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Survey of Pesticide Use in British Columbia: 2003

Environment Canada Environnement Canada

BRITISH COLUMBIA

Ministry of Environment

The Georgia Basin Ecosystem

Survey of Pesticide Use in British Columbia: 2003

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Executive Summary

The survey of pesticide sales and use in British Columbia during 2003 is the fourth in a series of such surveys conducted for Environment Canada and the British Columbia Ministry of Environment (MoE)[1]. The long-term objective of these surveys is to determine trends in pesticide sales and use. The first survey was commissioned after MoE (then MELP) began to encourage and promote the adoption of Integrated Pest Management (IPM) to reduce reliance on pesticides and eliminate unnecessary pesticide uses. The 2003 survey was conducted as part of the Georgia Basin Action Plan (GBAP) with funding from Environment Canada and MoE.

The objectives of the 2003 pesticide sales and use survey were to:

- obtain pesticide sales records for 2003, including commercial pesticides and veterinary flea control pesticides;
- obtain pesticide use data for 2003 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, landscape and forestry use categories;
- compile the information into databases and summary tables so that the data could be compared to the results from the previous three surveys;
- provide separate tabulations to show patterns of pesticide use within the Georgia Basin; and
- identify changes in the pesticide active ingredients used over time.

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 three 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 summary showed that in 2003, British Columbians purchased or used 4,666,709 kg of pesticide active ingredients, excluding most Domestic label pesticides. Of this total,

[1] formerly Ministry of Environment, Lands and Parks (MELP); Ministry of Water, Land & Air Protection

3,344,531 kg (73%) were anti-microbial pesticides, consisting primarily of commercially applied wood preservatives and anti-sapstain chemicals. Insecticides accounted for 408,662 kg (9%) of the total pesticides, fungicides for 304,682 kg (7%) and herbicides for 286,423 kg (6%). The remaining pesticides (5%) included biological control products/insecticides, fumigants, plant growth regulators, insect growth regulators, molluscicides, vertebrate control products, adjuvants and surfactants.

Twenty active ingredients accounted for 93% of the pesticides sold or used during 2003. Creosote alone accounted for 47% of the pesticide use in the province. The wood preservative chromated copper arsenate (CCA) and the anti-sapstain didecyl dimethyl ammonium chloride (DDAC) accounted for 18% and 4% of all pesticides used, respectively. Other important active ingredients included mineral oil (insecticidal or adjuvant), representing 7%; the wood preservative pentachlorophenol, representing 3%, glyphosate, representing 3%; and the wood preservative ammoniacal copper quaternary (ACQ), representing 2% of all pesticides used.

Evaluation of pesticide use in the Georgia Basin included identifying and tracking changes in quantities of pesticides of environmental concern. Several initiatives have developed lists of pesticides of particular concern in the Georgia Basin and Puget Sound. The lists include:

- the "1998 Nominating List of Toxic Substances in the Lower Fraser/Georgia Basin" developed under the Georgia Basin Ecosystem Initiative, the predecessor to GBAP;
- a list of contaminants of concern in Puget Sound developed for the US National Oceanic and Atmospheric Administration (NOAA); and
- a list of contaminants that could pose a health risk to southern resident killer whales.

In 2003, Reportable Pesticide Sales in the Georgia Basin included 40 active ingredients found on one or more lists of environmental concern. Eight active ingredients appear on two or more of the three lists of concern. These active ingredients are atrazine, simazine, chlorpyrifos, malathion, metolachlor, endosulfan, trifluralin and lindane. Together the eight active ingredients amounted to 30,478 kg or 5.7% of all pesticides sold in the Georgia Basin during 2003.

The long-term objective of the British Columbia pesticide surveys is to determine trends in pesticide sales and use. The 2003 survey provides three or four data points for most categories of pesticides. Three or four data points provide minimal statistical power for assessing long-term trends. Nevertheless, some conclusions can be drawn about changes in pesticide use. The major changes in pesticide sales and use from 1991 to 2003 were as follows (see summary table):

- From 1991 to 2003 the quantity of Reportable pesticides sold increased by almost 223,000 kg or 24%. However, 92% of the increase is attributable to increased sales of mineral oil (insecticidal or adjuvant), various strains of the biological

insecticide *Bacillus thuringiensis* and insecticidal soap. These pesticides are "less toxic" alternatives that might be chosen as part of an IPM program.

- Sales of federally-labelled Restricted pesticides decreased by 63% between 1991 and 2003. This class of pesticides includes products that have high toxicity or are associated with other environmental concerns.
- Sales of veterinary flea control products decreased by 83%. These pesticides largely have been replaced by products registered as drugs, which are administered orally or by injection or applied to one spot on the skin.
- Anti-sapstain chemical use by lumber mills declined by over 79%, and the decrease was statistically significant at the 1% level. There was no overall change in province-wide lumber production that could account for the decline, although a decrease in lumber production by coastal mills between 2001 and 2003 may have contributed to the change from 1999 use levels.
- The use of pesticides by landscape services in the Lower Mainland decreased by 50%. Linear regression analysis showed this trend to be significant at the 5% level.
- Of the eight active ingredients of concern in the Georgia Basin, there have been substantial decreases in the sales of atrazine, malathion and metolachlor. However, only metolachlor showed a statistically significant downward trend. Atrazine sales decreased between 1991 and 1995 but subsequently have risen. Sales of chlorpyrifos, lindane and simazine did not change substantially over the study period.

Summary of Changes in Pesticide Sales or Use in British Columbia, 1991 to 2003

Survey Category	1991 (kg)	1995 (kg)	1999 (kg)	2003 (kg)	Change from 1991 (kg)
Wood Preservative Use	3,685,955	6,905,728	6,529,878	3,236,267	-449,688
Anti-Sapstain Chemical Use	838,319	754,314	479,251	206,041	**-632,278**
Reportable Pesticide Sales	923,275	1,010,372	1,093,195	1,146,263	**+ 222,988**
Veterinary Sales	718	622	156	122	**-596**
Use by Landscape Services	15,154	14,802	9,071	7,541	**-7,613**
Use by Agriculture Services	42,083	No data	86,565	11,338	-30,745

Changes shown in **bold** represent significant trends and/or product replacements.

There also was a slight decrease in wood preservative use compared with 1991 and a large decrease (>3,000,000 kg) compared with 1999. However, this change can largely be explained by changes in creosote use, which normally can vary from year to year by over 1,000,000 kg. More notably, a new wood preservative active ingredient, alkaline copper quaternary (ACQ) was identified in 2003. This product is an arsenic-free

replacement for chromated copper arsenate (CCA), which was voluntarily withdrawn from use in the residential market at the end of 2003.

Use of pesticides by licensed services dealing with the agriculture sector was highly variable over the three years during which this sector was surveyed. Thus, although the quantity of pesticides used by these services was lower in 2003 than in previous years, no conclusions regarding trends are possible.

The study identified several replacements of pesticide active ingredients over the 1991-2003 survey period. Most of these substitutions identified occurred in the agriculture sector. Notable substitutions include *S*-metolachlor for metolachlor and M-metalaxyl for metalaxyl. These newer products contain higher levels of active isomers and therefore require lower application rates. In other cases, older active ingredients (e.g. metam, sulphur, chlorothalonil and insecticidal mineral oil) plus newer (post-1991) products like myclobutanil have replaced active ingredients that are no longer registered such as 1,3-dichloropropene, folpet, methidathion and dichlone. In addition, insect growth regulators like tebufenozide are beginning to replace some use of organophosphate insecticides on tree fruits.

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1.0 INTRODUCTION

1.1 Background

1.1.1 Purpose of Pesticide Sales and Use Surveys

The survey of pesticide sales and use in British Columbia during 2003 is the fourth in a series of surveys conducted for Environment Canada and the British Columbia Ministry of Environment (MoE). The long-term objective of these surveys is to determine trends in pesticide sales and use.

In 1991, the British Columbia Ministry of Environment, Lands and Parks (MELP - now MoE) established the objective of encouraging and promoting adoption of Integrated Pest Management (IPM). IPM methods reduce reliance on pesticides and eliminate unnecessary pesticide uses. By promoting IPM, MELP anticipated a 25% reduction in pesticide use province wide by the year 2001.

1.1.2 Previous Survey Components

In 1992, MELP commissioned the first survey of pesticide sales and use records in British Columbia, using data from 1991. MELP's intention was that similar surveys would be conducted periodically to document changes in pesticide use. In 1996, a survey of 1995 pesticide data was completed and compared the results with the 1991 study. The first two surveys were funded partially by Environment Canada through the Fraser River Action Plan. In 2000, under the Georgia Basin Ecosystem Initiative (GBEI), Environment Canada, in partnership with MELP, funded a survey of pesticide sales and use during 1999. While the objectives of this survey were similar to the 1991 and 1995 surveys, portions of the study focused on Georgia Basin (southern Vancouver Island and Lower Mainland reporting regions).

The 1991, 1995 and 1999 surveys included the following data sources:

- compilation of 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 pressure and thermal treatment wood preservation plants;
- a survey of anti-sapstain chemicals used by lumber mills; and
- various methods of surveying sales and/or use of Domestic-label pesticides, whose sales are exempted from the reporting requirements.

The 1991 study had the broadest scope of the four surveys, as it included compilation of use data for licensed pest control services from across the province, a survey of Domestic-label pesticide wholesalers and a survey of companies using slimicides (biocides used in cooling towers and paper making). The 1995 survey of pest control services included only companies located in the Lower Mainland Region (which extends approximately from Pemberton to Hope) and licensed in the landscape category. As well, the 1995 study surveyed only the Domestic pesticides sold by veterinarians. Slimicides were not included. The 1999 survey was similar in scope to the 1995 survey, except that it incorporated the results of a separate survey of domestic pesticide use in the Capital Regional District (CRD).

1.2 2003 Study Objectives

The major objectives of the 2003 survey were to:

- obtain pesticide[2] sales records for 2003, including veterinary and commercial pesticides;
- obtain pesticide use records for the Lower Mainland Region from annual summaries of use submitted by pest control services renewing licenses in the agriculture, landscape and forestry use categories;
- obtain pesticide use data for 2003 for anti-sapstain chemicals and wood preservatives;
- obtain pesticide use data for 2003 from golf courses in the Lower Mainland Region;
- obtain pesticide use data (if available) for the aquaculture industry;
- estimate the quantities of "inert" ingredients (e.g. solvents, surfactants, adjuvants) used in BC;
- identify (if available) data related to minor use permits, research permits and emergency registrations of pesticides;
- estimate, to the extent possible, domestic and exempted pesticides used in BC but not captured in the survey;
- determine, if possible, the significance of pesticides purchased outside British Columbia;

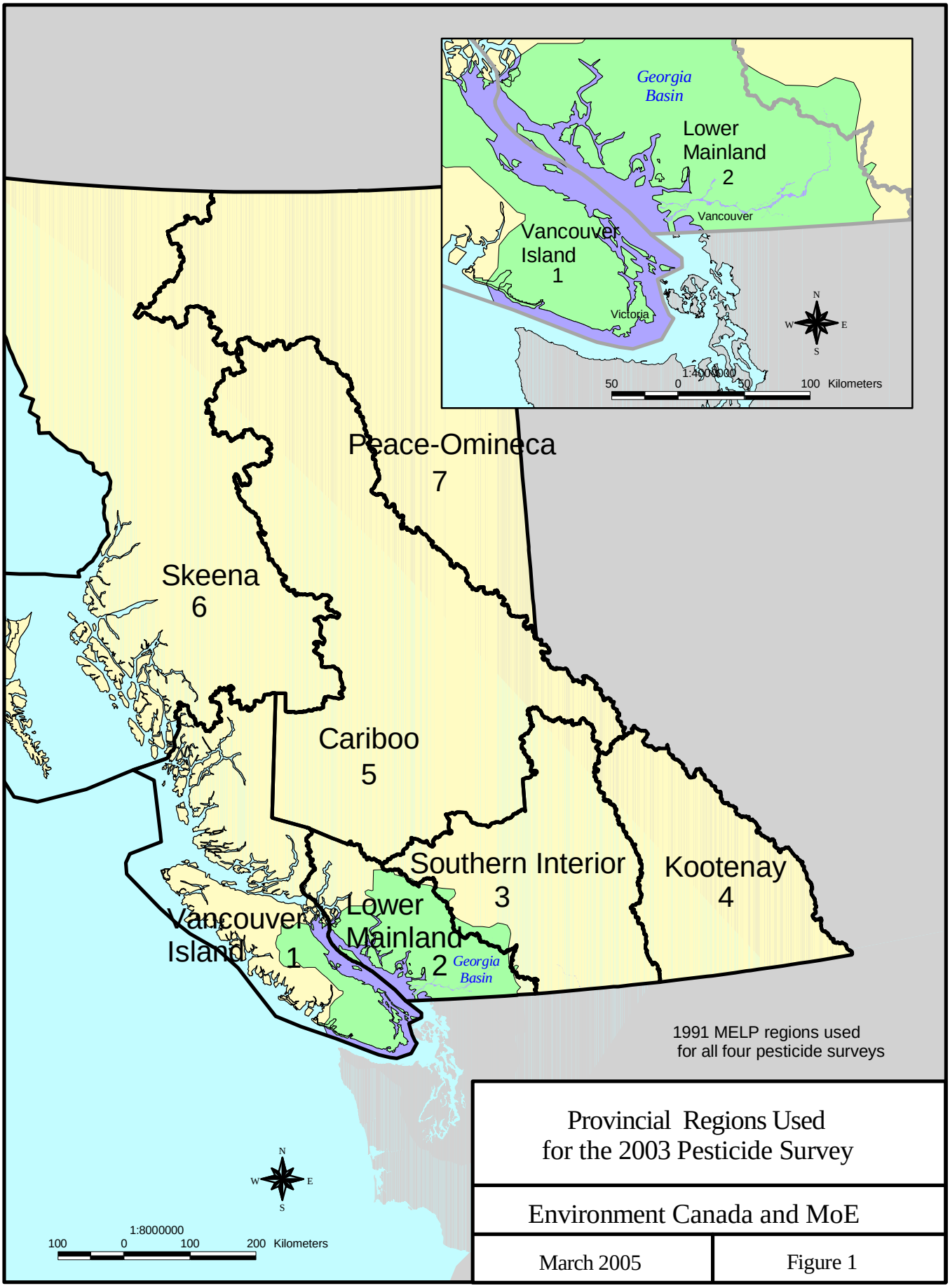
[2] In general, for this survey "pesticide" is defined as a product registered under the federal *Pest Control Products Act* and assigned a registration (PCP) number. An exception is the inclusion fertilizer-pesticide combinations registered under the *Fertilizer Act*. Products licensed as drugs are not included.

- compile the information into databases and summary tables so that (where applicable) the data can be compared to the results from the previous three surveys (Table 1); and
- identify changes in the pesticide active ingredients used over time.

Table 1 Comparison of 1991, 1995, 1999 and 2003 Pesticide Survey Major Components

1991	1995	1999	2003
Reportable Pesticide Sales	Reportable Pesticide Sales	Reportable Pesticide Sales	Reportable Pesticide Sales
Anti-Sapstain Chemicals	Anti-Sapstain Chemicals	Anti-Sapstain Chemicals	Anti-Sapstain Chemicals
Wood Preservatives	Wood Preservatives	Wood Preservatives	Wood Preservatives
Slimicides	--	--	--
Domestic Pesticide Sales	Domestic Pesticide Sales (Veterinary pesticides only)	Veterinary pesticides sales Domestic Pesticide Use (CRD only)	Veterinary pesticides sales Domestic and Exempted Pesticide Sales (estimate)
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)	Pesticide Applications by Licensed Services (Agriculture, Landscape and Forestry categories, Lower Mainland only)
--	--	--	Golf Courses (Lower Mainland only)
--	--	--	Aquaculture Pesticides
--	--	--	Minor use Permits, Research Permits and Emergency Registrations of Pesticides

This report presents detailed information on pesticide sales and use for British Columbia as a whole and for seven geographical regions (Figure 1). For consistency among the surveys, these regions are based on MELP's 1991 administrative regions, which differ from MoE's current administrative regions. The report discusses the data quality and includes a comparison with the 1991, 1995 and 1999 data sets. It also discusses pesticide sales and use patterns within the Georgia Basin, which consists of the 1991 MELP Region 2 and most of Region 1.



Provincial Regions Used for the 2003 Pesticide Survey

Environment Canada and MoE

March 2005 | Figure 1

2.0 SURVEY METHODS

2.1 Approach

The 2003 survey of pesticide sales and 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 major 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. These reports are submitted to MoE as part of the annual license renewal requirements for pesticide vendors and pest control services. Other existing data sources included MoE's Pesticide Use Permits (required for the aquaculture industry), emergency use and minor use registrations coordinated through the Pest Management Regulatory Agency (PMRA) and the BC Ministry of Agriculture and Lands. Data obtained in whole or in part from surveys of pesticide users included heavy-duty wood preservatives, anti-sapstain chemicals, golf courses and domestic flea control pesticides sold through veterinarians. 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 with MoE. 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 required 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 MoE 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 MoE 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.

For the 2003 survey, MoE provided the annual reports for all pesticide vendors plus pest control services licensees in the agriculture, landscape and forestry categories from the Lower Mainland (Region 2) only. Data from these reports were entered into databases, which were used to calculate and summarize sales or use of pesticide active ingredients, as discussed in the following sections.

2.2.2 Data Acquisition and Database Entry

MoE regional offices provided annual sales summaries from 130 vendors, not including reports indicating nil sales. The Lower Mainland Regional Office also provided annual use summaries from 188 agriculture, landscape and forestry pest control service licensees. ENKON entered all data from the summary forms into computer databases (one for vendors and one for each service license category). 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 12.5 to 37.5% based on the licensees' estimates of the proportion of their sales purchased by Alberta residents. The reductions were adjusted to account for estimates of pesticide purchases in Alberta by BC residents.

Several pest control services were licensed in more than one category. In order to limit the survey to agriculture, landscape and forestry use only, ENKON telephoned all multiple-category licensees and requested that they indicate the amounts of pesticides applied for agriculture, landscaping and forestry (and separate the amounts, if they were licensed in more than one of the target categories).

2.2.3 Data Analysis and Presentation

ENKON downloaded a computer database (the "PCP database") of active ingredients and percent guarantees for registered and formerly registered pesticides from the PMRA's ELSE Label Search website, http://eddenet.pmra-arla.gc.ca/4.0/4.01.asp. This database

included information on the type of pesticide[3] 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 concentration of active ingredient in the formulated product. 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.

In approximately 6% of the individual pesticide records[4], the recorder either failed to report a PCP number or reported a number that was in error. For example, a product described as Terbufos was reported with the PCP number for copper sulphate, or the PCP number reported was a technical or manufacturing product. The database was screened for these instances and the probable PCP numbers were identified based on the product names and formulations.

In a few 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 sold in the same region. 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 (most cases in 2003), 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 far in the past. ENKON used the 1991 and 1995 PCP databases to identify the formulations of products not currently registered. The outdated PCP numbers so identified included three products (two dormant oils and one gopher bait) that were identified as no longer registered as early as 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

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

[4] Not including all entries by one vendor who provided no PCP numbers

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 Plus). For these products one litre was assumed to equal one kilogram. This method is the standard recommended by MoE 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, MoE 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 previous surveys (Norecol 1993, Norecol, Dames & Moore 1997, ENKON 2001).
- 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, landscape and forestry 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.

These tables are included in the report as appendices.

2.2.4 Estimation of "Inert" Ingredients

Canadian pesticides labels generally do not list "inert" ingredients such as solvents that are part of the pesticide formulation. Partial exceptions are substances that Health Canada considers to be of toxicological concern. ENKON performed a full label search of the PMRA's online database for the words "toxicological concern" and "toxic formulant." The search identified 45 products for which an inert ingredient was listed. These products were compared with the products contained in the 2003 Reportable

pesticide sales database[5]. When matches were found, the quantities of inert ingredients sold were calculated.

Environment Canada expressed an interest in estimating quantities of other inert ingredients such as adjuvants and surfactants. Adjuvants and some surfactants have PCP registration numbers. These substances are captured in the Reportable Pesticide Sales database, and the quantities sold or used are included in the appendices to this report.

2.3 Golf Course Pesticide Survey

ENKON identified golf courses through an Internet search of sites such as the British Columbia Golf Association's member list (http://www.bcga.org/member_clubs.cfm) and http://www.golfcourse.com/search/locate.cfm. The search identified 96 golf courses in the Lower Mainland Region.

The golf course superintendents were contacted by letter (faxed) and telephone to request cooperation. Each received a survey form asking them to list all pesticides applied, with their PCP numbers and amounts used during 2003. Non-responses were followed up with telephone calls. Some of the golf courses could not be contacted because they were closed for the winter. Ultimately, 52 golf courses responded by providing pesticide use information.

2.4 Domestic Pesticide (Veterinary Flea Control Products) Vendors Survey

2.4.1 Identification of Wholesale Vendors

Vendors of Domestic label pesticides are not required to report their sales on an annual summary form. For the 1995 and 1999 pesticide use surveys Norecol, Dames & Moore (1997) and ENKON (2001) surveyed wholesale distributors of flea control products distributed through veterinarians. The wholesale distributors were identified through initial surveys of the British Columbia Veterinary Association and Lower Mainland veterinary clinics.

For the 2003 survey ENKON used the *Compendium of Veterinary Products* to identify nine manufacturers who potentially sell flea control products in British Columbia. When contacted, three of these companies said they did not sell any veterinary flea control products in British Columbia in 2003. The remaining companies did sell flea control products to veterinarians in BC. Five of these companies provided data.

