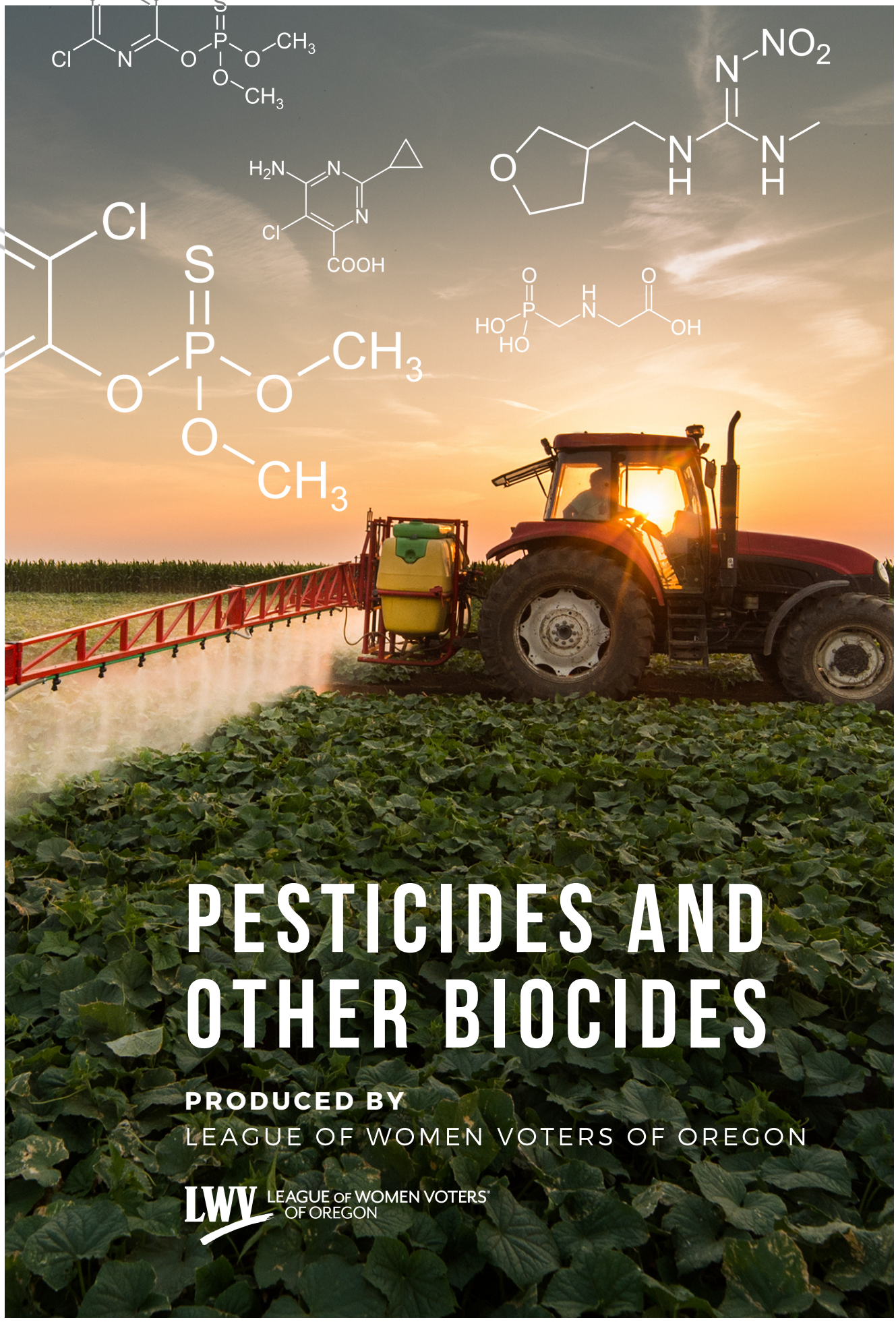

PESTICIDES AND OTHER BIOCIDES

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PESTICIDES AND OTHER BIOCIDES

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LEAGUE OF WOMEN VOTERS OF OREGON

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Find the full study with active links and supporting materials online at: **lwvor.org/studies**

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Executive Summary

Biocides are substances, typically chemicals, intended to kill, deter, or otherwise control specific organisms. These chemicals are used in agriculture and forestry to manage weeds and other pests so as to improve crop yields in order to feed and house a large and growing human population. Herbicides are also used to clean out ditches to support flood management, and to maintain clear road margins. Insecticides are used to control insects that may destroy crops, carry disease, invade food storage areas, or damage structures. Fungicides and rodenticides are useful biocides as well.

