17.0	- 319
Methoxychlor	83	-	0.63	+ 1
Fenbutatin Oxide	91	0.03	0.03	-
Dinoseb	--	1,454	-	- 1,454
Total Use		10,388	9,961	- 427
Percent of Total Agricultural Use		25%	12%	- 13%
Possible Nominated Toxic Substance				
Surfactant Blend	10	-	1,097	+ 1,097

Landscape Services

During 1999, landscape services in the Lower Mainland used nine pesticide active ingredients that were included in the "1998 Nominating List of Toxic Substances."

(Table 18). Applications of these chemicals totalled 123 kg or 1.4% of the pesticides applied by landscape services.

There was no apparent trend in the overall use of “nominated toxic substances” by landscape services between 1991 and 1999, as the amounts applied in 1995 were considerably higher than the amounts used in the other two years (Table 18). However, the total use of these chemicals was 16% lower in 1999 than in 1991. In addition, use of malathion, endosulphan, lindane and trifluralin showed a decreasing trend and no use of these four active ingredients occurred in 1999.

Table 18 Quantities of Active Ingredients That Are "Nominated Toxic Substances" Used by Landscape Services in the Lower Mainland, 1991 to 1999

Active Ingredient	1999 Rank	1991 Use (kg)	1995 Use (kg)	1999 Use (kg)	Change from 1991 (kg)
Simazine	15	41.4	93.6	76.7	+ 35.3
Nonylphenoxypolyethoxyethanol	32	0.14	47.6	25.1	+ 25.0
Methoxychlor	33	58.6	67.3	21.4	- 37.3
Fenbutatin Oxide	73	0.27	0.45	0.07	- 0.20
Malathion	--	34.0	17.4	-	-34.0
Endosulfan	--	8.00	3.32	-	-8.0
Octylphenoxypolyethoxyethanol	--	-	1.25	-	-
Lindane (Gamma-BHC)	--	0.78	0.38	-	-0.78
Trifluralin	--	3.52	0.35	-	-3.52
Total Use		147	232	123	-23.5
Percent of Total Landscape Use		1.0%	1.6%	1.4%	0.4%

7.0 CONCLUSIONS

There were some notable changes in pesticide sales and use between 1991 and 1999 (Table 19) with both increases and decreases in different pesticide categories. The major changes were as follows:

- From 1991 to 1999 the quantity of reportable pesticides sold increased by about 19%. However, sales of federally-labelled Restricted pesticides decreased by 48% over the same period.
- Anti-sapstain chemical use by lumber mills declined by over 40%, and the decrease was statistically significant at the 1% level.
- The quantity of flea control products sold by veterinarians declined by 78% due to a change in flea control technology (replacement of pesticides with a product administered orally or by injection).
- The use of pesticides by landscape services in the Lower Mainland decreased by 40%.

The apparent change in wood preservative use (Table 19) is due primarily to changes in the use of creosote. According to industry representatives, creosote use normally can vary by several million kilograms per year. Thus, the change in wood preservative use is not considered significant.

Table 19 Summary of Changes in Pesticide Sales or Use in British Columbia, 1991 to 1999

Survey Category	1991 (kg)	1995 (kg)	1999 (kg)	Change from 1991 (kg)
Wood Preservative Use	3,685,955	6,905,728	6,529,878	+ 2,843,923
Anti-Sapstain Chemical Use *	838,319	754,314	479,251	- 359,067
Reportable Pesticide Sales	916,933	1,005,086	1,093,195	+ 176,262
Flea Control Product Sales	718	622	156	- 562
Use by Landscape Services	15,154	14,802	9,071	- 6,083
Use by Agriculture Services	42,083	No data	86,565	+ 44,482

* 1999 anti-sapstain use is underestimated by approximately 8% due to the non-reporting of four mills. After accounting for this underestimate, there still is a reduction in anti-sapstain use on the order of 300,000 kg.

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