2.5 Wood Preservative Plant Survey

Data on use of heavy-duty wood preservatives were obtained by surveying the 16 thermal or pressure treatment wood preservation plants in the province. The same 16 plants were

[5] Compiled from the Annual Summaries of Reportable Pesticide Sales

surveyed in 1995 and 1999. Environment Canada confirmed that these 16 treatment plants were operating during 2003. In addition, ENKON contacted post and pole mills listed in *Major Timber Processing Facilities in British Columbia 2003* (Ministry of Forests, Economics and Trade Branch 2004) to determine their methods (if any) of wood treatment. None of these plants (except those among the 16 already identified) were using heavy duty wood preservatives.

The plant managers of the 16 thermal or pressure treatment plants were contacted by letter (faxed) 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 2003. Non-responses were followed up with phone calls.

Fourteen of the 16 companies contacted provided use data. The 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.

2.6 Anti-Sapstain Use Data

From 1991 to 1998, Environment Canada conducted an annual survey of lumber mills that included onsite inspections and compilation of chemical use data. The data obtained during these inspections was used for the 1991 and 1995 pesticide surveys. In 1999, ENKON conducted a letter and telephone survey of 46 lumber mills that had used anti-sapstains in 1998.

Environment Canada has not annually updated its list of anti-sapstain users since 1998. Therefore, in addition to contacting the 46 lumber mills surveyed previously, it was necessary to update the list of anti-sapstain users. This was done through a combination of methods, including:

- contacting MoE regional offices to determine whether staff members were aware of any new anti-sapstain users in their region;
- talking to the mill managers and/or regional managers for the larger forestry companies (e.g. Weyerhaeuser, Western Forest Products);
- talking to anti-sapstain vendors and other providers of services to lumber mills; and
- telephoning coastal lumber mills listed in *Major Timber Processing Facilities in British Columbia 2003* (Ministry of Forests, Economics and Trade Branch 2004).

During the 1999 pesticide survey, ENKON learned that lumber mills that held air quality permits from the Greater Vancouver Regional District (GVRD) were required to report their chemical use (including anti-sapstains) to the GVRD. Therefore, with the assistance of Environment Canada, ENKON contacted the GVRD, which provided anti-sapstain data for four of the plants within its jurisdiction. A review of the data suggested that not all mills were reporting anti-sapstain use and that most Lower Mainland mills would have to be surveyed individually.

ENKON contacted or attempted to contact the managers of the 46 lumber mills[6] that had used anti-sapstains in 1999. Ten of the lumber mills surveyed in 1999 no longer were in business. The managers of the mills newly-identified as anti-sapstain users also were contacted. The survey methods were identical to the wood preservative plant survey methods.

2.7 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 vendors listed in MoE's license database were received; particular emphasis was placed on obtaining information from large volume vendors identified in previous surveys, but an attempt was made to obtain reports from all vendors;
- 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 PMRA database (Section 2.2.3);
- screening calculated quantities of active ingredients for outliers, with follow up to determine whether outliers reflected 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 MoE 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 they were associated with a large quantity of product sold, and the product name given could be

[6] Except those whose anti-sapstain use data had been obtained from the GVRD

associated with several products having different formulations. 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 20% of services licensees by telephone to discuss their methods of calculating the quantities provided on the reporting forms[7]. This question was asked of all licensees contacted with other questions. Additional service licensees required to make up the 20% were selected at random. 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?
- Did you use some other method of calculating annual sales? If so, please describe.
- Did you report amounts used as diluted volumes or concentrate?

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

[7] 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.

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 not registered 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 (reporting non-standard units such as cases or jugs, omitting units, omitting 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 (ranging from submitting the daily purchase register to omitting information such as the licence number, postal code or vendor's name).

Of the 130 Reportable Sales Summaries received, 51% contained at least one error. 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. However, only 6.2% of the total data entries (lines on the reporting forms) contained PCP number errors compared >14% similar errors in 1999. The errors in PCP numbers included 41 products (1.0% of the total entries) that could not be identified in the PCP database. Most of these products appear to be something other than pesticides (e.g., wetting agent, anti-foam).

Other errors included the following:

- 0.2% of the entries contained quantity errors or irregularities;

- non-standard units (such as cases or jugs) accounted for 2.5% of the erroneous entries;
- 1.6% of the errors related to the "concept" packaging of two or more products.

3.1.2 Errors and Irregularities on Use Reports

Of the 188 Service Licence Use Summaries, only six (3%) contained errors, and only 9% of the data entries contained errors. The 2003 annual summary reports compared favourably with the 1999 reports, of which 45% contained at least one error, and 16% of the total data entries contained errors. The following types of errors and irregularities were identified on the 2003 reports:

- missing or incorrect PCP numbers (5% of the data entries); and
- incorrect units, for example kilograms reported for liquid pesticides (4% of the data entries).

3.1.3 Methods of Tracking Pesticide Use

Thirty-three service licensees were surveyed by telephone. Of these, twenty five (76%) used the Daily Use Record to calculate total pesticide use for the year. Six of the licensees (18%) used computerized methods of tracking use. Five licensees (15% of those surveyed) used only an inventory method of calculating use, while seven licensees used inventory to verify computerized or hand-written daily records.

Because the 1999 survey had identified several licensees who had reported diluted pesticide volumes, all telephone survey respondents were asked whether they had reported diluted or undiluted quantities. All respondents said that they had reported undiluted quantities.

There appeared to be an overall improvement in the accuracy of the 2003 service licensee reports compared with 1999. This may have been due, at least in part, to the changes in MoE's annual report forms, which clearly require that use must be reported in litres or kilograms of undiluted product.

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 formal attempt to determine how the wood treatment plant operators, lumber mill operators or golf course maintenance personnel calculated the quantities they reported. However, discussions with various mill operators suggested that they were obtaining information from their purchasing departments, which should be accurate except for potential carryover of purchased product from year to year. Discussions with golf course superintendents suggested that most golf courses keep accurate records of the numbers of times they apply pesticides, the products applied and the rates of application. These records should have permitted accurate calculation of the total amounts of pesticides applied.

The only inaccuracies apparent on the reports from these sectors involved PCP numbers of wood preservatives and anti-sapstains. In most cases the golf courses accurately reported PCP numbers. For the few golf courses that omitted PCP numbers, it was possible to fill in the missing information based on products used at other courses.

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 two formulations. In both the current survey and the previous three surveys, respondents reported using either 50% or 60% formulations. If both the PCP number and formulation were missing, the two formulations were assigned equally on a use-weighted basis. Errors associated with this method of estimating the CCA formulation could have (in the worst case) resulted in an overestimate of 4,913 kg or an underestimate of 9,158 kg, an error range of +0.6% to -1.1% of the total estimated CCA usage.

Similarly, there likely was some inaccuracy in the anti-sapstain data. For example, there are two anti-sapstain formulations that contain didecyl dimethyl ammonium chloride (DDAC) plus iodocarb (IPBC). Some companies reported using formulation A but provided the PCP number for formulation B or vice versa. Other companies did not provide a PCP number. To calculate the amounts of active ingredients, missing or questionable PCP numbers were assigned such that they produced approximately equal quantities of formulation A and formulation B. In the worst case[8], the resulting error would have amounted to ±5,052 kg of DDAC (±2.9%) and ±1,367 kg of iodocarb (±11.6%).

[8] The worst case assumes that all quantities assigned to formulation A actually were formulation B, while all quantities assigned formulation B actually were formulation B, or all quantities assigned to formulation B actually were formulation A, while all quantities assigned formulation A actually were formulation A.

4.0 SURVEY RESULTS

4.1 Overall Pesticide Sales and Use

Reportable pesticide and veterinary pesticide sales plus use of anti-sapstains and wood preservatives were summed to provide the total quantities of pesticide active ingredients sold or used during 2003. For the active ingredients methyl bromide, chloropicrin and *Bacillus thuringiensis* Berliner *ssp. kurstaki*, the quantities used by pest control service licensees replaced the sales data, as the quantities used greatly exceeded the quantities sold, suggesting out-of-province purchases of these pesticides.

The summary showed that in 2003 British Columbians purchased or used 4,666,709 kg of pesticide active ingredients, excluding most Domestic label products. Of this total, 3,344,531 kg (73%) were anti-microbial pesticides, consisting primarily of commercially applied wood preservatives and anti-sapstain chemicals (Figure 2, Table 2). Insecticides accounted for 408,662 kg (9%) of the total pesticides, fungicides for 304,682 kg (7%) and herbicides for 286,423 kg (6%). The remaining pesticides (5%) included biological control products/biological insecticides, 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, 2003

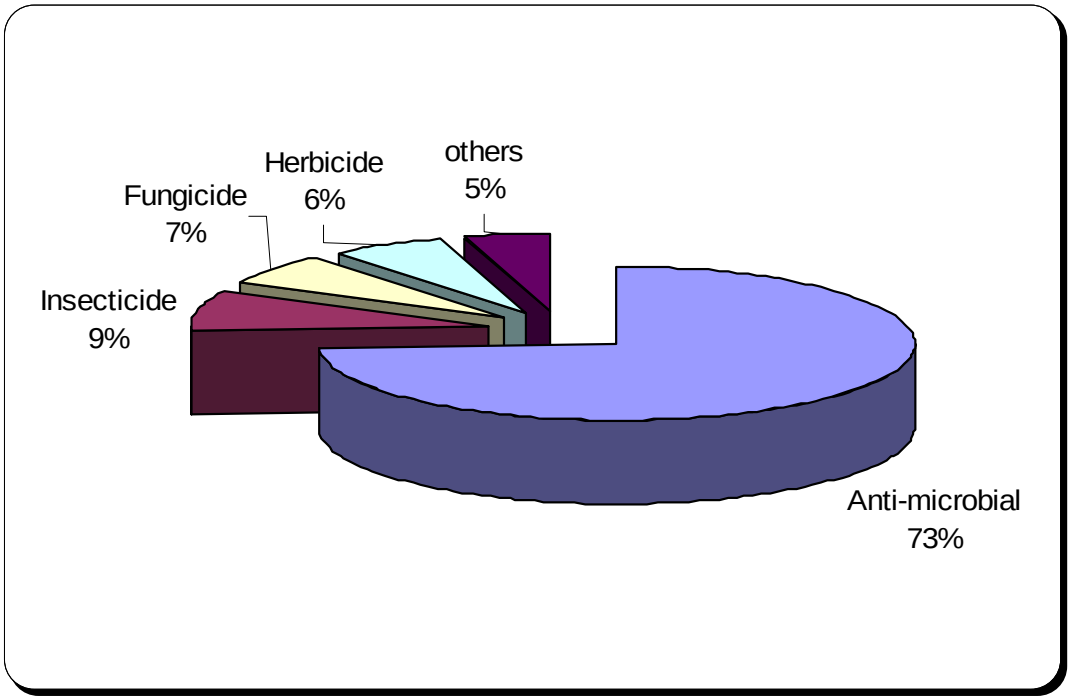


Table 2 Quantities of Active Ingredients (by Chemical Class) of Pesticides Sold or Used in British Columbia, 2003

Pesticide Type	Quantity (kg)
Anti-microbials	3,344,531
Insecticides	408,662
Fungicides	304,682
Herbicides	286,423
All Others	222,412
Total	4,666,709

The total, province wide pesticide use included 287 active ingredients (Appendix A). Twenty of these active ingredients accounted for 93% of the pesticides sold or used during 2003 (Table 3). Creosote alone (2,163,142 kg) accounted for 47% of the pesticide use in the province. The wood preservative chromated copper arsenate (CCA) and the anti-sapstain didecyl dimethyl ammonium chloride (DDAC) accounted for 824,100 kg or 18% and 174,606 kg or 4% of all pesticides used, respectively. Other important active ingredients included mineral oil (insecticidal or adjuvant), representing 317,108 kg or 7%; the wood preservative pentachlorophenol, representing 147,684 kg or 3%, glyphosate, representing 120,724 kg or 3%; and the wood preservative ammoniacal copper quaternary (ACQ), representing 74,448 or 2% of the pesticides used.

4.2 Reportable Pesticides Sold

4.2.1 Province-Wide Pesticide Sales

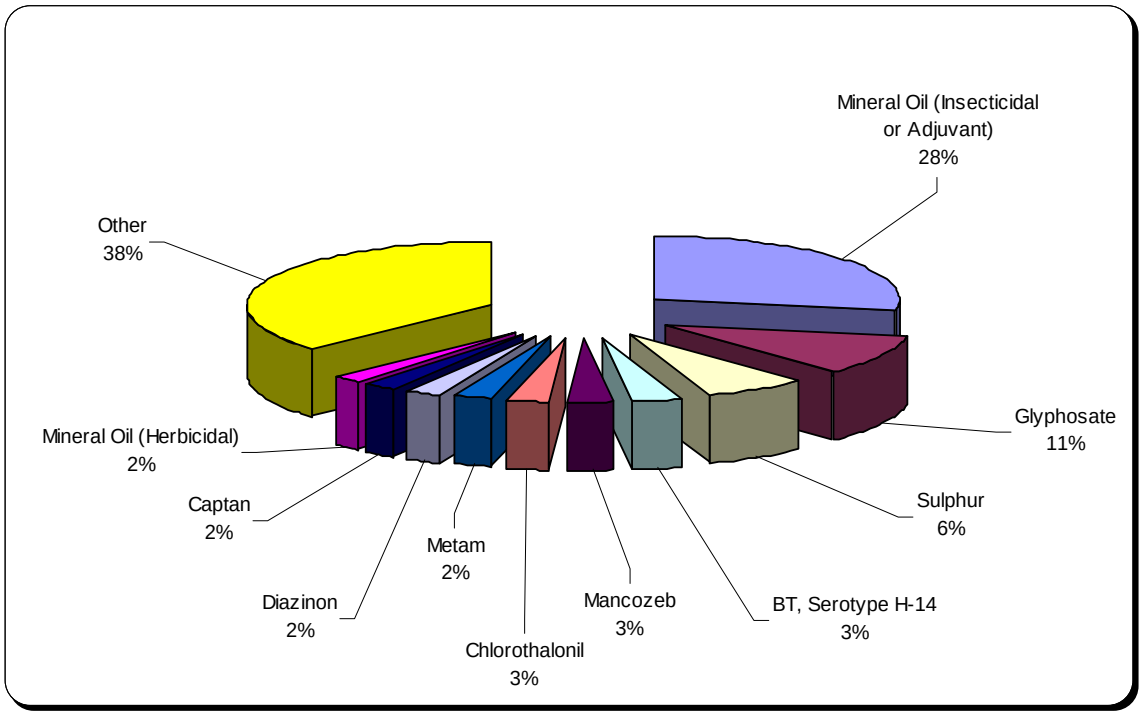
In British Columbia, Reportable pesticides are all products that have a Restricted or Commercial use label. They include pesticides used for agriculture and industrial applications.

The 1,146,263 kg of Reportable pesticides sold during 2003 accounted for 25% of the total quantity of pesticide active ingredients shown in Table 3. Ten active ingredients accounted for 63% of the Reportable pesticides sold. These active ingredients were insecticidal and herbicidal mineral oils (317,108 kg and 23,575 kg, respectively); the herbicide glyphosate (120,724 kg); the fungicides sulphur, mancozeb, chlorothalonil and captan; the insecticide diazinon, the biological insecticide *Bacillus thuringiensis* (BT) and the fumigants metam and methyl bromide (Figure 3, Appendix B).

Table 3 Quantities of the Top Twenty Pesticides Sold or Used in British Columbia, 2003 (Excluding Domestic Pesticides)

Active Ingredient	Quantity (kg)	Percent of Total
Creosote	2,163,142	47.1%
CCA	824,100	18.0%
Mineral Oil (Insecticidal or Adjuvant)	317,108	6.9%
Didecyl Dimethyl Ammonium Chloride	174,606	3.8%
Pentachlorophenol	147,684	3.2%
Glyphosate	120,724	2.6%
Bacillus thuringiensis Berliner *ssp. kurstaki*	85,765	1.9%
ACQ	74,448	1.6%
Sulphur	73,408	1.6%
Bacillus thuringiensis, Serotype H-14	39,153	0.9%
Mancozeb	34,888	0.8%
Chlorothalonil	33,505	0.7%
Metam	28,582	0.6%
Diazinon	27,074	0.6%
Captan	25,500	0.6%
Disodium Octaborate Tetrahydrate	24,679	0.5%
Mineral Oil (Herbicidal)	23,575	0.5%
Formaldehyde	21,822	0.5%
Lime Sulphur	20,524	0.4%
Copper Oxychloride (as Cu)	19,562	0.4%

Figure 3 Percentages of Active Ingredients of Reportable Pesticides Sold or Used in British Columbia, 2003



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 B. For consistency of year to year comparisons, the regions used for this summary are the 1991 MELP regions (Figure 1), which differ considerably from current MoE regions. The regional data may not entirely reflect regional use patterns, as the 1995 pesticide survey identified that some vendors may sell to purchasers in other regions.

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 56% of the pesticide active ingredient sales in the Okanagan (Region 3, 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[9]. Formaldehyde accounted for 4.2% of the reportable pesticide active ingredient sales in the Lower Mainland, where it is used as a fungicide/disinfectant in mushroom-growing and poultry operations. The herbicides glyphosate and MCPA ester accounted for 48% of the pesticide active

[9] The lack of sales in Region 4, which also has significant areas of fruit trees, suggests purchase of this pesticide from outside the region, likely from Region 3.

ingredients sold in the Peace River area (Region 7), where grains are the major crop. These herbicides (particularly glyphosate) were sold widely in British Columbia. Several other herbicides, including triallate, bromoxynil, glufosinate ammonium, imazamethabenz, ethalfluralin, tralkoxydim and fluazifop-p-butyl, were among the top 20 pesticides sold in Region 7, but sales of these products in the rest of the province were minimal. No Reportable pesticides were sold in Region 6 in 2003. Section 4.11 provides additional information on regional differences in agricultural production and the purposes for which major pesticides were applied.

4.2.3 Products Containing Major Reportable Pesticide Active Ingredients

Table 4 lists the major pesticide products that contain the top 20 Reportable pesticide active ingredients sold in British Columbia during 2003.

Table 4 Major Pesticide Products Containing the Top 20 Reportable Pesticide Active Ingredients Sold in British Columbia during 2003

Active Ingredient	Major Products
Mineral Oil (Insecticidal or Adjuvant)	Super 70 Oil, various Dormant Oil Sprays
Glyphosate	Roundup Original, Roundup Transorb, Nufarm Credit Liquid Herbicide, Touchdown IQ Liquid Herbicide, Expedite, Glyfos, Cheminova Glyphosate Soluble Concentrate Herbicide, Ipco Factor Liquid Herbicide
Sulphur	Dri-Kill Dust, Kumulus, Microfine Sulphur 92 Fungicide, Microscopic Sulphur Fungicide
Bacillus thuringiensis, Serotype H-14	Vectobac, Aquabac, Teknar Granules Larvicide For Mosquito Control
Mancozeb	Dithane, Gavel, Manzate, Ridomil Gold, Acrobat, Penncozeb, Maximum, Tuberseal Potato Seed Piece Dust
Chlorothalonil	Bravo, Daconil, Ridomil Gold, Rigo Exotherm Termil Protectant Fungicide
Metam	Vapam Liquid Solution Soil Fumigant, Guardsman Post & Pole Fumigant
Diazinon	Basudin; Agrox Seed Treatment Powders; Eliminator, Protector and Y-Tex Optimizer cattle ear tags; numerous products called Diazinon
Captan	Agrox Seed Treatment Powders, Maestro, numerous products called Captan

Table 4 (con't.) Major Pesticide Products Containing the Top 20 Reportable Pesticide Active Ingredients Sold in British Columbia during 2003

Active Ingredient	Major Products
Mineral Oil (Herbicidal)	Guardsman Agricultural Weedkiller No.1
Formaldehyde	Formalin Fungicide, Formaldehyde Solution 37% Fumigator, Profilm Fumigant Concentrate Solution
Lime Sulphur	Lime Sulphur Insecticide Miticide Fungicide, Orchard Lime Sulphur Insecticide-Fungicide
Copper Oxychloride (as Cu)	Fixed Copper, Copper Oxychloride
Bacillus thuringiensis Berliner ssp *kurstaki*	Dipel, Foray, Novodor, Bioprotec CAF Aqueous Biological Insecticide
Metiram	Polyram
2,4-D Amine	Killex, Par III, Trillion, Tri-Kill, Dyvel DS, Grazon, Clean Crop Ultramine 500 Herbicide, numerous products called 2,4-D Amine
MCPA Esters	Buctril M, Curtail M, Frontline B, Spectrum B, Prestige B, various products called MCPA ester
Carbaryl	Sevin, Dominion Dusting Powder
Atrazine	Aatrex, Laddock, Converge 480, Primextra II Magnum Agricultural Herbicide, Shotgun
Methyl Bromide	Meth-O-Gas Space Fumigant, Gardex Methyl Bromide Fumigant, Terr-O-Gas 67 Preplant Soil Fumigant

4.2.4 "Inert" Ingredients

For the purposes of this report, "inert" ingredients applied with pesticides fall into two categories.

- substances such as spreaders, defoamers and pH adjusters that are added before the pesticide is applied; and
- additives that are part of the pesticide formulation but do not have an active pest control function.