Unfortunately, biocides frequently have off-target impacts. They do not necessarily stay only in the areas where they are applied. Rather, they can be spread by wind, water, and animals to neighboring areas as well as carried on workers' clothing. They can contaminate our environment in unanticipated ways and with unanticipated consequences. Increasing evidence demonstrates that they can adversely impact workers, neighboring communities, consumers, and wildlife, including pollinators. As more evidence of negative impacts has accumulated, the need for effective control of their use has become clear. What action balances the benefits of biocide use with the harms? What policy changes can result in the widespread, or exclusive, use of best practices?

This study has looked at many aspects of how and why pesticides are developed, regulated and used, along with both the positive and negative impacts that are a consequence of that use. Currently, state and federal agencies overlap in some responsibilities, and a harmonization of policies between agencies at the state and federal level is warranted. This study has identified five key areas in pesticide policy (Figure 1).

Figure 1. The five key areas in pesticide policy that need to be considered.

Education, training, and labeling. Dissemination of best practices for pest control and pesticide use can, and have, minimized intentional and unintentional misuse and harms of pesticide products. Recommendations:

- Make pesticide labeling more user-friendly;
- Better educate the public about proper handling and potential hazards of pesticide use; and
- Improve training for pesticide applicators and farmworkers who are most likely to come in contact with higher concentrations of pesticides than the general public.

Transparency and information gathering. A lack of information about pesticide ingredients, how and when pesticides are used, and medical implications of pesticide exposure hampers our ability to identify problems with pesticides both before and after they occur, avoid exposure, and treat exposures resulting in harm to human and environmental health. Recommendations:

- Improve training for medical professionals to recognize and treat acute and chronic pesticide exposure;
- Increase monitoring and testing of the environment, wildlife, and farm workers for pesticide contamination and developing regulations and strategies to eliminate or at least mitigate the causes of these exposures once found;
- Maintain accessible national and state databases of residue contamination, medical and environmental adverse effects and contaminated sites; and
- Require more complete public disclosure of pesticide ingredients.

Funding, research, and evaluation. Adequate and stable funding for state and federal agencies is critical to implementation of policy. Without funding, monitoring of pesticide use and potential harms, enforcement of pesticide policy, completion of the best possible science, and evaluation of the latest scientific data all lapse. Recommendations:

- Ensure continuing and adequate funding for relevant agencies; and
- Increase the quantity and scope of publicly funded research into the off-target and long-term effects of pesticide use, including:
    - Review of combinations of pesticides that are used together to understand synergistic and antagonistic effects,
    - Potential hazard of other ingredients included in the pesticide formula, and
    - The potential impact of climate change on the migration of pests and how that may influence pesticide use.

Adaptive management and Integrated Pest Management. Pesticide policy must be nimble in order to keep pace with rapid advancements in technology and scientific knowledge. Flexibility is also required in order to address the myriad and varied pest concerns in different ecosystems and environments across the country. Policy must include consideration of emergencies that imminently threaten human or environmental health or our infrastructure. Recommendations:

- Regulate and manage pesticide use flexibly, with a continuous process of review and the ability to rapidly act on new information and research about its effects that will generate improved outcomes; and

- Increase implementation of Integrated Pest Management, which includes preferring cultural and mechanical means of addressing pests, minimizing use of pesticides, and using less-toxic alternatives known to have equivalent efficacy.

Burden of proof and the precautionary principle. What overarching principles should guide pesticide regulation and policy? While pesticide manufacturers must supply some initial data on pesticide properties and safety, it does not and realistically cannot cover all potential harms from pesticide use and reasonably foreseeable misuse. Implementation means reviewing how we address pesticide policy-making in the absence of complete information. Should we work from a principle that if there is no current evidence that a product/pesticide is harmful, we can assume it is safe? Should we err on the side of use or caution in the face of this uncertainty? When pesticides are used and harm is suspected, who should bear the burden of proof: The consumer or user who suspects that pesticides have harmed them, businesses and other organizations who have chosen to use the pesticides, or the pesticide manufacturer?

LWVOR is looking for member consensus on how we should support or oppose policy that will affect the use of biocides in the future.