The first type of substance (spreaders and defoamers) includes certain adjuvants and surfactants that are registered as pesticides. These substances have been quantified in the Reportable Pesticide Sales database (Appendix B), where they appear as surfactant blends and nonylphenoxypolyethoxyethanol.

In addition, on the Annual Summaries of Reportable Pesticide Sales several vendors (primarily in Region 3) reported sales of "anti-foam" or defoamer that did not have valid PCP numbers and likely are not registered pesticides. These sales totalled 209 L. The reportable sales summaries also showed 22.75 L of a "wetting agent" and 128 L of an ammonia-based pH balancer. The active ingredient in one of the defoamer products was listed as "dimethylpolysiloxone". Another anti-foaming agent, Halt, was identified by name on the Ontario Ministry of Agriculture's website[10], which indicated that it contains a silicone base active ingredient with a guarantee of 30%. Since the defoamers, wetting agents and pH balancers are not pesticides and not legally reportable, the reported sales probably represent only a small fraction of these agents sold in the province.

Pesticide manufacturers often consider the identities of "inert" ingredients proprietary information. Historically, these "inert" additives have not been listed on Canadian pesticide labels. However, under the new *Pest Control Products Act* (PCPA), which received royal assent at the end of 2002[11], inert ingredients identified as being of toxicological concern will need to be removed or identified on the product label. The PMRA (2005) has produced several "Lists of Formulants" (Appendix C). Substances on List 1 were to have been removed by January 1, 2005. Substances on List 2 are to be identified on all product labels by January 2006 (PMRA 2004a).

A few substances on List 1 and List 2 currently are listed on product labels. The PMRA label database currently lists 45 pesticides that have inert ingredients of "toxicological concern" or contain a "toxic formulant". Based on the label search, 12 pesticides containing 7 inert ingredients of toxicological concern were sold by vendors in British Columbia during 2003 (Table 5). However, the formulant listings on current labels are incomplete. For example, the PMRA has identified 72 products containing List 1 formulants alone (PMRA 2004a). Thus, the quantities of "inert" ingredients listed in Table 5 probably are greatly underestimated.

4.3 Wood Preservatives

As in the previous surveys, the majority of pesticides used in British Columbia in 2003 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 6 presents the results of the wood preservative use survey. Since two plants did not report their wood preservative use for 2003, the total amount of wood preservatives used (3,236,267 kg) is underestimated. In previous surveys, both companies reported using chromated copper arsenate (CCA). Based on their average wood preservative usage over the previous three surveys, it is estimated that 2003 CCA and total wood preservative

[10] http://www.gov.on.ca/OMAF/english/crops/facts/notes/halt.htm

[11] The legislation has not yet come into effect.

Table 5 Quantities of "Inert" Ingredients of Toxicological Concern in Reportable Pesticides Sold in British Columbia, 2003

Additive	Total Quantity (kg)
Di-2-ethylhexyl Adipate	3.72
Dimethyl Formamide	3,490
Dipropylene gycol monomethyl ether	14.37
Formaldehyde	7.92
Isophorone	6,726
Methylene Chloride	1,157
Rhodamine Dye [a]	2.23

Caution: This table is incomplete, as not all inert ingredients of concern are listed on all labels and/or quantities may not be given.

[a] One product containing Rhodamine B dye had no concentration listed

Table 6 Quantities of Wood Preservative Active Ingredients Used in Wood Treatment Plants in British Columbia, 2003

Preservative	Region					Total (kg)
	2	3	4	5	6	
Creosote	1,320,313	254,063		588,766	--	2,163,142
Chromated Copper Arsenate (CCA)	542,438	70,279	92,518	79,807	39,059	824,100
Pentachlorophenol	80,005	--	55,142	12,537	--	147,684
Alkaline Copper Quaternary (ACQ)	74,448	--	--	--	--	74,448
Disodium Octaborate Tetrahydrate	24,679	--	--	--	--	24,679
Alkaline Copper Zinc Arsenate (ACZA)	2,214	--	--	--	--	2,214
Total	2,044,097	324,342	147,659	681,110	39,059	3,236,267

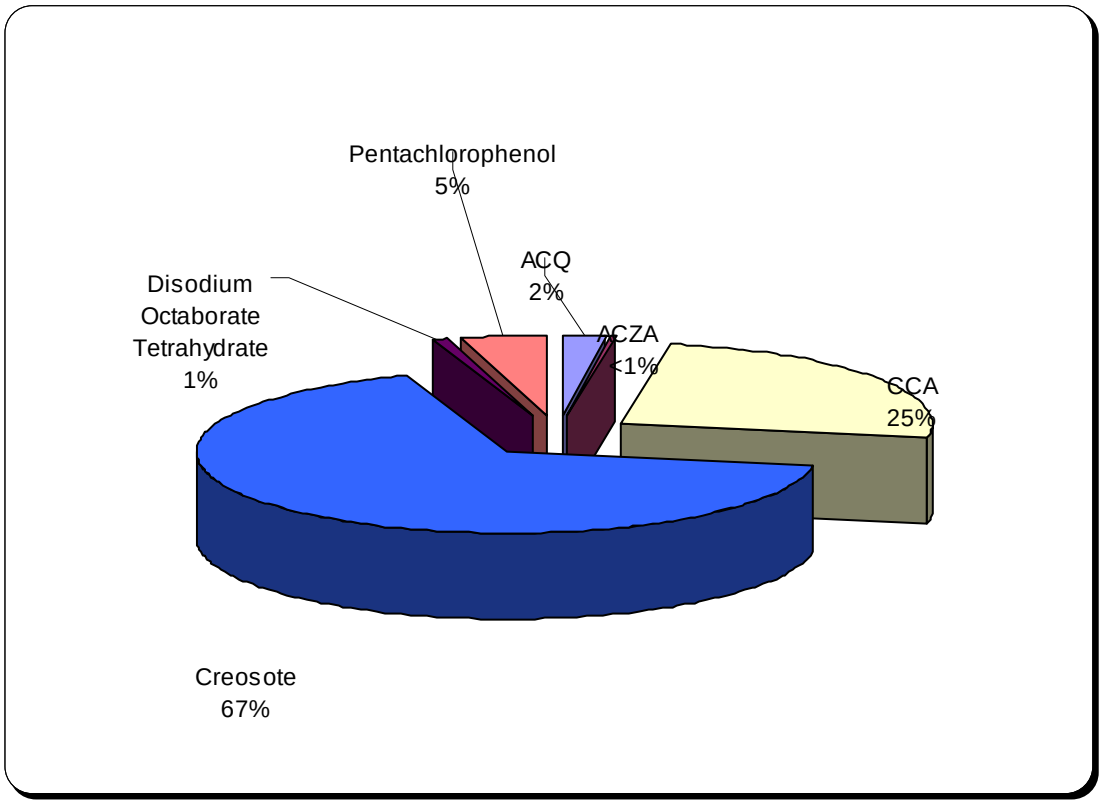
Note: There are no wood preservation plants in Region 1 or Region 7.

Two wood preservation plants did not respond to the 2003 survey. In previous surveys, both plants reported using CCA at a combined 85,000 to 120,000 kg. annually - these quantities are not included in Table 6 above.

usage could be underestimated by approximately 85,000 kg to 120,000 kg. This range amounts to a 3% to 4% underestimate of total wood preservative usage and a 10% to 15% underestimate of CCA usage.

Only five types of heavy-duty wood preservatives were used in British Columbia in 2003. These products were creosote, CCA, pentachlorophenol, alkaline copper quaternary (ACQ), disodium octaborate tetrahydrate 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 (2.16 million kg; Figure 4). A single plant applied ACZA, which in 1999 had replaced the ammoniacal copper arsenate (ACA). Three plants used ACQ, which is beginning to replace CCA as part of voluntary decision by the industry to move consumer use of treated lumber products away from a variety of pressure-treated wood that contains arsenic by Dec. 31, 2003[12].

Figure 4 Percentages of Wood Preservative Active Ingredients Used in Wood Treatment Plants in British Columbia, 2003



12 http://yosemite.epa.gov/opa/admpress.nsf/0/1a8cfb4970823b3885256b5e006ffd67?OpenDocument

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.

The survey identified 51 mills that had used or were using anti-sapstains. Of these, ten mills, which were surveyed in 1999, were no longer in business. This number includes two mills that had operated for a portion of 2003. A further six facilities, which had participated in previous surveys, did not use anti-sapstain in 2003. Of the remaining mills, 31 provided anti-sapstain use data and four did not provide data.

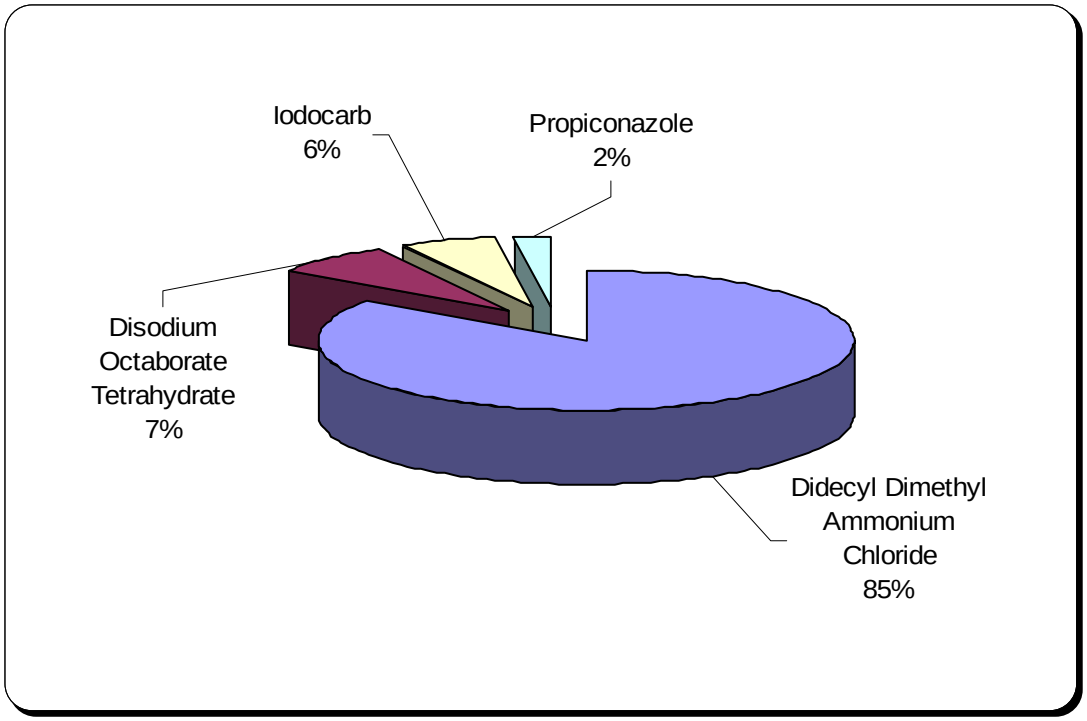
Including the two mills that are closed but had operated for a portion of 2003, six mills did not provide 2003 anti-sapstain use data. Five of these mills had participated in previous surveys. The sixth mill had not been included in Environment Canada's 1990-1998 surveys or in the 1999 survey. Together the five mills accounted for about 9% of the total anti-sapstain use in 1998 but less than 3% of the total anti-sapstain use in 1999. In 1998, they accounted for 9% of the didecyl dimethyl ammonium chloride (DDAC) use and 7% of disodium octaborate tetrahydrate the use. In 1999, they accounted for 3% of the total usage for these two active ingredients. Thus, the missing data for these mills likely does not represent a significant bias in the total anti-sapstain use data. However, one of the mills that did not provide 2003 data was the only user of (2-benzothiazolylthio)methyl thiocyanate (TCMTB) in 1998 and 1999.

The lumber mills that responded to the survey used 206,041 kg anti-sapstain active ingredients (Table 7). They applied only four active ingredients: DDAC, disodium octaborate tetrahydrate, iodocarb (3-iodo-2-propynyl butyl carbamate or IPBC) and propiconazole. Most of the anti-sapstain used was DDAC, which accounted for 174,606 kg or 85% of the total anti-sapstain usage in 2003 (Figure 5).

Table 7 Quantities of Anti-Sapstain Active Ingredients Used in British Columbia in 2003

Active Ingredient	Region			Total
	1	2	6	
Didecyl Dimethyl Ammonium Chloride (DDAC)	105,614	45,021	386	174,606
Disodium Octaborate Tetrahydrate	10,415	42	568	14,908
Iodocarb (IPBC)	9,269	3,736		11,822
Propiconazole	2,628	2,077		4,705
Total	127,925	50,875	953	206,041

Figure 5 Percentages of Anti-Sapstain Active Ingredients Used by Lumber Mills in British Columbia, 2003



4.5 Pesticide Use by Lower Mainland Service Licensees

The 2003 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, agriculture and/or forestry. Quantities of all pesticides applied for agriculture and landscape are given in Appendix D.

Landscape services in the Lower Mainland applied 7,541 kg of pesticides, equivalent to 1.4% of the total Reportable pesticides sold in Region 2 during 2003. Landscape services used 77 different active ingredients, of which ten accounted for 86% of the pesticides applied (Figure 6). The largest volume active ingredients were insecticidal mineral oil (1,171 kg), glyphosate (969 kg) and 2,4-D amine (899 kg). These three active ingredients accounted for 40% of the total pesticide applied. The other major active ingredients used by landscape services included the herbicides mecoprop amine salts and dichlobenil; the insecticide diazinon; and the fungicides quintozene, lime sulphur and chlorothalonil.

Lower Mainland agriculture services applied 11,338 kg of pesticides, which is equivalent to 2.2% of the Reportable pesticides sold in Region 2 during 2003. Agriculture services used 83 different active ingredients, of which five accounted for 60% of the pesticides applied. The five were the fumigant methyl bromide (2,026 kg), the herbicide atrazine (1,810 kg), the fungicides chlorothalonil (1,096 kg) and mancozeb (941 kg) and the fungicide/insecticide chloropicrin (998 kg) (Figure 7).

Figure 6 Percentages of Pesticide Active Ingredients Used by Licensed Landscape Services in the Lower Mainland Region, 2003

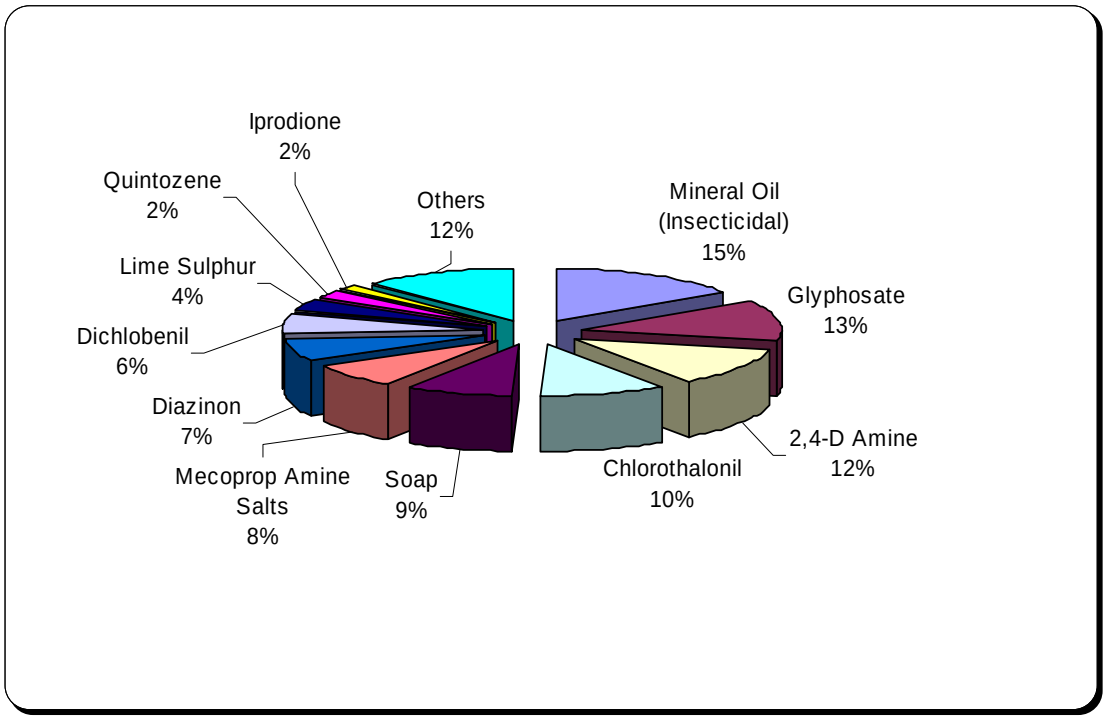
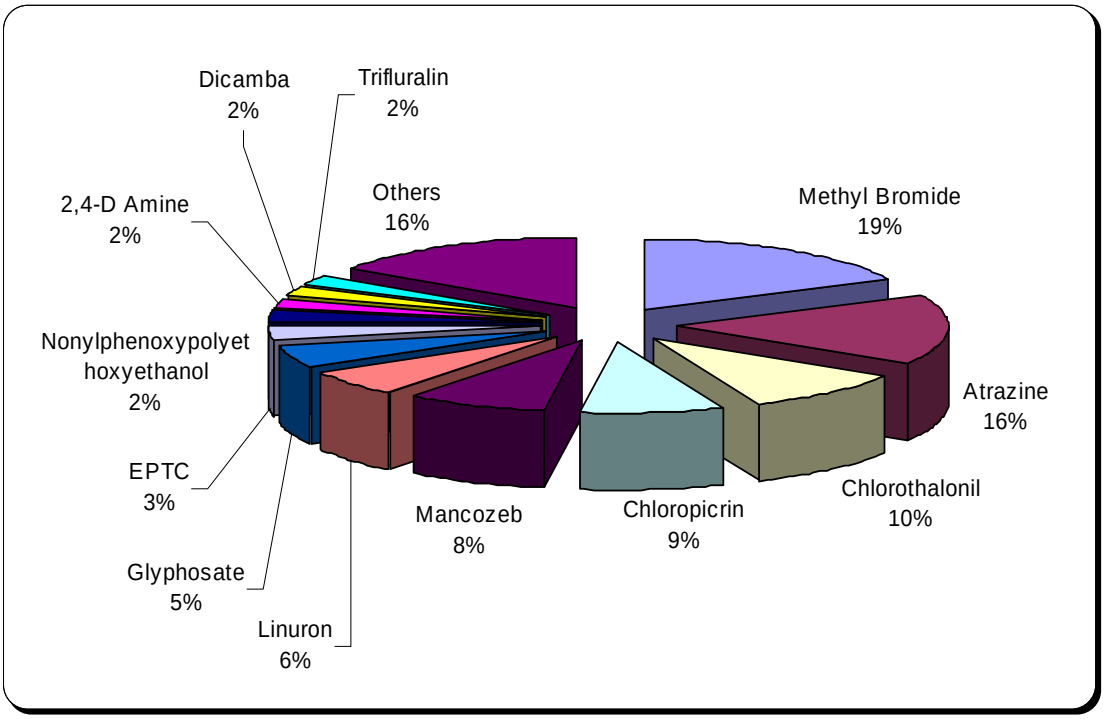


Figure 7 Percentages of Pesticide Active Ingredients Used by Licensed Agriculture Services in the Lower Mainland Region, 2003

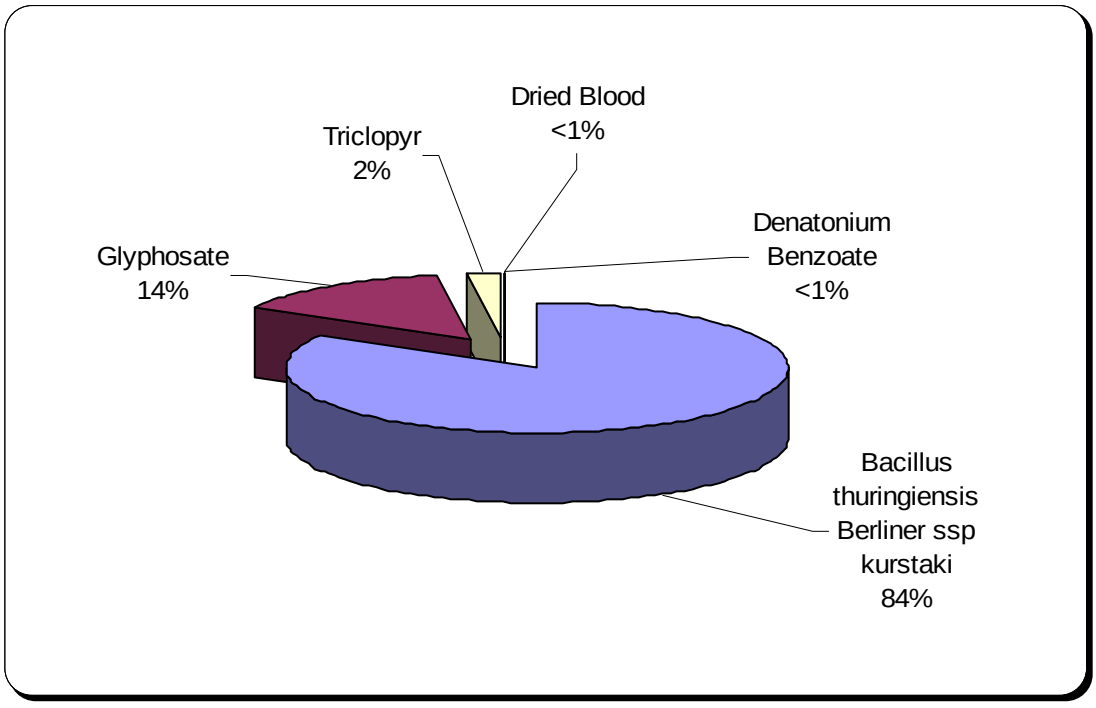


Services licensed in the Forestry category applied 102,804 kg of pesticides in 2003. This total is about 20% of the total kilograms of Reportable pesticides sold in Region 2 (Appendix B). However, the comparison is misleading because the quantity of biological insecticide *Bacillus thuringiensis* Berliner ssp. *kurstaki* (BTK) (85,765) used was almost seven times the amount sold in the region and five times the amount sold in the province. Forestry services used only five active ingredients in 2003. BTK, which is used to control gypsy moth and spruce bud worm, comprised 84% of the total active ingredients applied (Table 8, Figure 8). The herbicide glyphosate made up another 14%. The remaining active ingredients were the herbicide triclopyr and two deer repellents, denatonium benzoate and dried blood.

Table 8 Total Quantities of Pesticides Applied by Lower Mainland Pest Control Services Licensed in the Forestry Category, 2003

Active Ingredient	Amount Applied (kg)
Bacillus thuringiensis Berliner ssp *kurstaki*	85,765
Glyphosate	14,790
Triclopyr	2,249
Dried Blood	0.12
Denatonium Benzoate	0.00024
Total	102,804

Figure 8 Percentages of Pesticide Active Ingredients Used by Licensed Forestry Services in the Lower Mainland Region, 2003



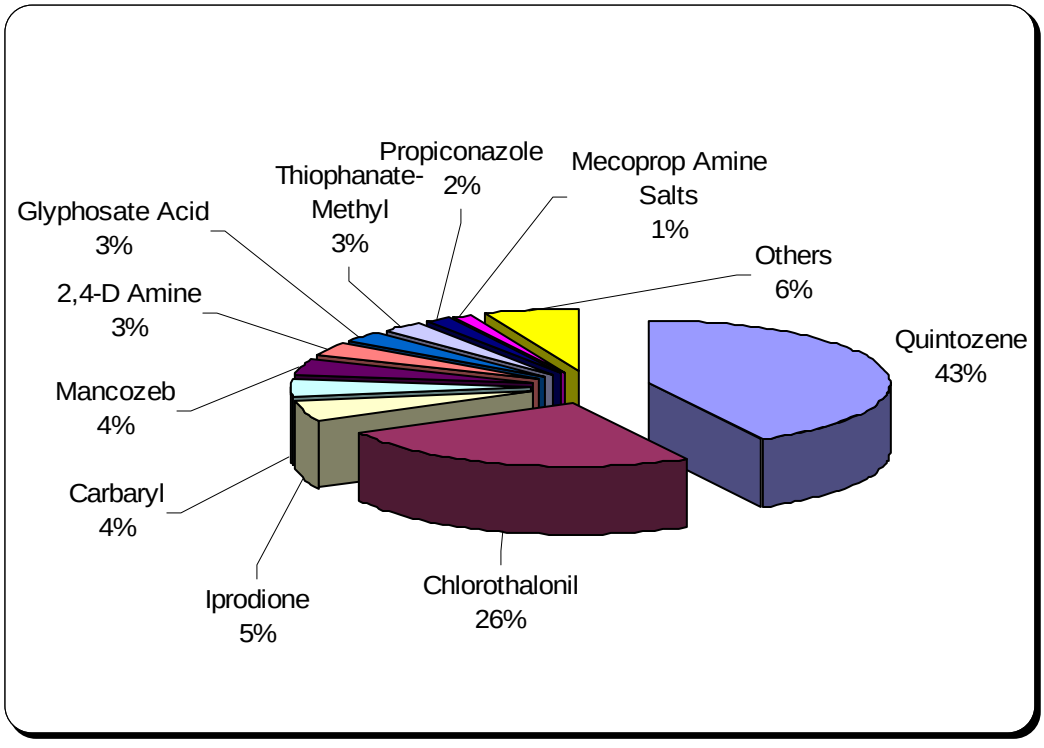
4.6 Lower Mainland Golf Course Pesticides Use

Fifty-three golf courses responded to the survey. Fifty courses provided pesticide use data. Two golf courses did not use pesticides, and one course was unable to provide the quantities of pesticides used. The respondents ranged from nine-hole pitch and putt to 36-hole championship courses. The golf courses that provided data (including nil reports) represented 54% of the courses surveyed on an individual course basis and 55% weighted by the numbers of holes.

The 54% of golf courses responding to the survey applied 7,440 kg of pesticide active ingredients (Appendix E). Thus, all golf courses in the Lower Mainland Region are estimated to have used about 14,000 kg of pesticide active ingredients in 2003. Based on this estimate, use by golf courses accounts for about 2.7% of the Reportable pesticides sold in the Lower Mainland Region.

Ten active ingredients comprised 94% of the pesticides applied to golf courses in 2003. Together the fungicides quintozene (3,149 kg) and chlorothalonil (1,877 kg) comprised about 68% of the pesticides applied (Figure 9). Other pesticides commonly used on golf courses included the fungicides iprodione, mancozeb, thiophanate-methyl, fosetyl-al and propiconazole; the insecticide carbaryl; and the herbicides 2,4-D amine and mecoprop amine.

Figure 9 Percentages of Pesticide Active Ingredients Applied to Lower Mainland Golf Courses in 2003



4.7 Aquaculture Use

The use of pesticides on fish farms potentially includes products to control net fouling and products that are administered externally to control parasites such as sea lice (*Salmon Aquaculture Review* – BC Environmental Assessment Office Final Report, 1997). The PRMA's ELSE database (pesticide label search) lists seven products that are currently registered for aquaculture use, six of which are cuprous oxide-containing products to control net fouling. The remaining registered pesticide, which contains the active ingredient azamethiphos, is for treatment of sea lice. The net treatment pesticides all are labelled "Commercial", while the sea lice treatment is labelled "Restricted". Therefore, sales of all these products should appear on the MoE Reportable Pesticide Sales records, provided that the pesticides were purchased in British Columbia. None of the seven products were reported as having been sold in British Columbia during 2003.

In addition, application of pesticide to water requires a permit from MoE, and the quantities of pesticide actually applied must be reported as part of the permit requirement. MoE (Dan Cronin, personal communication) reported that no Pesticide Use Permits were issued to the aquaculture industry during 2003. Thus, this sector apparently did not use any products that are registered as pesticides during the survey period. However, it is possible that the permit system might have missed some users of anti-fouling net treatments because this is a "non-traditional" pesticide use (Rob Adams, MoE, personal communication).

It should be noted that many of the products used to control external salmon parasites such as sea lice are administered through feed (e.g., ivermectin). These products are controlled as drugs, not as pesticides. Such products were not included in the 2003 pesticide survey.

4.8 Domestic Pesticides

4.8.1 Flea Control Products Sold by Veterinarians

Of the six companies identified as having sold flea control pesticides[13] to veterinarians in 2003, five provided sales data. The company that did not provide data accounted for only 3% of the total veterinary flea control products captured in the 1999 pesticide survey. However, this company sold higher percentages of some active ingredients.

Based on the manufacturers' data, veterinarians sold approximately 122 kg of flea control pesticide active ingredients in 2003 (Table 9). One active ingredient alone, imidacloprid (102.8 kg), accounted for almost 84% of the pesticides sold by veterinarians for home use in dog and cat flea control. Permethrin (11.94 kg) accounted for an additional 10%. Piperonyl butoxide and the insect growth regulator, methoprene, each accounted for about 3% of the total veterinary flea control product sales.

[13] Does not include flea control products registered as drugs

Table 9 Quantities of Pesticide Active Ingredients in Flea Control Products Sold by Veterinarians in British Columbia, 2003

Active Ingredient	Total Sales (kg)
Imidacloprid	102.80
Permethrin	11.94
Piperonyl Butoxide	3.20
Methoprene	3.12
Pyrethrins	1.23
Pyriproxyfen	0.11
Total Veterinary Sales	122.40

4.8.2 Other Domestic Label Pesticides

Reporting of Domestic label pesticides sales was not required under any legislation that was in effect in 2003. However, some vendors of Commercial pesticides included a few Domestic label products (e.g. Corry's Slug & Snail Death, Safer's Trounce) in their annual summary reports. In addition, some vendors from Vancouver Island (Region 1) and the Kootenays (Region 4), who sold primarily or entirely Domestic label pesticides reported their entire sales inventory. While these reports provide insufficient information to quantify Domestic pesticide sales, they do provide an indication of the types of active ingredients sold for home use (Table 10). However, the 56 active ingredients shown in Table 10 are unlikely to be the complete list, as the small sample of Domestic label pesticide vendors probably missed some product lines. Users of Table 10 should consider the probability that it contains an incomplete list of active ingredients used in Domestic label pesticides.

Within the parameters of the 2003 pesticide survey, there is no valid way to estimate the magnitude of pesticide sales or use represented by the Domestic market.

4.9 Emergency Registrations, Minor Use Registrations and Research Permits

4.9.1 Emergency Registrations

Emergency registrations are time limited registrations, granted by the PMRA for a period of one year or less. According to the Ministry of Agriculture and Lands (MAL) Pesticide Wise website[14], "an emergency is generally deemed to exist when the following criteria are met:

[14] http://www.agf.gov.bc.ca/pesticides/

Table 10 Pesticide Active Ingredients in Some Domestic Label Pesticides Sold in British Columbia during 2003

Soap	Dried Blood
Sulphur	Copper Naphthenate (as Cu)
Fatty Acid	Ferbam
Silicon Dioxide (Diatomaceous Earth)	Diazinon
Natural Gum Resins	Tribasic Copper Sulphate (as Cu)
Metaldehyde	Copper Oxychloride (as Cu)
Glyphosate	Dichlobenil
Creosote	Folpet
2,4-D Amine	Phosalone
Mecoprop Amine Salts	Glufosinate Ammonium
Propoxur	Borax
Chlorpyrifos	Diphacinone
Dichlorvos	Benomyl
Deet	Ethion
Disodium Octaborate Tetrahydrate	Pirimicarb
Malathion	D-Trans Allethrin
Carbaryl	Rotenone
Pyrethrins	Tetramethrin
Permethrin	Bromadiolone
Thiram	Triforine
Bacillus thuringiensis, Serotype H-14	Oxine Benzoate
Dicamba	Cholecalciferol
N-Octyl Bicycloheptene Dicarboximide	D-cis Trans Allethrin
Piperonyl Butoxide	Denatonium Benzoate
Dimethoate	Methoprene
Di-N-Propyl Isocinchomeronate	Warfarin
Asphalt Solids	Chlorophacinone
Polymerized Butenes	4-CPA

Caution: this table likely contains an incomplete list of the active ingredients in Domestic-label pesticides

- a pest outbreak or pest situation occurs that can cause significant economic, environmental or health problems;
- there is no effective product or application method registered in Canada for the control of the pest; and

- there is no effective, alternative control method available."

Emergency registrations can permit a new use for a pesticide currently registered in Canada. For example, the fungicide Quadris (azoxystrobin) is registered for use on canola, legume vegetables (dried shelled peas and beans, except soybeans), seed corn, potatoes and tomatoes. In 2003, an emergency registration allowed its use on ginseng to treat a specific disease, the fungus *Rhizoctonia* (Table 11). An emergency registration also can permit the use of a new product or even a new active ingredient for a limited time period. New products receiving emergency registration are given valid PCP numbers. The only new product registered in this manner in 2003 was Oxidate (hydrogen peroxide).

Table 11 Emergency Registrations of Pesticide in British Columbia, 2003

Crop	Pest	Product Name	Active Ingredient	Effective Dates
Greenhouse cucumber	*Pythium*	Ridomil Gold 480EC	Metalaxyl-M and S-isomer	Feb. 26, 2003 to Jan 31, 2004
Greenhouse lettuce	Aphids	Intercept 60WP	Imidacloprid	March 11, 2003 to Dec. 31, 2003
Honeybees	Varroa mites	Checkmite+	Coumaphos	For the 2003 use season expires Dec. 31, 2003
Potatoes	Wireworms	Pyrinex 480EC	Chlorpyrifos	April 1, 2003 to July 15, 2003
Potatoes	Wireworms	Pyrifos 15G	Chlorpyrifos	April 1, 2003 to July 15, 2003
Greenhouse peppers	Aphids	Endeavor 50 WG	Pymetrozine	July 4, 2003 to Sept. 30, 2003
Caneberries	Cutworms, leafrollers	Success 480 SC	Spinosad	July 25, 2003 to Aug. 15, 2003
Mushrooms	Green mould	Senator 70 WP	Thiophanate-methyl	Oct. 3, 2003 to Aug. 31, 2004
Greenhouse lettuce	*Botrytis*	Decree 50WDG	Fenhexamid	Expires Dec. 31, 2003
Ginseng	*Rhizoctonia*	Quadris Flowable	Azoxystrobin	Sept. 22, 2003 to April 30, 2004
Potatoes	Late blight	Oxidate	Hydrogen Peroxide	June 18, 2003 to Dec. 31, 2003

Vendors report pesticides sold under emergency registrations as they would any other pesticides. Thus, sales of the products listed in Table 11 are captured in the Reportable pesticides database (Appendix B). All of the pesticide active ingredients listed in Table 11 except hydrogen peroxide are contained in several products and/or have a variety of registered uses. The proportion of the total sales of these pesticides attributable to emergency registrations likely is negligible. For example, the amount of hydrogen peroxide sold under emergency registration amounted to only 0.02% of the total reportable pesticide sales in 2003.

4.9.2 Minor Use Registrations

A "minor use" registration applies to a pesticide product for which the anticipated volume of sales is not high enough for a manufacturer to justify the cost of registering it in Canada. Minor use registration can extend the label (allow additional uses) of a currently registered pesticide or permit registration of a new product. New active ingredients receiving minor use registration must already be registered in an OECD[15] country.

The PMRA considers a product for minor use registration at the request of a user group that is willing to fund the additional research necessary to register the product. The request for a minor use registration undergoes a review that usually takes several years (Tracy Hueppelsheuser, MAFF, personal communication). Often a pesticide will be registered under an emergency registration while it undergoes review for minor use registration.

Pesticides with minor use registrations would have been sold through licensed vendors and reported on the Annual Pesticide Sales Summaries. Thus, any sales for applications under minor use registrations are included in the Reportable Pesticide Sales database. The quantities of pesticides applied for minor uses would be an insignificant fraction of the total sales (Tracey Hueppelsheuser, personal communication).

4.9.3 Research Permits

The PMRA grants research permits to allow field trials of:

- a new use for registered product;
- a new formulation and/or new uses for an active ingredient in a currently registered product; and
- a new active ingredient.

For a new active ingredient, the PMRA will require submission of toxicology data (PMRA 1998). The amount of data required depends upon the number of researchers involved, the plot size and total treatment area for trials. There are three categories of testing for new products, which range from use by a single researcher on <5 ha to use by several co-operators on 40 ha plots with a total treatment area of 500 ha. Increasingly detailed toxicology data are required as the size of the test area increases.

The label of a product registered for research will say, "Not for sale. Not for distribution to any person other than the researcher or co-operator." Thus, products registered under research permits are not captured in the Reportable pesticide sales database.

The PMRA (Ilze Rupners, BC Regional Manager, personal communication) provided a listing of the pesticide active ingredients and quantities applied under research permits

[15] Organisation for Economic Co-operation and Development

during 2003 (Table 12). All of the new active ingredients and most of the new formulations or uses granted research permits were biological control products. The total quantities of new pesticide active ingredients applied under research permits were small.

Table 12 Quantities (kg) of Pesticide Active Ingredients Applied under Research Permits during 2003

Active Ingredient	Type	PCP#	Total Quantity (kg)
Bacillus thuringiensis ssp. *kurstaki*	Biological insecticide	24977	1000
Bacillus sphaericus serotype H5a5b strain 2362	Biological larvicide	--	58.2
Acetic Acid	Herbicide	--	5.97
Bacillus subtilis QST 713	Biological fungicide	--	0.105
Gliocladium catenulatum strain J1446 (FGG)	Biological fungicide	--	0.32
Trichodema harzianum Rifia strain DRL-AG2	Biological fungicide	27115	1
Total Active Ingredients			1066

For consistency with the calculation of kilograms of active ingredients in Reportable pesticides, quantities were calculated using litres as equivalent to kilograms. For formulations expressed as a percent, total quantities of product were converted to percent active ingredients. Biological pesticides with guarantees expressed as active units (e.g. BIU/L) were assumed to contain 100% active ingredient.

4.10 Pesticides Purchases Outside of British Columbia

There are several possibilities for pesticide purchases outside of British Columbia. BC residents living near the Alberta border (primarily in Region 7 - Peace River Region) could purchase pesticides in Alberta. Lower Mainland residents could purchase pesticides in the United States (although they could not legally import pesticides lacking a valid Canadian label). Users of bulk products like wood preservatives, anti-sapstains and fumigants may purchase from suppliers in eastern Canada or the US.

These purchases are not likely to be a gap in the overall characterization of pesticide sales and use during 2003. Interviews with pesticide vendors in Region 7 (Dawson Creek, Fort St. John and Rolla) and in Grand Prairie, Alberta, suggested that there is a net flow of pesticides from British Columbia to Alberta. This observation is consistent with the findings of the previous pesticide surveys. It is not possible to quantify pesticide purchases in the US, but the quantities involved are expected to be minor. One anti-sapstain product reported by several lumber mills and a methyl bromide–chloropicrin soil fumigant applied by a Lower Mainland agricultural service did not appear on the annual pesticide use reports. In addition, the total quantity of a methyl bromide structural fumigant reported by pest control service licensees was approximately 1.7 times the amount of methyl bromide sold in British Columbia during 2003. Similarly, use of *Bacillus thuringiensis* Berliner ssp. *kurstaki* by forestry service licensees was 4.9 times

the amount of this biological insecticide sold in British Columbia in 2003. However, these pesticides have been captured by the service licensee and lumber mill surveys. Overall, the survey is expected to be relatively complete, except for Domestic label pesticides.

4.11 Purposes of Pesticide Application

Statistics Canada's *2001 Agriculture Community Profiles* (based on the 2001 census) and MAFF's *Crop Profiles 2002-2004* were used to identify the purposes for which agricultural pesticides sold or used in British Columbia had been applied. The *2001 Agriculture Community Profiles* list the top five crops produced in each regional district during 2001. The production in all regional districts was summed to identify the major crops produced in each pesticide survey region (Figure 1). The results are presented in Table 13. Note that the values shown in Table 13 may not represent the entire area in production for some crops, as plantings that were not among the top five crops in a given regional district would have been missed.

The census data (Table 13) show that the major crops produced in all regions of the province are fodder crops such as alfalfa and tame hay. According to MAFF (2001), forage crops generally are treated with pesticides far less frequently than vegetable or fruit crops. Major crops on which pesticides more typically are used include oats, barley, canola, corn, mixed grains, potatoes, apples, blueberries, grapes, raspberries, cranberries, cherries, ginseng, green or waxed beans and spring wheat.

MAFF's crop profiles identify the pesticides most widely applied to the major crops shown in Table 13 (excluding corn, grains and fodder crops) and a few lesser crops. The crop profiles also identify the regions of production and hectares in production. Table 14 identifies the pesticide active ingredients applied to specific crops. It also shows the areas where these crops were grown and the acreages that were in production based on the crop profile documents (which do not always correspond with the values in Table 13).

Table 14 shows that most of the top 20 Reportable pesticides sold in British Columbia during 2003 were used extensively on fruits, berries and potatoes. The exceptions are:

- *Bacillus thuringiensis*, Serotype H-14, which is used for mosquito control;
- formaldehyde, which is used as a fungicide for cleaning mushroom growing houses and equipment[16] and as a fumigant/disinfectant in poultry production;
- MCPA esters, a selective herbicide, which is used primarily on wheat, barley, oats, and flax with some products registered for use on corn, rye, forage seeds and grasses;
- atrazine, a selective herbicide used primarily on corn with some products labelled for use on triazine tolerant canola; and

[16] Formaldehyde also is registered as a fungicide for treating seed potato tubers, seed grains and bulbs (tulips, gladiolus, etc.).

Table 13 Major Crops by Region Based on the 2001 Canadian Census

Crop	Hectares in Production						
	Region 1	Region 2	Region 3	Region 4	Region 5	Region 7	Total
All other tame hay and fodder crops	13,094	23,814	17,636	7,650	71,399	67,862	201,455
Alfalfa and alfalfa mixtures	1,801	1,305	42,785	16,564	55,577	75,529	193,561
Forage seed for seed						36,198	36,198
Oats	446			752	4,444	24,677	30,319
Canola				692		22,552	23,244
Barley	269		3,011	1,373	8,183		12,836
Corn (sweet and forage)	983	5,941	1,942				8,866
Apples			5,068				5,068
Blueberries		2,882					2,882
Potatoes	290	2,085		257			2,632
Grapes			2,629				2,629
Raspberries		1,928					1,928
Cranberries		1,505					1,505
Mixed grains				131	992		1,123
Cherries (sweet)			768				768
Ginseng			732				732
Green or wax beans		627					627
Spring wheat					612		612

Adapted from: Statistics Canada. *2001 Agriculture Community Profiles* . Online at http://www25.statcan.ca:8081/AgrProfile/acphome.jsp. Extracted February 22, 2005.