Abbreviations

2,4-D	2,4-Dichlorophenoxyacetic acid
ACE	U.S. Army Corps of Engineers
ACP	aminocyclopyrachlor
AEZ	Application Exclusion Zone
AgFF	Agricultural, Forestry, and Fishing
ATSDR	Agency for Toxic Substances and Disease Registry
BPM	Best Practices Management
Bt	Bacillus thuringiensis
CA DPR	California Department of Pesticide Regulation
CDC	Centers for Disease Control
CHAMACOS	Center for the Health Assessment of Mothers and Children of Salinas
CWA	Clean Water Act
DEQ	Department of Environmental Quality
EDRR	Early Detection Rapid Response
EPA	Environmental Protection Agency
ERCs	Education Research Centers
EU	European Union
FAO	Food and Agricultural Organization
FERNS	Forest Activity Electronic Reporting and Notification System
FFDCA	Federal Food, Drug and Cosmetic Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FPA	Forest Practices Act
FQPA	Food Quality Protection Act
GMO	Genetically Modified Organism
HAZMAT	Hazardous Materials Response Teams
IPM	Integrated Pest Management
IVM	Integrated Vegetation Management
LC	Lane County
LCPW	Lane County Public Works
LWV	League of Women Voters
LWVOR	League of Women Voters of Oregon
MCL	Maximum Contaminant Level
MOU	Memorandum of Understanding
NGO	Non-Governmental Organization
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NPIC	National Pesticide Information Center
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OECA	Office of Enforcement and Compliance Assurance

OHA	Oregon Health Authority
OIRA	Office of Information and Regulatory Affairs
OPC	Oregon Poison Center
OR DEQ	Oregon Department of Environmental Quality
ORS	Oregon Revised Statutes
OSHA	Occupational Safety and Health Administration
OSU	Oregon State University
PARC	Pesticide Analytical and Response Center
PDP	Pesticide Data Program
PEER	Public Employees for Environmental Responsibility
PEOA	polyethoxylated amine
PERC	Pesticide Educational Resource Collaborative
PEST	Pesticide Exposure, Safety, and Tracking
PFAS	Per- and Poly-Fluoroalkyl Substance
PHAC	Public Health Advisory Committee (Lane County)
PICOL	Pesticide Information Center Online
PMP	Pesticide Management Plan
PPE	Personal Protective Equipment
PRP	Pesticide Recordkeeping Program
PSEP	Pesticide Safety Education Program
PSP	Pesticide Stewardship Program
REI	Restricted Entry Interval
SDWA	Safe Drinking Water Act
SFM	State Fire Marshall
UN	United Nations
U.S.	United States of America
U.S.C.	United States Code
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
WA Ecology	Washington State Department of Ecology
WPCP	Waste Pesticide Collection Program
WPS	Worker Protection Standard
WQPMT	Oregon Water Quality Pesticide Management Team

Introduction

Biocides are used throughout Oregon to control pest populations. Use of these compounds can provide significant benefits, but also poses risks to human and environmental health. An important component of biocides policy is determining when benefits outweigh risks. In this report, we review the current process for development, testing, and release of new pesticides, and the federal, state, regional, and local agencies that regulate their use. We also examine some positive and negative effects of their use. Finally, we suggest policy changes that may improve the process used to make decisions about pesticides and their use considering the overarching responsibility to protect human populations and the environment while promoting a stable and secure food and timber supply.

The major elements covered in this study include:

1. **Life Cycle of a Pesticide:** How a pesticide is developed, studied for its effects, and marketed, and what, if any, post-marketing reviews take place to ensure that adverse effects, especially of chronic long-term exposures, are not missed.
2. **Oversight and Regulation:** The numerous agencies and pieces of legislation involved in regulating pesticides, and what criteria are used to determine efficacy and safety, and evaluate the benefit vs cost balance between the two.
3. **Impacts and Issues Surrounding Pesticide Use:** Studies by environmental groups, research scientists and medical professionals that demonstrate initially unpredicted adverse impacts on human populations (including highlights about farmworkers and their families), animal populations, and the environment.
4. **Notable Events**: Example events in Oregon involving pesticide (mis)use, subsequent investigations or lack there-of, and linked adverse impacts.
5. **Recommendations for Regulations:** Recommendations to improve regulation, with the goal of minimizing harmful impacts of pesticide use while maintaining intended benefits.
6. **Recommendations for Principles**: The consequences of the method we use to evaluate risk and a possible change to the principle we apply to that decision-making.