Note: Provincial totals for crops other than tame hay/fodder and alfalfa likely are underestimated, as the *Agriculture Community Profiles* only lists data for the top five crops in each region. Thus, if a crop is not among the top five in a particular region, this table counts the hectares in production in the region as zero.

Table 14 Major Pesticide Active Ingredients Used for Agriculture in BC
Based on *BC Crop Profiles* 2002-2004

Active Ingredient	Type	Reportable Pesticide Sales Rank	% of Acreage or Crop Treated					
			Blueberries	Cranberries	Raspberries	Strawberries	Grapes	Apples
Primary Production Areas			Region 2 (>99%) Region 1 (<1%)	Region 2 (99%) Region 1 (1%)	Region 2 (99%) Region 1 (1%)	Region 2 (94%) Region 1 (6%)	Regions 3&4 (98%) Region 2 (1%) Region 1 (1%)	Regions 3&4 (99%) Region 2 (<1%) Region 1 (<1%)
Hectares in Production 2001			3000	1473	2031	643	2629[a]	4656
Dormant Oil	I	1						90
Glyphosate	H	2	75	100			95	95
Sulphur + Lime Sulphur	F	3, 12			20	<5	80-95	25-70
Mancozeb	F	5						10-25
Chlorothalonil	F	6	20	60-75		<5		
Metam sodium (Metam)	Fu	7				10		
Diazinon	I	8		100	75	20		65
Captan	I	9	75		100	100	<5	5-10
Mineral Oil (Herbicidal)	H	10		100				
Copper (hydroxide, oxychloride, tribasic copper sulphate)	F	46, 13, 197	75	30		<5		<2
Bacillus thuringiensis var. *kurstaki*	B/I	14	10		50			70
Metiram	F	15						30-50
2,4-D Amine	H	16		100				2
Carbaryl	I	18	<5			<5	50	95
Simazine	H	24	10		75	75		30-50
Fosetyl-aluminum	F	26			20	50		
Dichlobenil	H	30	15	100	10			2
Azinphos-methyl	I	31	10		75	<5		85
Paraquat	H	33	15		50		10	10
Napropamide	H	34	15	100	20	75		
Endosulfan	I	36				50		20
Linuron	H	38						
Chlorpyrifos	I	39						
Iprodione	F	40			10	20-40	50-80	
Dimethoate	I	41				50		2
Azoxystrobin	F	42	50					
Trifluralin	H	48				10		
Propamocarb hydrochloride	F	52						
Metalaxyl-M	F	54	20		50	75		
Glufosinate ammonium	H	55			5			
Diquat	H	57						
Ziram	F	59						10-15
Maleic hydrazide	PGR	60						
Fludioxonil	F	62			40			
Phosmet	I	63	<5	<5				18
Pendimethalin	H	65						60
Phosalone	I	67						19
Triforine	F	68	75	<10				
Fluazifop-p-butyl	H	74	10	?	5	10		
Myclobutanil	F	75					25-75	70-90
Clopyralid	H	78	5	35		10		15
Monolinuron	H	79						

a Value from Statistics Canada
b ? is included in the Crop Profile

Table 14 (con't) Major Pesticide Active Ingredients Used for Agriculture in BC Based on *BC Crop Profiles* 2002-2004

Active Ingredient	Type	Reportable Pesticide Sales Rank	% of Acreage or Crop Treated					
			Blueberries	Cranberries	Raspberries	Strawberries	Grapes	Apples
Primary Production Areas			Region 2 (>99%) Region 1 (<1%)	Region 2 (99%) Region 1 (1%)	Region 2 (99%) Region 1 (1%)	Region 2 (94%) Region 1 (6%)	Regions 3&4 (98%) Region 2 (1%) Region 1 (1%)	Regions 3&4 (99%) Region 2 (<1%) Region 1 (<1%)
Hectares in Production 2001			3000	1473	2031	643	2629[a]	4656
Fenhexamid	F	84				75	25-75	
Acephate	I	85		25				
Methamidophos	I	86						
Sethoxydim	H	91	10	25+	5	10		
Propiconazole	F	92	25	<10				
Permethrin	I	94					25	
Terbacil	H	106	<5		10	10		
Pirimicarb	I	108				20		
Tebufenozide	IGR	114						25
Imidacloprid	I	117	25					25
Kresoxim-methyl	F	122					>50?[b]	5-15
Spinosad	I	126						20
Cyprodinil	F	127					25-75	2-5
Abamectin	I	128						
Oxyfluorfen	H	141			90			
Cypermethrin	I	144				25		
Cymoxanil	F	146						
Cyhalothrin-lambda	I	165				50		
Deltamethrin	I	170	20					
(Z,Z)-3, 13-Octadecadienyl Acetate (Isomate-P)	B	232						
Dinocap	F	247						

The criterion for inclusion of a pesticide active ingredient in this table is its use on at least 40% of one or more crops.

Key to pesticide types:
B - Biological control product
F - Fungicide
Fu - Soil fumigant
H - Herbicide
I - Insecticide
PGR - Plant growth regulator

a Value from Statistics Canada
b ? is included in the Crop Profile

Table 14 (con't) Major Pesticide Active Ingredients Used for Agriculture in BC Based on *BC Crop Profiles* 2002-2004

Active Ingredient	Type	Reportable Pesticide Sales Rank	% of Acreage or Crop Treated					
			Cherries	Peaches	Pears	Potatoes	Broccoli	Ginseng
Primary Production Areas			Regions 3&4 (100%)	Regions 3&4 (>99%) Region 1 (1%)	Regions 3&4 (>99%) Region 1 (1%)	Region 2 (79%) Region 1 (11%) Regions 3&4 (10%)	Region 2 (98%) Region 1 (1%) Regions 3&4 (1%)	Region 3 (100%)
Hectares in Production 2001			824	485	339	2353	571	233
Dormant Oil	I	1	60	75	100			
Glyphosate	H	2	70	100	95	10		100
Sulphur + Lime Sulphur	F	3, 12	50	50-90	90			
Mancozeb	F	5				70-80		100
Chlorothalonil	F	6	<10	<5		95	50	50
Metam sodium (Metam)	Fu	7					10	
Diazinon	I	8	70	5			5	
Captan	I	9	<10	10-20				
Mineral Oil (Herbicidal)	H	10						
Copper (hydroxide, oxychloride, tribasic copper sulphate)	F	46, 13, 197		70-95	<5	50	5-10	
Bacillus thuringiensis var. *kurstaki*	B/I	14	80	2	40		5	
Metiram	F	15						<5
2,4-D Amine	H	16		10				
Carbaryl	I	18	70	3		20		
Simazine	H	24			10-25			
Fosetyl-aluminum	F	26					5-10	100
Dichlobenil	H	30		<5				
Azinphos-methyl	I	31	40	5	<2		5	
Paraquat	H	33	70	10		30-75		
Napropamide	H	34					2-3	
Endosulfan	I	36	10-15	40	10	20	10	
Linuron	H	38				95		
Chlorpyrifos	I	39				35-40	100	
Iprodione	F	40	90	50				100
Dimethoate	I	41	30			50	25-40	
Azoxystrobin	F	42						100
Trifluralin	H	48					75	
Propamocarb hydrochloride	F	52				40-50		
Metalaxyl-M	F	54				90		100
Glufosinate ammonium	H	55				20		
Diquat	H	57				76-100		
Ziram	F	59		30-40				
Maleic hydrazide	PGR	60				45		
Fludioxonil	F	62				40		
Phosmet	I	63		2	70	0-20		
Pendimethalin	H	65	20	50				
Phosalone	I	67	5		40			
Triforine	F	68	15	5-15				
Fluazifop-p-butyl	H	74					5	100
Myclobutanil	F	75	70	10-40				
Clopyralid	H	78						
Monolinuron	H	79				10-60		

a Value from Statistics Canada
b ? is included in the Crop Profile

Table 14 (con't) Major Pesticide Active Ingredients Used for Agriculture in BC Based on *BC Crop Profiles* 2002-2004

Active Ingredient	Type	Reportable Pesticide Sales Rank	% of Acreage or Crop Treated					
			Cherries	Peaches	Pears	Potatoes	Broccoli	Ginseng
Primary Production Areas			Regions 3&4 (100%)	Regions 3&4 (>99%) Region 1 (1%)	Regions 3&4 (>99%) Region 1 (1%)	Region 2 (79%) Region 1 (11%) Regions 3&4 (10%)	Region 2 (98%) Region 1 (1%) Regions 3&4 (1%)	Region 3 (100%)
Hectares in Production 2001			824	485	339	2353	571	233
Fenhexamid	F	84						
Acephate	I	85						
Methamidophos	I	86				20-80	10	
Sethoxydim	H	91				10	5	
Propiconazole	F	92	50	10-20				
Permethrin	I	94						20
Terbacil	H	106		40				
Pirimicarb	I	108		35		10-95		
Tebufenozide	IGR	114			40			
Imidacloprid	I	117	70			<5		
Kresoxim-methyl	F	122						
Spinosad	I	126			40			
Cyprodinil	F	127						
Abamectin	I	128			60			
Oxyfluorfen	H	141						
Cypermethrin	I	144				80	50	
Cymoxanil	F	146				80		
Cyhalothrin-lambda	I	165				15	30	
Deltamethrin	I	170		20		25	75	
(Z,Z)-3, 13-Octadecadienyl Acetate (Isomate-P)	B	232	2	50				
Dinocap	F	247			45			

The criterion for inclusion of a pesticide activ

Key to pesticide types:
B - Biological control product
F - Fungicide
Fu - Soil fumigant
H - Herbicide
I - Insecticide
PGR - Plant growth regulator

a Value from Statistics Canada
b ? is included in the Crop Profile

- methyl bromide, a structural fumigant, which the 1991 pesticide survey report (Norecol Environmental Consultants 1993) identified as being used to treat the grain terminals at Vancouver Harbour; recent discussions with a pest control service licensee suggests it also may be used to treat rail cars.

Two of the top 20 Reportable pesticides sold in 2003, glyphosate and metam, were among the top three pesticides used by nursery growers in 2002 (Zbetnoff 2003). The 2002 survey conducted for the BC Landscape Nursery Association included 53 growers representing 35% of the total acreage in nursery production.

Many of the predominant active ingredients used in the Peace River (Region 7) differ from the active ingredients listed in Table 14. The major crops in the Peace River Region are grains and forages (Table 13), which are not included in MAFF's crop profiles. Important active ingredients sold in the Peace River Region are herbicides, which are used to control weeds on the following crops:

- Glyphosate, trimethylsufonium salt – flax, wheat, barley, oats, canola, forages;
- Triallate – barley, flax, mustard, canola, wheat;
- Trifluralin – barley, wheat;
- Bromoxynil – barley, canary seed, wheat, rye, corn, flax, oats;
- Imazamethabenz – barley, wheat, sunflower, sunflower, seed rye;
- Ethalfluralin – alfalfa, canola, mustards, safflower;
- Tralkoxydim – barley, rye, wheat, cereals, forage;
- Fluazinfop-p-butyl – alfalfa, canola, fescue, flax, mustard, red clover; and
- Clopyralid – barley, wheat, oats, timothy hay, flax.

5.0 COMPARISON WITH PREVIOUS SURVEYS

5.1 Objectives and Limitations

The long-term objective of the pesticide surveys which begun in 1991 is to determine the trends in pesticide sales and use. For several sectors, the 2003 survey provides four data points, enough to show trends for some active ingredients, although the statistical power associated with four data points is limited. Short term trends include the replacement or near replacement of certain active ingredients.

In the absence of strong trends or product replacements, interpretation of year to year variability can be difficult. Year to year variation can occur without any overall changes in pesticide 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.

A more powerful trend analysis is possible for the anti-sapstain data. Anti-sapstain use was surveyed annually from 1991 through 1999. The 2003 data can be compared to the 1991-1999 trend.

5.2 1991 to 2003 Comparisons

The following comparisons were determined to be the most useful for the 1995 and 1999 surveys and are repeated for the 2003 survey:

- sales of all Reportable pesticide active ingredients;
- sales of the top 20 Reportable pesticides; for 2003 this comparison includes selected additional pesticides whose sales have shown potentially significant increases or decreases since 1991;
- 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; and
- pesticides used by landscape services and agriculture services in Region 2.

5.2.1 Reportable Pesticides

All Reportable Pesticides

Total sales of Reportable pesticides in British Columbia rose from 923,275 kg in 1991 to 1,146,263 kg in 2003, an increase of 24%. Linear regression analysis shows this change to be statistically significant ($P<0.01$). About 69% of the increase is due to an increase of 154,863 kg in sales of mineral oil (insecticidal or adjuvant). A further 23% of the increase (50,480 kg) is attributable to sales of the various strains of *Bacillus thuringiensis* (biological insecticides) (Table 15).

Sales of all reportable pesticides for the years 1991, 1995, 1999 and 2003 are compared in Appendix F. Table 15 compares the sales of the top 20 and other selected Reportable pesticides sold in 1991, 1995, 1999 and 2003. Although there were changes in the total quantities sold, four active ingredients remained among the top five sold in all four years (Table 15). These active ingredients were mineral oil (insecticidal or adjuvant), glyphosate, sulphur, and mancozeb.

Sales of several of 2003's top 20 pesticides have increased steadily since 1991. As previously noted, sales of insecticidal mineral oil increased from 162,245 kg in 1991 to 317,108 kg in 2003; the trend was statistically significant ($P<0.01$). There also is a significant ($P=0.02$) positive trend in sales of *Bacillus thuringiensis*, Serotype H-14. Other active ingredients that showed relatively consistent and substantial sales increases from 1991 to 2003 included the fungicides chlorothalonil and formaldehyde; although for these active ingredients, the trends are not statistically significant ($P>0.05$). Sales of chlorothalonil increased from 3,721 kg in 1991 to 33,505 kg in 2003, while formaldehyde sales increased from 3,007 kg in 1991 to 21,822 kg in 2003, with a peak of over 25,000 kg in 1999. Consistent but smaller increases in sales occurred for sulphur, 2,4-D amine, MCPA ester and diazinon (Table 15). The trends for 2,4-D amine, MCPA ester and diazinon are statistically significant. In addition, use of insecticidal soap, which was not among the top 20 active ingredients, increased by 5,814 kg (563%), and the trend is significant ($P<0.01$).

Sales of some pesticides that were among the top 20 in 1991 had decreased substantially by 2003. For example, sales of ethalfluralin declined from 26,917 kg to 1,546 kg, a decrease of 94%, and the declining trend is statistically significant ($P<0.05$). Atrazine sales declined from 22,898 kg to 11,535 kg, a decrease of nearly 50%; although most of the change took place between 1991 and 1995 (Appendix F). Between 1995 and 2003 atrazine sales fluctuated within a range of about ±10% around a three-year (1995, 1999, 2003) average of 10,818 kg.

Between 1991 and 2003, sales of several other active ingredients not among the top 20 decreased by over 10,000 kg (Table 15). These pesticides included malathion, triallate, ethalfluralin, sodium metaborate tetrahydrate and metolachlor. For triallate and ethalfluralin the downward trend is statistically significant ($P<0.05$). For sodium metaborate tetrahydrate and metolachlor, the trend likely is not statistically significant because it is non-linear (after log-transformation). These pesticides showed sharp drops in sales between 1999 and 2003.

Table 15 Comparison of the Top 20 Reportable Pesticide and Other Selected Active Ingredients Sold in British Columbia in 1991-2003

Active Ingredient	Total Sales (kg)				Rank			
	2003	1999	1995	1991	2003	1999	1995	1991
Mineral Oil (Insecticidal or Adjuvant) **	317,108	261,845	206,440	162,245	1	1	1	1
Glyphosate	120,724	135,573	124,698	110,157	2	2	2	2
Sulphur	73,408	36,393	26,319	28,101	3	4	6	6
Bacillus thuringiensis, Serotype H-14 *	39,153	21,875	11,270	3,188	4	13	20	
Mancozeb	34,888	44,682	41,907	29,511	5	3	3	4
Chlorothalonil (P=0.07)	33,505	26,640	15,871	3,721	6	9	14	
Metam	28,582	30,855	20,422	27,437	7	6	12	8
Diazinon **	27,074	24,563	22,552	19,643	8	11	8	13
Captan	25,500	27,498	29,160	28,451	9	7	4	5
Mineral Oil (Herbicidal or Plant Growth Regulator)	23,575	35,260	25,215	38,540	10	5	7	3
Formaldehyde	21,822	25,495	14,342	3,007	11	10	16	
Lime Sulphur or Calcium Polysulphide	20,524	10,851	20,565	8,835	12	18	11	
Copper Oxychloride (as Cu)	19,562	14,699	16,316	10,202	13	15	13	20
Bacillus thuringiensis Berliner ssp. *kurstaki*	17,608	17,895	12,283	3,095	14	14	19	
Metiram	15,293	23,890	20,874	27,618	15	12	10	7
2,4-D Amine (P=0.05)	14,756	13,903	12,340	12,327	16	17	18	16
MCPA Esters *	12,810	10,847	7,697	4,973	17	19		
Carbaryl	12,363	9,271	8,984	7,274	18			
Atrazine	11,535	9,991	10,928	22,898	19			10
Methyl Bromide	9,948	9,353	21,888	21,958	20			10
Soap (Insecticidal) **	6,846	3,599	2,405	1,033				
Malathion (P=0.08)	4,658	6,691	6,523	12,094				
Triallate *	2,248	3,289	5,958	20,584				
Ethalfluralin *	1,546	2,289	5,033	26,917				
Sodium Metaborate Tetrahydrate	37.5	8,773	29,020	14,259				
Metolachlor	29.9	5,621	6,807	10,727				

Statistical significance of trend analysis: ** P<0.01
* P<0.05

Methyl bromide sales appear to have decreased by over 50% between 1995 and 1999, but this does not reflect an actual change in methyl bromide use. In 2003, pest control service licensees reported using 18,808 kg of methyl bromide,[17] more than twice the amount sold in British Columbia. A similar situation occurred in 1999. Apparently the service licensees import methyl bromide from outside the province.

Restricted Pesticides

The sales of federally-labelled Restricted pesticides (excluding the biological insecticide *Bacillus thuringiensis*, Serotype H-14[18]) declined by over 37,000 kg (62%) between 1991 and 2003 (Figure 10, Table 16). Restricted pesticides are so-classified because of their oral or dermal toxicity (to humans) or because of environmental concerns[19]. Thus, a reduction in the sales of Restricted pesticides is a reduction in toxicological and environmental risk.

5.2.2 Wood Preservatives

The use of wood preservatives was lower in 2003 than in 1991 for the first time since the inception of the provincial pesticide surveys. Wood preservative use was highest during the 1995 survey year. The among-year differences were due primarily to changes in creosote use (Table 17, Figure 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 1991 to 1999, with a 152,387 kg decrease in 2003 relative to 1999. The 1999 survey noted a probable under-reporting of CCA use in 1999, which may have resulted in an underestimation in wood preservative use that year. Under reporting of this product also has occurred in 2003.

In addition, there have been changes in the active ingredients used. Ammoniacal copper arsenate, which never received major use, was replaced by ammoniacal copper zinc arsenate in 1999. More significantly, alkaline copper quaternary (ACQ) appeared in 2003. According to one mill manager, this product will replace CCA, which has been withdrawn from residential use in both Canada and the United States as of January 1, 2004 (PMRA 2002). The withdrawal was a voluntary action in response to Environment Canada's and the US-EPA's concerns about the exposure of children to arsenic, which is a known human carcinogen[20] and, along with hexavalent chromium, a toxic substance under the *Canadian Environmental Protection Act*, 1999. Therefore, CCA is no longer being produced for use in most residential settings, including decks and playsets.

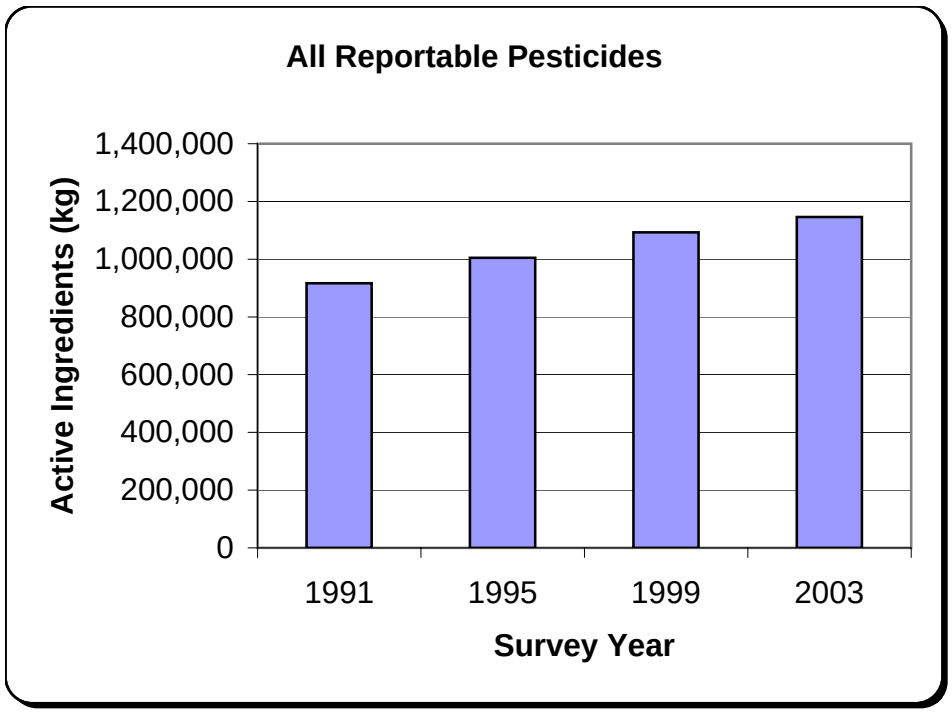
[17] Most of the methyl bromide (16,782 kg) was used for structural fumigation, which is not discussed in Section 4.5.