General Information

The terms “biocide” and “pesticide” are not consistently defined in scientific literature, public policy, and articles for the general public. According to the United States Environmental Protection Agency (US EPA) definition (7 U.S.C. § 136(u) (2013)), a pesticide is:

1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest,
2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and
3) any nitrogen stabilizer.

These chemicals are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). While biocide can refer to antiseptics, antibiotics, water purification chemicals and disinfectants, in this report we will mainly focus on pesticides used in agriculture and forestry.

There are many categories of pest controllers and many pesticide or non-pesticide options that can be chosen by them. Anyone who wishes to diminish or remove the negative impact of a pest infestation may choose to use a pesticide/biocide. These might include (Figure 2):

- homeowners with rodent or insect invasions, weeds or other unwanted plant growth;
- farmers and foresters dealing with a bacterial or fungal blight, an insect invasion, or invasive or noxious weeds
- farmers and organizations like the Army Corps of Engineers who need to keep water channels clear of plants
- utility companies that need to keep lines clear
- city, county, and state governments that maintain parks, roadways and public buildings
- garden centers and nurseries protecting their inventory against varying infestations
- commercial applicators for hire, who deal with these problems for others on a contract basis

a): *b):*

Figure 2. Examples of pesticide use (a) in the home and (b) in an agricultural field.

Uncontrolled pest infestations can have serious consequences. A person or animal bitten by a mosquito or tick may contract a serious disease. A farmer's tainted fruit may be refused by a distributor or at the cannery, or a load of wheat contaminated with wild garlic may be declined by the mill. A homeowner may have to spend thousands of dollars to repair termite damage. Overgrown vegetation along roadsides could cause flooding or accidents due to impaired visibility (Figure 3).

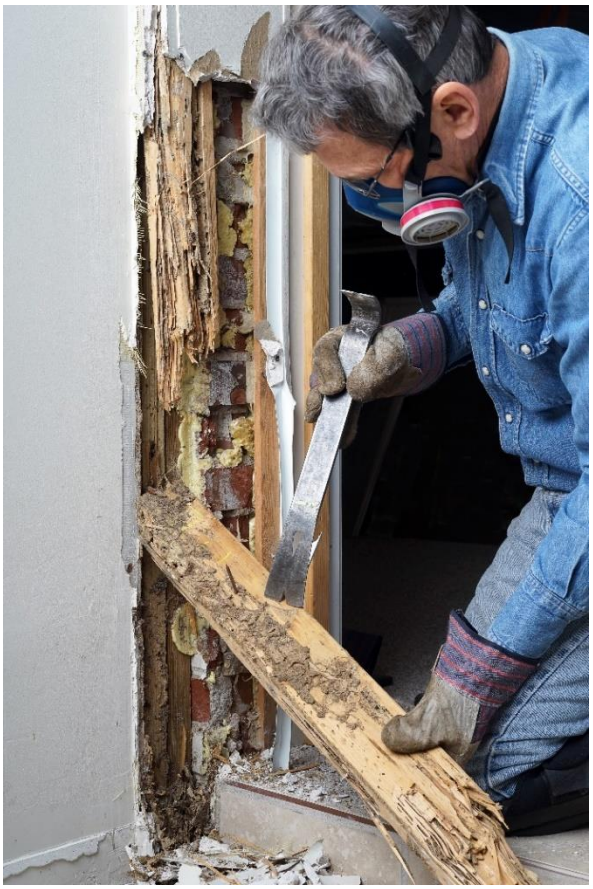

Figure 3. Termite damaged wood being removed from a house.

The proper use of pesticides benefits society. Farmers can improve crop yield and contribute to food security. Less labor is required to prevent the spread of invasive species and clear drainage ditches. Vector control protects people against pathogen-carrying insects and rodents. Structures are protected against damaging pests. Pesticide application controls unwanted tree species in managed forests or blocks the spread of invasive insects like gypsy moths, which damage or kill the trees. All of these benefits improve human health and our economy.

However, the use of pesticides may also cause harm to humans and the environment. Pesticides are designed to be toxic and can have unintended effects. Many pesticides, particularly if used improperly, have adverse impacts on environmental and human health, such as harming pollinators, or impairing human reproduction and development. In recent years, particular concern has arisen concerning the effects of certain pesticides on pollinators and other wildlife as well as contamination of watersheds and human drinking water sources. More and more, scientific research is revealing adverse off-target effects and unintended consequences of pesticide use.