[18] 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. BT is not included in Table 14.

[19] Criteria: acute oral LD_{50} <50 mg/kg, acute dermal LD_{50} <100 mg/kg, significant environmental risks, or control products used in aquatic or forestry situations (PMRA 2004b).

[20] "Chromated Copper Arsenate (CCA)" online at http://www.epa.gov/oppad001/reregistration/cca/

Figure 10
Changes in Quantities of Reportable and Restricted Pesticides Sold in British Columbia, 1991-1999



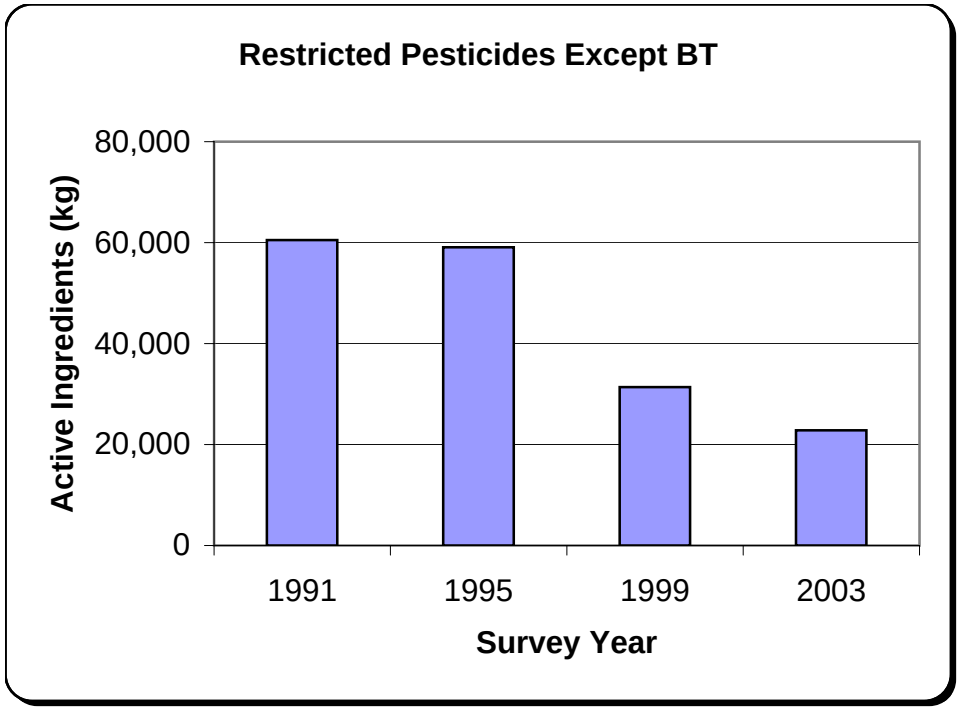


Table 16 Changes in Sales of Restricted Pesticides, 1991 to 2003

Active Ingredient	1991 Sales (kg)	1995 Sales (kg)	1999 Sales (kg)	2003 Sales (kg)	Change from 1991 (kg)
4-Aminopyridine	0.07	0.21	0.47	0.011	-0.059
Aluminum Phosphide	200	736	151	196	-3.55
Amitraz	0	69.3	32.7	14.6	+ 14.6
Azinphos-Methyl	17,820	21,804	10,595	6,499	-11,321
Bendiocarb	346	216	118	60.7	-285
Capsaicin/ Oleoresin Capsicum	0	0.73	0.51	0.088	+ 0.088
Carbofuran	1,021	997	478	484	-537
Copper Triethanolamine Complex	276	96.5	24.0	0	-276
Dinoseb	7,233	6	48	0	-7,233
Disulfoton	702	556	343	0	-702
Fensulfothion	211	0	0	0	-211
Fonofos				12.0	+ 12.0
Formetanate Hydrochloride	14.7	59.3	55.2	0	-14.7
Methamidophos	2,947	1,910	1,500	984	-1,963
Methyl Bromide [a]	21,958	21,888	9,353	9,948	-12,010
Oxamyl	141	2,027	658	698	+ 557
Oxyfluorfen	184	234	180	209	+ 24.9
Parathion	4,054	4,125	3,792	203	-3,851
Phorate	878	0	0	0	-878
Propetamphos	16.3	7.59	4.18	31.2	+ 14.9
Pyrazophos	12	9	0	0	-12.0
Strychnine	61.1	49.2	30.01	47.0	-14.1
Sulfotep	2,131	3,665	1,593	0	-2131
Terbufos	143	585	2,405	3,210	+ 3,068
Triadimefon	13.5	0	0	0	-13.5
Water Soluble Dyes	149	48.6	25.2	18.7	-130
Total Sales	60,511	59,090	31,385	22,829	-37,682

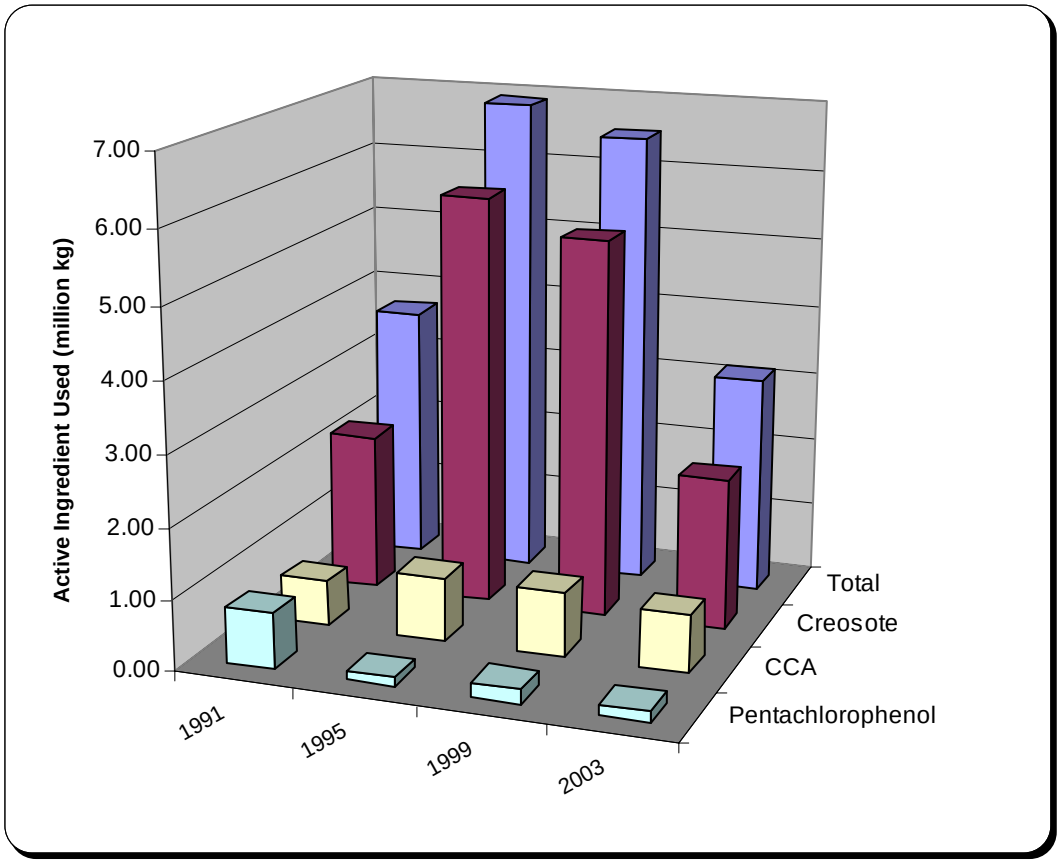
[a] Methyl bromide sales are misleading, as ≥50% of the methyl bromide used in British Columbia comes from outside the province.

Table 17 Comparison of Wood Preservative Active Ingredients Used by Wood Treatment Plants, 1991 to 2003

Active Ingredient	1991 Use (kg)	1995 Use (kg)	1999 Use (kg)	2003 Use (kg)	Change from 1991 (kg)
Creosote	2,245,711	5,869,461	5,387,761	2,163,142	- 82,569
Chromated Copper Arsenate (CCA)	651,134	912,392	923,987	824,100	+ 172,966
Pentachlorophenol	789,110	122,966	201,642	147,684	- 641,426
Ammoniacal Copper Arsenate (ACA)	500	909	0	-	- 500
Alkaline Copper Quaternary (ACQ)	-	-	-	74,448	+ 74,448
Disodium Octaborate Tetrahydrate	-	-	-	24,679	+ 24,679
Ammoniacal Copper Zinc Arsenate	-	-	16,488	2,214	+ 2,214
Total Used	3,686,455	6,905,728	6,529,878	3,236,267	- 450,188

Note: The values in this table have not been adjusted for plants that did not report wood preservative use in 1999 and 2003 (2 plants each year).

Figure 11 Changes in Wood Preservative Use 1991-2003



5.2.3 Anti-Sapstains

Ten years of data are available for anti-sapstain use (1991-1999 and 2003). The total amount of anti-sapstain chemicals used annually declined steadily from 1994 through 2003 (Figure 12). Since there were enough data points for statistical analysis, a linear regression analysis was performed using the 1994-1998 data. The downward trend is statistically significant at the 1% level. The 1999 and 2003 data were omitted from the analysis as not all mills reported anti-sapstain use. The plot of 1999 and 2003 data on the 1994-1998 regression line suggests that the decrease in anti-sapstain use between 1999 and 2003 has not been as steep as the decline from 1994 to 1998.

Figure 12 Changes in Total Use of Anti-Sapstain Chemical Active Ingredients in British Columbia, 1991 to 2003

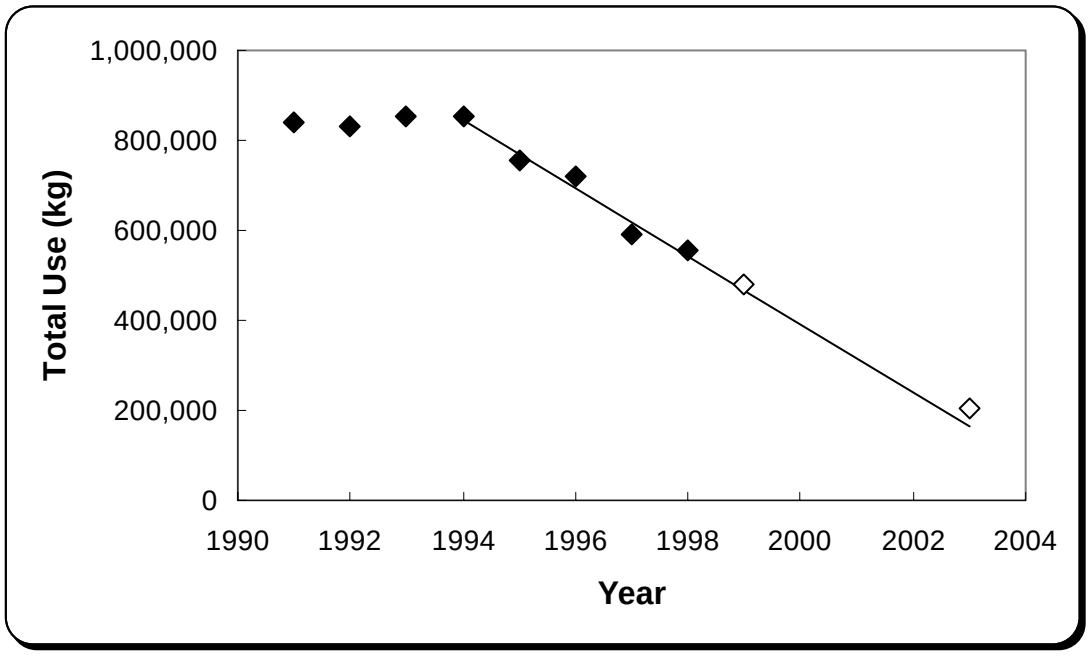
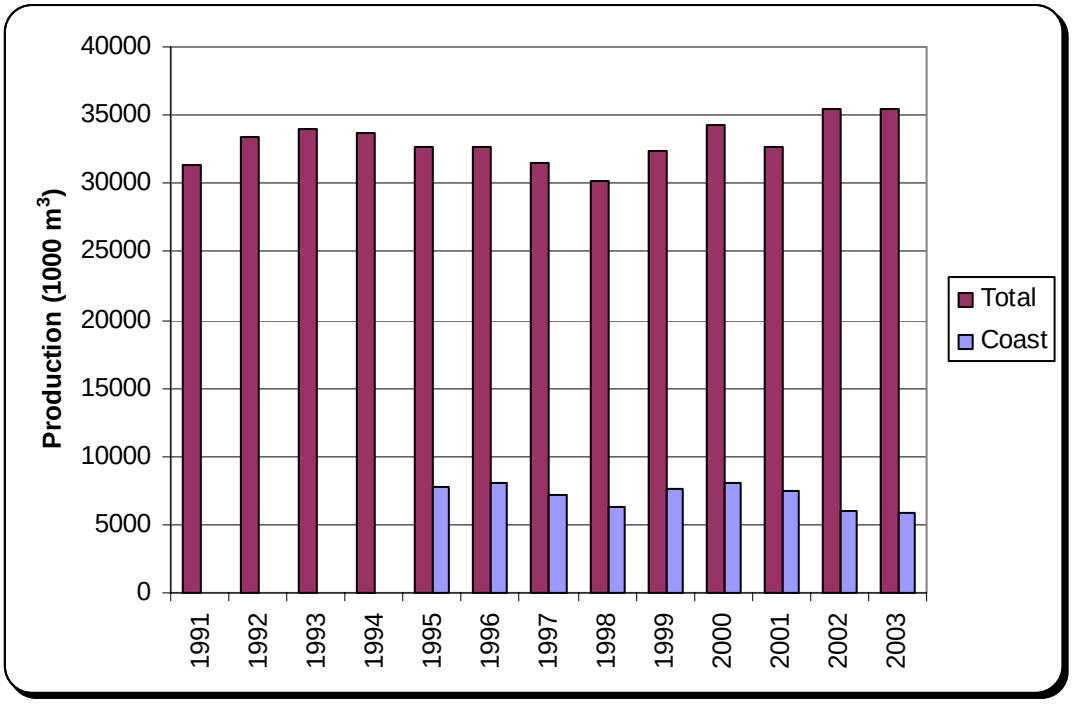


Figure 13 shows the rates of lumber production in all of British Columbia from 1991 through 2003 and in coastal areas from 1995 to 2003. Most anti-sapstain use occurs in coastal areas (Table 7) because fungi that cause sapstain thrive in the moist coastal climate. The figure shows that there was a decline in lumber production along the British Columbia coast between 2000 and 2003, which may have contributed to the decrease in anti-sapstain use since 1999. However, there was no overall trend toward lower lumber production from 1995 to 2003 that would explain the longer term declining trend in anti-sapstain use.

The change in total anti-sapstain use from 1994 to 1999 was due largely to a decrease in the use of DDAC and iododcarb (IPBC) combined with a steep decline in the use of azaconazole after 1995 (Figure 14). There have been other changes in the types of anti-sapstains used between 1991 and 2003. For example, 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. The only mill that used TCMTB in 1999 has not provided a report for 2003. Copper 8-quinolinolate (not shown on Figure 13) was used as an anti-sapstain in 1991 and 1992 but has not been used since 1992.

Figure 13 Trends in Lumber Production in British Columbia, 1991-2003



Source: Ministry of Management Services (2005)

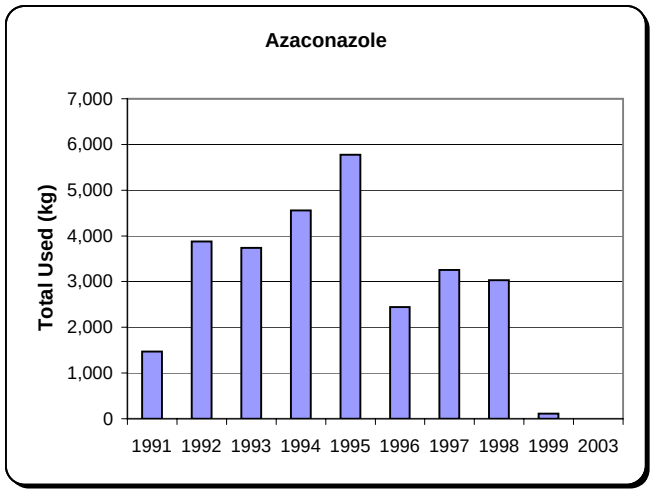
5.2.4 Landscape, Agriculture and Forestry Services

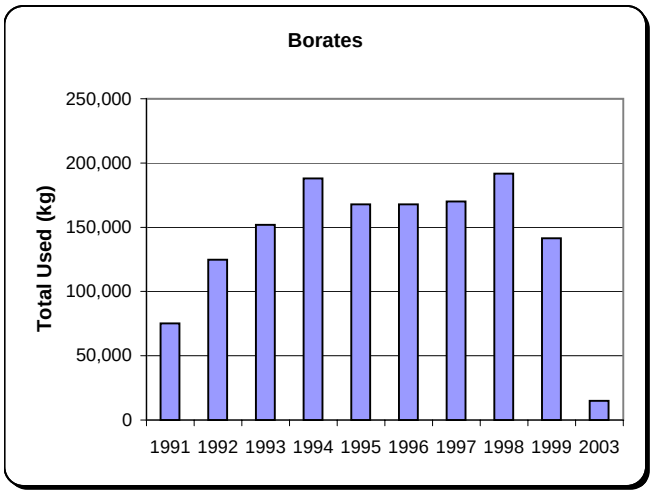
Appendix G contains a complete comparison of the current (2003) and historical use of pesticide active ingredients by licensed pest control services in the Lower Mainland Region. Only 1991, 1999 and 2003 data are available for services licensed in the agriculture category, while 1991, 1995, 1999 and 2003 data are available for landscape services. The following sections discuss overall changes in pesticide use by licensed services and changes in use of the top 20 active ingredients. Changes in specific active ingredients are discussed further in Section 6.0.

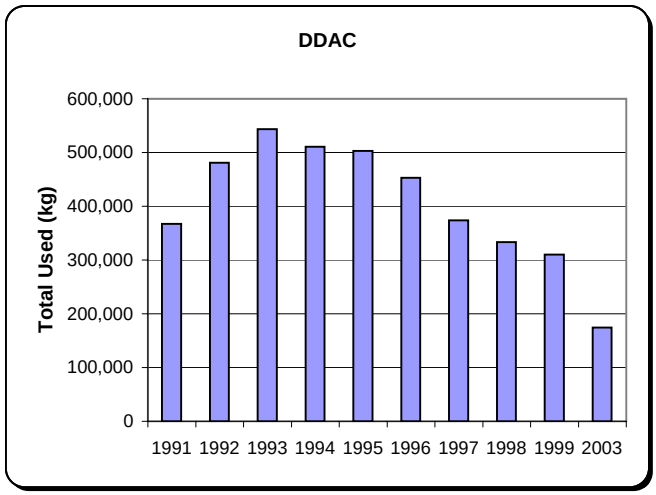
Landscape Services

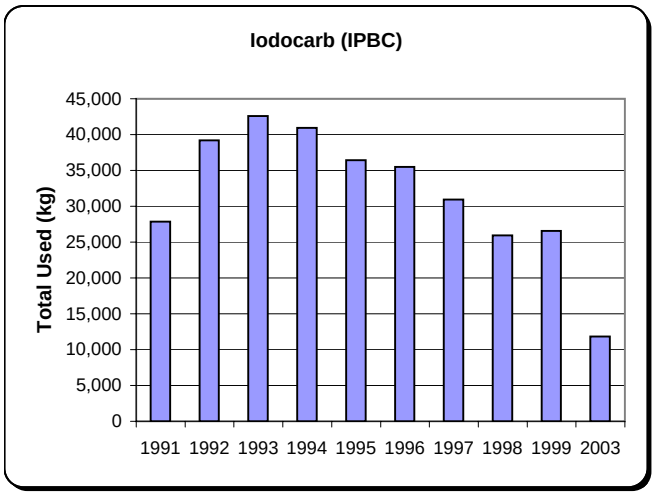
There was a 50% decrease (7,613 kg) in use of pesticide active ingredients by landscape services between 1991 and 2003. Linear regression analysis shows this trend to be significant at the 5% level. The use of glyphosate and mineral oil (insecticidal or adjuvant) decreased by over 1,000 kg (52% and 55%, respectively), but these changes

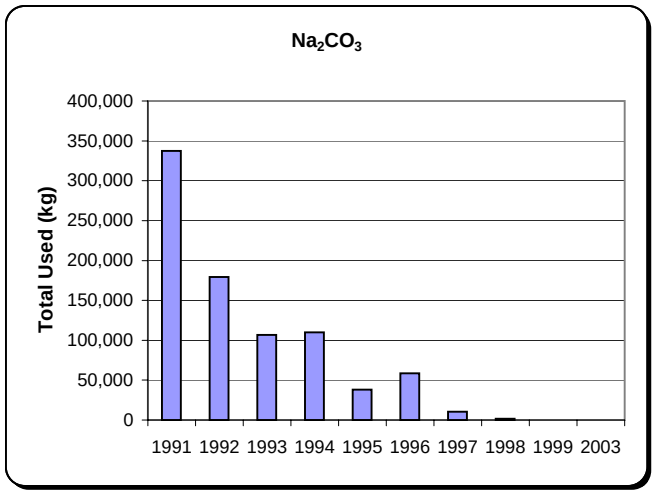
Figure 14
Changes in Quantities of Anti-Sapstain Active Ingredients Used in British Columbia, 1991-1999

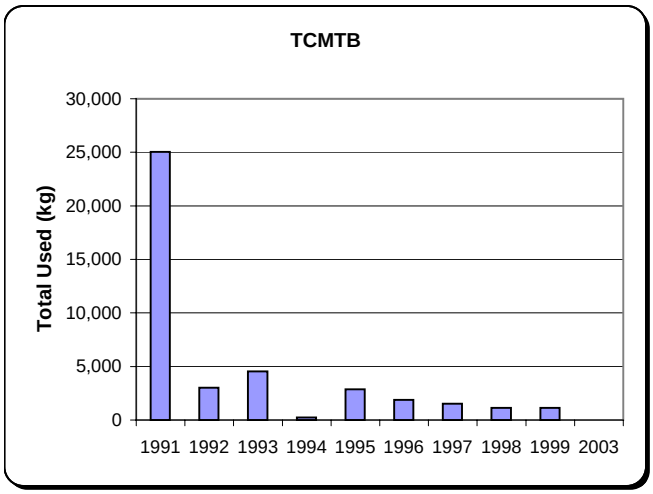












Borates = Disodium Octaborate Tetrahydrate + Disodium Tetraborate Decahydrate

are not statistically significant. The use of insecticidal mineral oil appears to vary substantially from year to year. However, in 2003 the use of this product was 1,485 kg (56%) lower than its average use during the previous three surveys.

The use of several active ingredients increased considerably between 1991 and 2003 (Table 18). For example, the use of chlorothalonil increased by 747 kg (2615%) between 1991 and 2003, and the change is statistically significant (P=0.01). The use of iprodione increased 145% from 50.4 kg in 1991 to 124 kg in 2003, while the use of simazine increased by 32.3 kg (78%). However, use of the latter two active ingredients was slightly lower in 2003 than in 1999, and the changes in usage are not statistically significant.

Table 18 Changes in the Top 20 Active Ingredients Used by Lower Mainland Pest Control Services Licensed in the Landscape Category, 1991-2003

Active Ingredient	1991 Use (kg)	1995 Use (kg)	1999 Use (kg)	2003 Use (kg)	Change from 1991 (kg)
Mineral Oil (Insecticidal or Adjuvant)	2,443	4,183	1,342	1,171	-1,272
Glyphosate	2,145	1,068	1083.9	968	-1,177
2,4-D Amine Salts	921	1,088	863	899	-22
Chlorothalonil	28.5	72.1	371	774	745
Soap (Insecticidal)	0	359	1,031	654	654
Mecoprop, Amine Salts	669	903	567	569	-100
Diazinon	676	539	639	507	-169
Dichlobenil	394	636	452	464	69.8
Lime Sulphur	328	379	428	300	-27.5
Quintozene	468	371	794	175	-293
Iprodione	50.4	61.8	128	124	73.1
Dicamba	140	204	129	100	-39.6
Simazine	41.4	93.6	76.7	73.7	32.3
Amitrole	91.1	46.6	43.8	63.7	-27.4
Copper Oxychloride	132	146	74.0	62.0	-70.0
Thiophanate-Methyl	93.4	39.5	30.1	57.9	-35.5
Acetic Acid	0	0	0	50.6	50.6
Fatty Acid	0	38.0	66.8	46.4	46.4
Dimethoate	0	0	0	45.0	45.0
Ferrous Sulfate	0	82.2	64.8	36.0	36.0
Total	**15,154**	**14,802**	**9,071**	**7,541**	**-7,613**
Number of Licensed Services	**200**	**235**	**189**	**162**	**-38**

The reduction in pesticide use by landscape services is important, because MoE has been working to educate licensees and the public and to promote Integrated Pest Management (IPM) in this sector. Both the overall reduction in pesticide use and usage of "less toxic" active ingredients like insecticidal soap (which was not used in 1991) are consistent with the implementation of IPM.

Some of the reduction in total pesticide use likely is related to a reduction in the number of pest control services licensed in the landscape category. The number of landscape licensees reporting pesticide use has declined steadily since 1995 and was about 19% lower in 2003 than in 1991 (Table 18). However, in 1991, the average landscape licensee used 76 kg of pesticide active ingredients. In 2003, the average licensee applied 47 kg of pesticide active ingredients, a reduction of 39% compared with the amount applied in 1991.

Agriculture Services

Since there are only three data points (1991, 1999 and 2003) for pesticide applications by services licensed in the agriculture category, statistical comparisons are not possible. Visual inspection of the data shows that year to year variability is high. For example, the total quantity of pesticide active ingredients applied by agriculture services increased more than 100% between 1991 and 1999 and then decreased by a greater magnitude in 2003 (Table 19, Appendix G). ENKON (2001) attributed the 1991-1999 change to a change in the BC *Pesticide Control Act Regulation*, 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 subsequent decline in pesticides may be directly related to the decreased use of Restricted pesticides. As these pesticides have been replaced by other products a farmer's need to obtain applicator certification or hire a licensed service would have declined.

The most notable changes in pesticide active ingredient use, however, were decreases in methyl bromide, atrazine, glyphosate and EPTC (Table 19). Of these, only methyl bromide is restricted.

Forestry Services

Forestry services were included in the 1991 pesticide survey but not in the 1995 or 1999 survey. A number of inconsistencies were noted in the 1991 data (Norecol Environmental Consultants Ltd. 1993), notably:

- double reporting of pesticide use by Ministry of Forests and their contractors; and
- discrepancies from data reported to MELP under provincial permit requirements that remained after the double reporting had been corrected.

Due to the problems with the 1991 data and the lack of data for intervening years, there has been no attempt to assess trends in the quantities of pesticides used for forestry.

Table 19 Comparison of the Top 20 Active Ingredients Used by Lower Mainland Pest Control Services Licensed in the Agriculture Category, 1991, 1999 and 2003

Active Ingredient	1991 Use (kg)	1999 Use (kg)	2003 Use (kg)	Change from 1991
Methyl Bromide *	5,186	6,403	2,026	- 3,160
Atrazine	4,647	4,840	1,810	- 2,837
Chlorothalonil	0	1,124	1,096	+ 1,096
Chloropicrin	1,116	3,039	998	- 119
Mancozeb	155	212	941	+ 786
Linuron	0	531	676	+ 676
Glyphosate	1,719	1,706	621	- 1,098
EPTC	1,270	864	367	- 903
Nonylphenoxypolyethoxyethanol	53.3	1,476	279	+ 226
2,4-D Amine	371	757	263	- 109
Dicamba	656	527	258	- 398
Trifluralin	567	595	230	- 337
Diquat	39.4	155	167	+ 128
Metalaxyl-M (Mefenoxam)	0	0	146	+ 146
Mineral Oil (Insecticidal or Adjuvant)	0	624	127	+ 127
Captan	358	597	124	- 234
Propamocarb Hydrochloride	0	260	120	+ 120
Paraquat	22.5	164	118	+ 95
Paraffin Base Mineral Oil (Adjuvant)	887	2,035	114	- 773
Bentazon	195	483	107	- 88
Total	**42,083**	**86,565**	**11,338**	**-30,745**
Number of Licensed Services	**15**	**14**	**16**	**1**

* The amount of methyl bromide used in 1999 has been adjusted downward based on discussion with the service licensee who applied it. A product registered for both soil fumigation and structural fumigation was used solely for structural fumigation.

However, it is possible to compare the active ingredients used for forestry in 1991 and 2003. The two major pesticide active ingredients used in Region 2 in 1991 were glyphosate (77%) and *Bacillus thuringiensis* Berliner ssp. *kurstaki* (BTK) (23%). Three other active ingredients, triclopyr, amitrole and picloram together comprised <1% of the total forestry pesticide use. In 2003, glyphosate and BTK similarly were the most important pesticides used for forestry in Region 2, although the proportions of these active ingredients used were reversed (14% glyphosate and 84% BTK). Triclopyr made up about 2% of the active ingredients in 2003, while amitrole and picloram were not applied by forestry services in 2003.

5.2.5 Golf Course Pesticide Use

Use of pesticides by golf courses was not included in the 1991, 1995 and 1999 pesticide surveys. However, UMA Environmental (1996) completed an inventory of golf courses in the Fraser Basin that included gathering data on pesticide use from 1990 to 1996. Fifteen golf courses in the Lower Mainland provided information on pesticide use, although in many cases, the information included only the pesticide active ingredients applied without the corresponding quantities. The UMA Environmental study makes it possible to compare pesticide active ingredients used by golf courses in 2003 with the active ingredients used in the early to mid-1990s (Table 20).

Table 20 Percentages of Lower Mainland Golf Courses Using Various Pesticide ActiveIngredients, 2003 and 1990-1996

Active Ingredient	2003	1990-96
2,4-D, all forms	54%	33%
Azoxystrobin	64%	0%
Benomyl	0%	33%
Carbaryl	16%	0%
Chloroneb	4%	20%
Chlorothalonil	74%	33%
Diazinon	10%	7%
Dicamba	50%	40%
Fosetyl-Al	26%	0%
Glyphosate	32%	27%
Iprodione	74%	33%
Mancozeb	22%	40%
Maneb	0%	13%
Mecoprop, all forms	58%	40%
Metalaxyl/Metalaxyl-M	2%	7%
Myclobutanil	30%	0%
Propiconazole	70%	0%
Quintozene	92%	87%
Thiophanate-methyl	34%	47%

Source of 1990-96 data: UMA Engineering (1996)

Although the fungicide quintozene was the most-used golf course pesticide in both the early to mid-1990s and in 2003, some notable changes in the use of pesticide active ingredients occurred. For example, the fungicides benomyl and maneb, which were

applied by 33% and 13% of the golf courses in 1990-1996, respectively, were not used at all in 2003. Fungicides used in 2003 but not identified in UMA's (1996) golf course survey included azoxystrobin (used by 64% of golf courses), fosetyl-al (used by 26%), myclobutanil (used by 30%) and propiconazole (used by 70%). The insecticide carbaryl, which was not identified in the UMA survey, was used by 16% of the golf courses in 2003. Use of this product may reflect responses to localized pest outbreaks.

5.2.6 Flea Control Products

Sales of flea control products through veterinarians have declined by a total of 596 kg (83%) since 1991 (Table 21). The largest decrease occurred between the 1995 and 1999 surveys. The 2003 sales were only 20% of the 1995 sales but 78% of the 1999 sales.

Table 21 Comparison of Flea Control Products Sold by Veterinarians in British Columbia, 1991 to 2003

Active Ingredient	1991 Sales (kg)	1995 Sales (kg)	1999 Sales (kg)	2003 Sales (kg)	Change from 1991 (kg)
Amitraz	-	-	0.39	-	0.0
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	3.12	-36.88
N-Octyl Bicycloheptene Dicarboximide	255	150	15	-	-255
Imidacloprid	-	-	96.3	103	+103
Permethrin	1.63	42.6	13.4	11.94	+10.31
Piperonyl Butoxide	210	307	17	3.20	-206.8
Propoxur	-	5.81	0.13		0.0
Pyrethrins	70.2	56.1	3.9	1.23	-68.97
Pyriproxyfen	-	-	-	0.11	0.11
Tetrachlorvinphos	-	-	2.4		0.0
Total Sales	718	622	156	122	-596

There has been a major change in the types of external flea control pesticides applied. Imidacloprid, which comprised 84% of the veterinary flea control products in 2003 and

62% in 1999, was not used at all in 1991 or 1995. Four of the eight active ingredients sold in 1991 were not sold in 1999 or 2003. Among these products was chlorpyrifos, which amounted to 121 kg or 17% of the flea control pesticides sold by veterinarians in 1991, but which was not sold after 1995.

The changes in flea control pesticide sales are real and are due to changes in flea control technology. During the 1999 survey and again during the 2003 survey, several vendors told the interviewers that flea control products registered as pesticides had almost entirely been replaced by products registered as drugs. The newer products include substances such as lufenuron (a hormone that sterilizes female fleas) and ivermectin, which are administered orally or by injection or applied to one spot on the skin. As they are not pesticides, these products were not included in the 1999 and 2003 pesticide surveys.

5.3 Product Replacements

Interviews conducted during the course of the surveys identified replacements of some pesticide active ingredients, such as the wood preservative CCA and most active ingredients used for veterinary flea control with newer products (Sections 5.2.2 and 5.2.6). Replacement of other active ingredients, particularly in the agriculture sector, were identified through:

- comparison of 1991 pesticide use patterns summarized from crop production guides (Norecol Environmental Consultants 1993) with current pesticide use discussed in the *BC Crop Profiles*;
- discussions with MAFF staff members; and
- discussions with pesticide vendors in the Lower Mainland and Peace River Regions.

Major replacements of agricultural pesticides are summarized in Table 22. Of particular note is the replacement between 1999 and 2003 of metolachlor with *S*-metolachlor, a single-isomer version of metolachlor. *S*-metolachlor is an 88% pure version of the active component of the metolachlor isomer mixture. Due to its purity, *S*-metolachlor effectively controls weeds at only 65% of the application rate for the original metolachlor. In the United States, *S*-metolachlor was registered under a "reduced risk" initiative, which speeds the registration process for pesticides that can be used in smaller quantities. It is estimated that through the 2001 season, the replacement of original metolachlor *with S*-metolachlor reduced the material that entered the environment in the U.S. by about 60 million pounds (~27 million kg) (Brown 2002).

Other new pesticides with low application rates have entered the market and are replacing older products. For example, M-metalaxyl is a version of metalaxyl that contains more active isomers and has a lower application rate than the original fungicide. In 2003, 2,504 kg of M-metalaxyl were sold compared with 418 kg of metalaxyl. Azoxystrobin, one of the pesticides most frequently used by golf courses (Section 5.2.5) is another low application rate product. Azoxystrobin is also used on blueberries and (under emergency registration) on ginseng.

Table 22 Replacement of Agricultural Pesticide Active Ingredients 1991-2003

Active Ingredient	Crop	Pest	Replaced By
1,3-Dichloropropene	Raspberries, strawberries	Nematodes	No real replacement - relatively small proportions of strawberry crops treated with metam or methyl bromide, raspberries with oxamyl (on established fields)
	Potatoes, carrots	Root-knot nematode	Metam and dazomet (carrots)
Dodine	Apples	Apple scab	Myclobutanil, sulphur, metiram, mancozeb, others
Dinoseb	Raspberries	First shoot removal	Oxyfluorfen (primarily), glufosinate ammonium
	Blueberries, peas, beans	Weeds	Glyphosate, dichlobenil, napropamide, paraquat, others
Folpet	Cranberries	Fruit rot	Chlorothalonil, copper oxychloride
Methidathion	Apples	Caterpillars, leaf rollers, aphids	Mineral oil (insecticidal), azinphos-methyl, *Bacillus thuringiensis* Berliner ssp. *kurstaki*, diazinon, many others in smaller amounts
	Potatoes	Flea beetle, Colorado potato beetle, leaf hopper	Pirimicarb (aphids only), cypermethrin, methamidophos, dimethoate
Propargite	Grapes	Mites	Sulphur and lime sulphur
Sulfotep	Ornamental greenhouse plants	Spider mites (red spider), aphids, whitefly, and some species of mealy bugs, thrips, and soft brown scale	No specific replacement, but DDDP and nicotine are used
Vernolate	Corn	Weeds	All corn: atrazine, *S*-metolachlor; sweet corn: bromoxynil, bentazon; field corn: nicosulfuron
Difenzoquat	Spring & winter wheat, barley, underseeded forages	Wild oats and broadleaf weeds	Clodinafop-propargyl
Phorate	Potatoes	Aphids, leafhoppers, leaf miners, psyllids, tuber flea beetles, potato flea beetle, wireworm, Colorado potato beetle	Pirimicarb (aphids only), cypermethrin, methamidophos, dimethoate, chlorpyrifos under emergency registration (wireworms)
Dichlone	Apple trees	Apple scab, cedar apple, rust	Myclobutanil, sulphur, metiram, mancozeb, others
	Peach, plum, cherry	Brown rot	Iprodione, sulphur, myclobutanil, propiconazole, others copper (peaches)
Metolachlor	Corn, potatoes, beans	Weeds	*S*-metolachlor
Metalaxyl	Potatoes	Late blight	Metalaxyl-M
	Raspberries, strawberries	Root rot	
Triallate	Wheat, barley	Weeds	Clodinafop-propargyl

Other substitutions include use of older active ingredients (e.g. metam, sulphur, chlorothalonil and insecticidal mineral oil) plus newer (post-1991) products like myclobutanil to replace active ingredients that are no longer registered such as 1,3-dichloropropene, folpet, methidathion and dichlone. In addition, insect growth regulators like tebufenozide are beginning to replace some use of organophosphate insecticides on tree fruits (Madeline Waring, MAFF, personal communication).

6.0 GEORGIA BASIN PESTICIDE SALES AND USE

6.1 Reportable Pesticide Sales

For all practical purposes, the Georgia Basin is equivalent to MELP/MoE Region 1 plus Region 2 (Figure 1). Table 23 shows quantities of the top 20 Reportable pesticides sold in the Georgia Basin. Most of these active ingredients are also among the top 20 Reportable pesticides for all of British Columbia. Exceptions include the soil fumigants methyl bromide and dazomet, the herbicide dichlobenil, the surfactant nonylphenoxypolyethoxyethanol, and the fungicide fosetyl-al.

Table 23 Quantities of the Top Twenty Reportable Pesticide Active Ingredients Sold in the Georgia Basin in 2003

Active Ingredient	Rank	Quantity Sold (kg)	Percent Of Total
Glyphosate	1	48,010	8.93%
Bacillus thuringiensis, Serotype H-14	2	38,808	7.22%
Mineral Oil (Insecticidal or Adjuvant)	3	37,866	7.04%
Chlorothalonil	4	31,040	5.77%
Sulphur	5	29,267	5.44%
Metam	6	24,107	4.48%
Mineral Oil (Herbicidal)	7	23,575	4.39%
Captan	8	23,081	4.29%
Formaldehyde	9	21,739	4.04%
Mancozeb	10	20,677	3.85%
Diazinon	11	17,085	3.18%
Copper Oxychloride (as Cu)	12	13,921	2.59%
Atrazine	13	10,341	1.92%
Methyl Bromide	14	9,948	1.85%
Dazomet	15	8,179	1.52%
Fosetyl-Al	16	7,025	1.31%
2,4-D Amine	17	6,756	1.26%
Lime Sulphur	18	6,485	1.21%
Dichlobenil	19	6,300	1.17%
Nonylphenoxypolyethoxyethanol	20	6,291	1.17%

6.2 Pesticide Active Ingredients of Concern in the Georgia Basin

This section identifies and discusses sales of pesticides of particular concern in the Georgia Basin and Puget Sound. The pesticides considered (Table 24) have been identified as part of several environmental initiatives:

- As its first task under the Georgia Basin Ecosystem Initiative (GBEI), the predecessor to the Georgia Basin Action Plan (GBAP), Environment Canada produced the "1998 Nominating List of Toxic Substances in the Lower Fraser/Georgia Basin" ("1998 Nominating List") (ENKON 1999). This list of 44 substances emphasizes suspected endocrine-disrupting chemicals and includes 14 pesticide active ingredients or groups of active ingredients.
- A consultant to the US National Oceanic and Atmospheric Administration (NOAA) recently developed a list of contaminants of concern in Puget Sound for consideration by the international Puget Sound/Georgia Basin Toxics Work Group. This list contains 48 in-use and persistent, formerly used pesticides. Active ingredients from the NOAA list that have been sold or used in British Columbia since 1991 are included in Table 24.
- Grant and Ross (2002, cited in Verrin *et al*. 2004) prepared a list of contaminants that could pose a health risk to southern resident killer whales. The list includes 16 pesticide active ingredients that may persistent in the environment and bioaccumulate, thereby presenting a possible health risk to biota.

In 2003, Reportable pesticide sales in the Georgia Basin (Regions 1 and 2) included 40 active ingredients[21] found on one or more lists of environmental concern. Sales of these active ingredients amounted to 95,446 or 17.8% of all pesticides sold in the Georgia Basin during 2003 (Table 25). Of the 40 active ingredients, only diazinon, atrazine, 2,4-D amine, and nonylphenoxypolyethoxyethanol were among the top 20 pesticides sold in the Georgia Basin.

Eight Reportable pesticide active ingredients[21] appear on two or more of the three lists of concern (Table 24). These active ingredients are atrazine, simazine, chlorpyrifos, malathion, metolachlor, endosulfan, trifluralin and lindane. Together the eight active ingredients amounted to 30,478 kg or 5.7% of all pesticides sold in the Georgia Basin during 2003.

There have been substantial decreases in the sales of atrazine, malathion and metolachlor since 1991 (Table 26, Figure 15). However, only metolachlor shows a statistically significant (P=0.03) downward trend. Furthermore, all sales of metolachlor in 2003 were *S*-metolachlor, while sales in 1991-1999 were the mixture of metolachlor isomers. Atrazine sales decreased between 1991 and 1995 but subsequently have risen. Sales of chlorpyrifos, lindane and simazine did not change substantially over the study period.

[21] Does not include the heavy duty wood preservative pentachlorophenol.

Table 24 Pesticide Active Ingredients of Potential Concern in the Georgia Basin and Puget Sound

Source			
1998 Nominating List	**NOAA Puget Sound List**		**Killer Whale List**
Insecticides			
Endosulfan **Lindane** **Malathion** Methoxychlor Organotins (includes fenbutatin oxide)	Carbaryl Carbofuran **Chlorpyrifos** Diazinon **Lindane** **Malathion** Oxamyl Propargite		**Chlorpyrifos** Dicofol **Endosulfan** Fenthion Fenvalerate **Lindane** Permethrin Phorate
Herbicides			
Atrazine **Dinoseb** **Metolachlor** Parathion **Simazine** **Trifluralin**	2,4-D **Atrazine** Bromacil Chlorhtal Dicamba **Dinoseb** Diuron EPTC Linuron	MCPA **Metolachlor** Metribuzin Napropamide **Simazine** Tebuthiuron Terbacil Triclopyr **Trifluralin**	Ethalfluralin Oxadiazon Pendimethalin Triallate **Trifluralin**
Fungicides			
			Quintozene
Adjuvants and Surfactants			
Non-ionic surfactants (nonyl- and octylphenolethoxylates)			
Anti-sapstains			
Didecyl dimethyl ammonium chloride (DDAC)			
3-iodo-2-propynyl-butyl carbamate (IPBC or iodocarb)			
Heavy Duty Wood Preservatives			**Pentachlorophenol**
Pentachlorophenol (a chlorinated phenol)			
Polycyclic aromatic hydrocarbons (constituents of creosote)			
Chromium, copper and arsenic (constituents of chromated copper arsenate and ammoniacal copper zinc arsenate)			

Active ingredients included on two or more lists of concern are shown in **bold**.

Table 25 Pesticide Active Ingredients of Potential Concern Sold in the Georgia Basin during 2003

Active Ingredient	Quantity Sold (kg)	Rank	Percent of Total Sales
Diazinon	17,085	11	3.18%
Atrazine	10,340	13	1.92%
2,4-D Amine	6,756	17	1.26%
Nonylphenoxypolyethoxyethanol	6,291	20	1.17%
Simazine	6,179	21	1.15%
Quintozene	5,426	23	1.01%
Napropamide	5,125	25	0.95%
Linuron	4,585	26	0.85%
Chlorpyrifos	4,252	27	0.79%
MCPA Amine Salts	4,018	28	0.75%
MCPA Esters	3,694	30	0.69%
Malathion	3,444	34	0.64%
***S*-Metolachlor**	3,445	34	0.64%
Octylphenoxypolyethoxyethanol	2,210	42	0.41%
Dicamba	1,769	50	0.33%
Carbaryl	1,646	53	0.31%
Endosulfan	1,533	55	0.29%
Trifluralin	1,135	60	0.21%
2,4-D LV Esters	777	70	0.14%
Diuron	757	72	0.14%
Oxamyl	698	73	0.13%
Permethrin	666	76	0.12%
EPTC	584	81	0.11%
Oxadiazon	580	82	0.11%
Pendimethalin	566	83	0.11%
Carbofuran	480	86	0.09%
Terbacil	294	98	0.05%
Dicofol	202	110	0.04%
Parathion	198	112	0.04%
MCPA Potassium or Sodium Salt	198	112	0.04%
Metribuzin	161	119	0.03%
Lindane (Gamma-BHC)	152	122	0.03%
Fenbutatin Oxide	90.4	133	0.02%

Table 25 (con't) Pesticide Active Ingredients of Potential Concern Sold in the Georgia Basin during 2003

Active Ingredient	Quantity Sold (kg)	Rank	Percent of Total Sales
Bromacil	31.2	164	0.01%
Didecyl dimethyl ammonium chloride	24.8	170	<0.01%
2,4-D Acid	23.8	171	<0.01%
Chlorinated phenols	17.2	179	<0.01%
Methoxychlor	12.5	183	<0.01%
Fenthion	0.46	211	<0.01%
Fenvalerate	0.20	213	<0.01%
Total Active Ingredients of Concern	95,446		17.8%

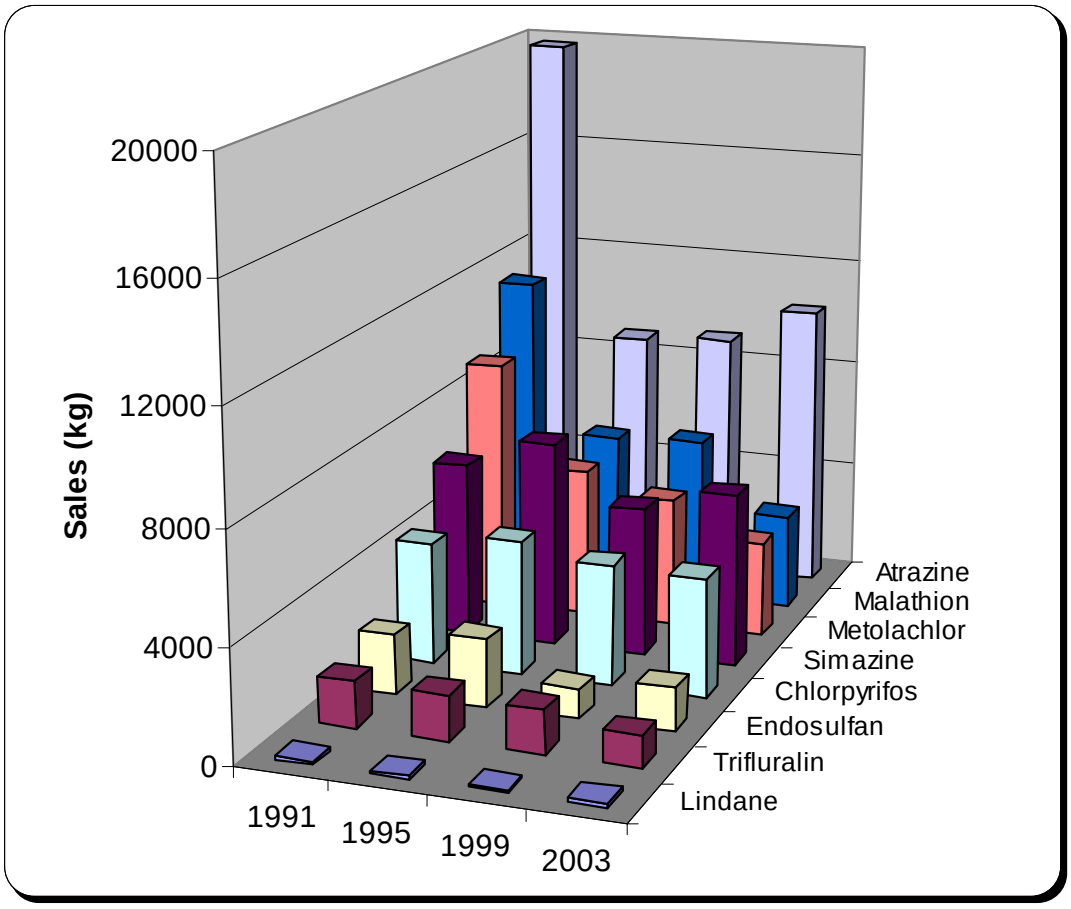
Active ingredients included on two or more lists of concern are shown in **bold**.

Table 26 Changes in Sales of Eight Pesticide Active Ingredients of Concern in the Georgia Basin 1991-2003

Active Ingredient	1991 Sales (kg)	1995 Sales (kg)	1999 Sales (kg)	2003 Sales (kg)	Change from 1991(kg)
Atrazine	19,789	8,797	9,002	10,340	-9,449
Malathion	11,385	5,780	5,941	3,444	-7,941
Metolachlor/ *S*-Metolachlor	9,080	5,389	4,669	3,445	-5,635
Simazine	6,255	7,371	5,331	6,179	-76
Chlorpyrifos	4,339	4,815	4,324	4,252	-88
Endosulfan	2,124	2,393	1,076	1,533	-591
Trifluralin	1,671	1,611	1,572	1,134	-537
Lindane	135	115	103	152	17

Note: Only *S*-metolachlor was sold in 2003. From 1991 to 1999 the metolachlor sold was a mixture of isomers.

Figure 15 Sales of Eight Pesticide Active Ingredients of Concern in the Georgia Basin 1991-2003



Metolachlor sold in 2003 is *S*-metolachlor.

Lindane sales were somewhat higher in 2003 than during the previous surveys. In 2003 all of the lindane-containing products sold in the Georgia Basin were seed treatments. In contrast, in 1991 only 18% of the lindane was sold for seed treatment. The remaining products would have been used to treat fields, lawns, greenhouses and/or dwellings. Thus, although the total quantity of lindane sold in the Georgia Basin has not decreased, and even has increased slightly, the change in the use pattern of this pesticide may have affected the potential for its release into the environment.

6.3 Use by Pest Control Services

6.3.1 Agriculture Services

In 2003, Lower Mainland pest control services licensed in the agriculture category applied 4,026 kg of active ingredients that are included among the pesticides of concern (Table 24). These active ingredients amounted to approximately 36% of the pesticides applied by agriculture services in 2003. The total quantity of active ingredients of

concern applied by agriculture services was 9,136 kg (about 69%) lower in 2003 than in 1991 (Table 27).

Table 27 Quantities of Pesticide Active Ingredients of Concern Used by Agriculture Services in the Lower Mainland, 1991 to 2003

Active Ingredient (AI)	2003 Rank	1991 Agriculture Use (kg)	1999 Agriculture Use (kg)	2003 Agriculture Use (kg)	Change from 1991 (kg)
2,4-D Amine	10	371	757	263	- 109
2,4-DB Esters	--	7.50	2.81	-	- 7.50
Atrazine	2	4,647	4,840	1,810	- 2,837
Carbaryl	--	20.4	209	-	- 20.4
Carbofuran	--	7.20	3.84	-	- 7.20
Chlorpyrifos	50	-	233	3.84	+ 3.84
Diazinon	24	143	122	46.8	- 95.9
Dicamba	11	656	527	258	- 398
Dicofol	--	1.00	-	-	- 1.00
Dinoseb	--	1,454	-	-	- 1,454
Endosulfan	--	92.0	35.8	-	- 92.0
Ethalfluralin	--	208	-	-	- 208
EPTC	8	1,270	864	367	- 903
Fenbutatin Oxide	61	0.03	0.03	0.72	+ 0.69
Linuron	6	-	531	676	+ 676
Malathion	53	336	17.0	3.23	- 333
MCPA Amine Salts	35	68.0	210	20.6	- 47
MCPA K or Na Salt	--	1.88	-	-	- 1.88
Methoxychlor	--	-	0.63	-	-
Metolachlor/S-Metholachlor	26	2,700	2,515	39.2	- 2,661
Metribuzin	--	-	65.4	-	-
Napropamide	51	46.0	316	3.50	- 43
Nonylphenoxypolyethoxyethanol	9	53.3	1,476	279	+ 226
Parathion	--	405	200	-	- 405
Pendimethalin	--	-	18.4	-	-
Permethrin	75	1.00	4.92	0.061	- 0.94
Quintozene	72	-	-	0.11	+ 0.11
Simazine	31	105	18.1	25.0	- 80.3
Trifluralin	12	567	595	230	- 337
Total Use – Active Ingredients of Concern		13,162	13,562	4,026	- 9,136
Percent of Total Agricultural Use		31%	16%	36%	

Active ingredients in **bold** are included on two or more lists of concern (Table 24).

6.3.2 Landscape Services

During 2003, landscape services in the Lower Mainland used 1,878 kg of pesticide active ingredients that are included among the pesticides of concern in the Georgia Basin (Table 24). Applications of these chemicals amounted to 25% of the pesticides used by landscape services.

Landscape services applied 833 kg less of active ingredients of concern in 2003 than in 1991 (Table 28), a decrease of 31%. The actual decrease in applications of these pesticides occurred between 1999 and 2003.

There is no apparent trend in landscape services' use of most individual pesticides of concern between 1991 and 2003. However, the use of endosulfan, lindane and trifluralin showed a decreased from 1991 to 1995, and these active ingredients were not used in 1999 or 2003.

6.3.3 Forestry Services

In 2003, forestry services operating in the Lower Mainland applied only one pesticide active ingredient listed in Table 24. This active ingredient was the herbicide triclopyr, and 2,249 kg of it were applied. In 1991, the only other year during which forestry pesticide use was included in the survey, triclopyr also was applied in the Lower Mainland Region. Due to differences between the two forestry data sources[22] used for the 1991 survey (Norecol Environmental Consultants 1993), a precise value for the quantity of triclopyr applied is not available. However, both data sources suggest that the amount was <100 kg. Thus, there appears to have been a large increase in the use of triclopyr for forest vegetation control between 1991 and 2003. In reviewing forestry pesticide applications during the 1990s, Verrin *et al.* (2004) also noted the increasing use of triclopyr.

[22] Service license reports and permits issued to Ministry of Forests

Table 28 Quantities of Pesticide Active Ingredients of Concern Used by Landscape Services in the Lower Mainland, 1991 to 2003

Active Ingredient	2003 Rank	1991 Use (kg)	1995 Use (kg)	1999 Use (kg)	2003 Use (kg)	Change from 1991 (kg)
2,4-D Acid	--	0.72	0.30	-	-	- 0.72
2,4-D Amine	3	921	1,088	863	899	- 22.0
2,4-D LV Esters	31	0.87	7.19	-	13.7	+ 12.8
Bromacil	--	65.0	84.4	2.79	-	- 65.0
Carbaryl	29	53.0	26.4	7.40	15.2	- 37.8
Chlorthal	53	6.0	14.2	20.1	0.75	- 5.21
Chlorpyrifos	--	15.4	20.0	16.3	-	- 15.4
Diazinon	7	728	539	639	507	- 220
Dicamba	12	140	204	129	100	- 39.5
Dicofol	65	34.4	10.4	0.29	0.025	- 34.3
Diuron	--	-	-	17.6	-	-
Endosulfan	--	8.00	3.32	-	-	- 8.00
Fenbutatin Oxide	68	0.27	0.45	0.070	0.015	- 0.26
Lindane (Gamma-BHC)	--	0.78	0.38	-	-	- 0.78
Malathion	--	34.0	17.4	-	22.4	- 11.6
MCPA Amine Salts	23	65.0	62.1	65.9	35.8	- 29.2
MCPA Esters	40	7.8	5.4	10.0	5.00	- 2.75
MCPA K or Na Salt	--	6.00	2.40	3.09	-	- 6.00
Methoxychlor	43	58.6	67.3	21.4	3.88	- 54.7
Napropamide	41	15.7	15.3	37.7	4.50	- 11.2
Nonylphenoxypolyethoxy-ethanol	36	0.14	47.6	25.1	9.27	+ 9.13
Permethrin	33	11.7	0.012	0.19	12.2	+ 0.47
Propargite	--	6.00	1.20	0.08	-	- 6.00
Quintozene	10	468	371	794	175	- 293
Simazine	13	59.1	93.6	76.7	73.7	+ 14.6
Tebuthiuron	--	2.45	-	-	-	- 2.45
Trifluralin	--	3.52	0.35	-	-	- 4.00
Total Use - Active Ingredients of Concern		2,711	2,682	2,730	1,878	- 833
Percent of Total Landscape Use		17%	17%	30%	25%	

Active ingredients in **bold** are included on two or more lists of concern (Table 24).

7.0 CONCLUSIONS

There were some notable changes in pesticide sales and use between 1991 and 2003 (Table 29) with both increases and decreases in different pesticide categories. The major changes were as follows:

- From 1991 to 2003 the quantity of Reportable pesticides sold increased by about 24%. However, 92% of the increase is attributable to increased sales of mineral oil (insecticidal or adjuvant), various strains of the biological insecticide *Bacillus thuringiensis* and insecticidal soap. These pesticides are "less toxic" alternatives that might be chosen as part of an IPM program.
- Sales of federally-labelled Restricted pesticides decreased by 63% between 1991 and 2003. This class of pesticides includes products that have high toxicity or are associated with other environmental concerns.
- Sales of veterinary flea control pesticides decreased by 83%. These pesticides have largely been replaced by products registered as drugs, which are administered orally or by injection or applied to one spot on the skin.
- Anti-sapstain chemical use by lumber mills declined by over 79%, and the decrease was statistically significant at the 1% level. There was no overall change in province-wide lumber production that could account for the decline, although a decrease in lumber production by coastal mills between 2001 and 2003 may have contributed to the change from 1999 use levels.
- The use of pesticides by landscape services in the Lower Mainland decreased by 50%. Linear regression analysis shows this trend to be significant at the 5% level.

Table 29 Summary of Changes in Pesticide Sales or Use in British Columbia, 1991 to 2003

Survey Category	1991 (kg)	1995 (kg)	1999 (kg)	2003 (kg)	Change from 1991 (kg)
Wood Preservative Use	3,685,955	6,905,728	6,529,878	3,236,267	-449,688
Anti-Sapstain Chemical Use	838,319	754,314	479,251	206,041	**-632,278**
Reportable Pesticide Sales	923,275	1,010,372	1,093,195	1,146,263	**+ 222,988**
Veterinary Sales	718	622	156	122	**-596**
Use by Landscape Services	15,154	14,802	9,071	7,541	**-7,613**
Use by Agriculture Services	42,083	No data	86,565	11,338	-30,745

Changes shown in **bold** represent significant trends and/or product replacements.

An apparent change in wood preservative use (Table 29) 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.

Use of pesticides by licensed services dealing with the agriculture sector was highly variable over the three years during which this sector was surveyed (Table 29). Thus, although the quantity of pesticides used by these services was lower in 2003 than in previous years, no conclusions regarding trends are possible.

The study identified several replacements of pesticide active ingredients over the 1991-2003 survey period. Most of these substitutions identified occurred in the agriculture sector. Notable substitutions include *S*-metolachlor for metolachlor and M-metalaxyl for metalaxyl. These newer products contain higher levels of active isomers and therefore require lower application rates. In other cases, older active ingredients (e.g. metam, sulphur, chlorothalonil and insecticidal mineral oil) plus newer (post-1991) products like myclobutanil have replaced active ingredients that are no longer registered such as 1,3-dichloropropene, folpet, methidathion and dichlone. In addition, insect growth regulators like tebufenozide are beginning to replace some use of organophosphate insecticides on tree fruits.

8.0 FUTURE PESTICIDE SURVEYS

8.1 Federal *Pest Control Products Act* (2002)

The new *Pest Control Products Act* (PCPA), which received royal assent at the end of 2002 but has not yet come into force, requires all registrants of pest control products, as a condition of registration, to record and report information on sales of their products. Specifically, the PCPA requires every registrant to submit an Annual Report to the PMRA detailing sales information by province and territory for each product sold during the previous calendar year. The sales information is required for all end-use products, technical grade active ingredients and manufacturing concentrates.

Initially, it was planned that the first reporting year would be 2003, which would have provided data to compare with the British Columbia pesticide sales and use survey. However, the registrants successfully argued that they did not have the tracking systems in place to report sales by province (Dan Cronin, MoE, personal communication).

Within the next few years pesticide registrants will provide annual summaries of their sales in British Columbia (and other provinces and territories). These reports will include Domestic label pesticides in addition to all the sectors surveyed in the current study. A federal-provincial committee currently is developing a database to handle the pesticide sales reports.

8.2 Implications for Future Pesticide Surveys

The federally legislated pesticide reporting requirement has implications for future British Columbia pesticide surveys. In theory, it could replace the provincial survey and at the same time provide data not readily available currently, particularly sales of Domestic label pesticides. The database produced from the annual (federal) reports could be used to:

- provide information on the "top 20" active ingredients in both Commercial and Domestic label pesticides sold province-wide in any year; and
- track changes in sales of Restricted pesticides or other pesticides of concern.

However, the federal reporting requirement will not provide the regional breakdown that has been a characteristic of some components of the British Columbia surveys conducted since 1991. It also will not provide actual use data, particularly use by sectors of interest, such as landscaping contractors or golf courses.

Therefore, there could be reasons for continuing the British Columbia pesticide surveys, depending upon the purposes for which Environment Canada and MoE use (or would like to use) the data. If future British Columbia pesticide surveys are desired, it should be possible to repeat the survey components completed in 2003, as MoE has no immediate

plans to remove its reporting requirements for pesticide vendors or pest control service licensees.

8.3 Recommendations for Future Surveys

There are advantages to conducting another British Columbia pesticide survey after the PCPA reporting requirement comes into effect[23]. Such a survey would include compiling and summarizing data from the Annual Summaries of Reportable Pesticide Sales along with surveys of lumber mills and heavy duty wood preservation plants. The total sales of Reportable pesticide active ingredients obtained from the survey could be compared with the same year's registrants' reports. This would provide a quality control check for both MoE's licensee reports and for the federal reporting system (although it could take some effort to resolve discrepancies and determine which system is more accurate). The federal data also could provide a useful check on the completeness of data obtained from surveying the lumber mills and heavy duty wood preservation plants.

In addition, Environment Canada and/or MoE may wish to continue surveying pesticide use by specific sectors, as the federal reporting requirement will not provide use data. Such a survey or surveys could include compiling annual report data for pest control service licensees, surveying golf course superintendents, and/or conducting limited surveys of domestic pesticide use (similar to the Georgia Strait Alliance's 1999 survey) or farm pesticide use (which has not been done previously).

[23] It is recommended that if a survey is to be conducted, it be should done in 2007 to maintain the four-year interval for statistical purposes.

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