Pesticides are widely used and may be applied to an area with little or no notification or signage to inform people who may be in the area. They can be applied anywhere, including in natural areas, public areas, residential neighborhoods, farm and timber lands, and even areas thought to be pristine and unmanaged.

It can be challenging for even careful consumers to discern which products are treated with pesticides. For example, seeds and nursery plants are often not labeled as having been treated with pesticides. *(Fessenden, L., personal communication, 2019)* Even products labeled organic may have been treated with a limited set of natural pesticides (e.g., copper-based products) or contaminated by pesticide drift from a neighboring area.

In many circumstances, alternative practices may more safely accomplish desired outcomes. Integrated Pest Management (IPM) is one such method that requires a tiered approach, starting with mechanical and non-pesticide methods, followed with using less toxic pesticides, and finally resorting to more toxic pesticides only if these approaches fail (Figure 4). *(Keeler, H., personal communication, 2019)* Comparing the effectiveness of these methods, and the additional work

involved to deal with pests by using them, instead of the immediate use of pesticides, requires a judgement about benefit and risk under varying circumstances.

a):

b):

c):

Figure 4. Examples of alternatives to managing pests with pesticides. A) Biological control: Ladybugs can control aphid populations. B) Mechanical control: Yellow color can attract certain pests to sticky traps. C) Manual removal: Team of gardeners pulls weeds.

Life Cycle of a Pesticide

Due to the expense and the long timeframe for a return on investment, it is challenging for new pesticides to come to market. The first step in the life of a new pesticide is the discovery of a compound that is believed to have potential efficacy based on mode of action or empirical data. Once this occurs, many issues must be taken into consideration before decisions are made about whether or not to proceed. Development and testing of a new pesticide can take a manufacturer nearly a decade and cost hundreds of millions of dollars.

There are many phases of development, with US EPA oversight at key points, including testing for both functionality and toxicity. Considerations of performance in comparison to existing pesticides and growers' need for new product options are taken into account to make sure it is a financially sound investment. Different formulations of the compound are investigated to see if they possess better profiles of activity, toxicity or ability to prevent development of a target pest's resistance. These characteristics, along with target pest selectivity and crop safety, must all be studied.

Comprehensive data is collected, including product chemistry and chemical and physical characteristics; effects on wildlife, both land-based and aquatic; mammalian toxicology and endocrine effects; effects on non-target insects; spray drift; subsequent environmental fate and residue chemistry. Both acute and sub-chronic (90-day) toxicology are studied and include potential pathways of entry such as oral, dermal and inhalation. More long-term feeding experiments are also carried out, usually on mice and rats. Neurological effects are investigated. Finally, extensive field studies are carried out.

Methods to mitigate human toxicity and other off-target effects are also considered. For example, can toxicity be reduced by use of a lower dosage or limitations to specific uses? Can exposure be decreased by restricting application timing, termination of use by a pre-harvest interval of cessation, use of personal protective equipment, closed bait stations, geographic restrictions (i.e. not near a water source) or restrictions on use based on soil type or weather conditions?

Once the studies are complete, the data is submitted in a registration package to the EPA. Part of this package is the pesticide label, which describes proper use, necessary precautions, and disposal. If approved, manufacturing is initiated. Approval is sought in other countries and the product is marketed and sold. *(Jacketta, personal communication, 2019)*

Pesticides are sold in hardware stores, large chain stores like Home Depot and Walmart, garden centers, stores that are licensed to sell restricted pesticides to licensed applicators, or they may even be purchased online. There may be knowledgeable sales staff to help a buyer consider the best options for their needs, describe required methods of use, necessary personal protective equipment, practices and proper disposal, but more likely this will not be the case. Manufacturers may provide technical support to users who purchase large quantities of their pesticide.

Any user, from the homeowner to the farmer to the commercial applicator, is required by law to follow instructions for use as described on container labels (Figure 5), although it is unlikely most home users know this fact. After its application, the pesticide user may achieve the wanted result. Both intended and potentially unintended targets may be damaged or eliminated. The pesticide’s final fate in the environment depends on where and how it was used and whether it is stable in the environment or breaks down to either non-toxic residual compounds or end-products with varying levels of toxicity. This data can be gathered by taking samples of air, water, or soil in the area of use and by checking for the pesticide’s presence, or the presence of its breakdown products, in blood and tissue samples of animals in the area.

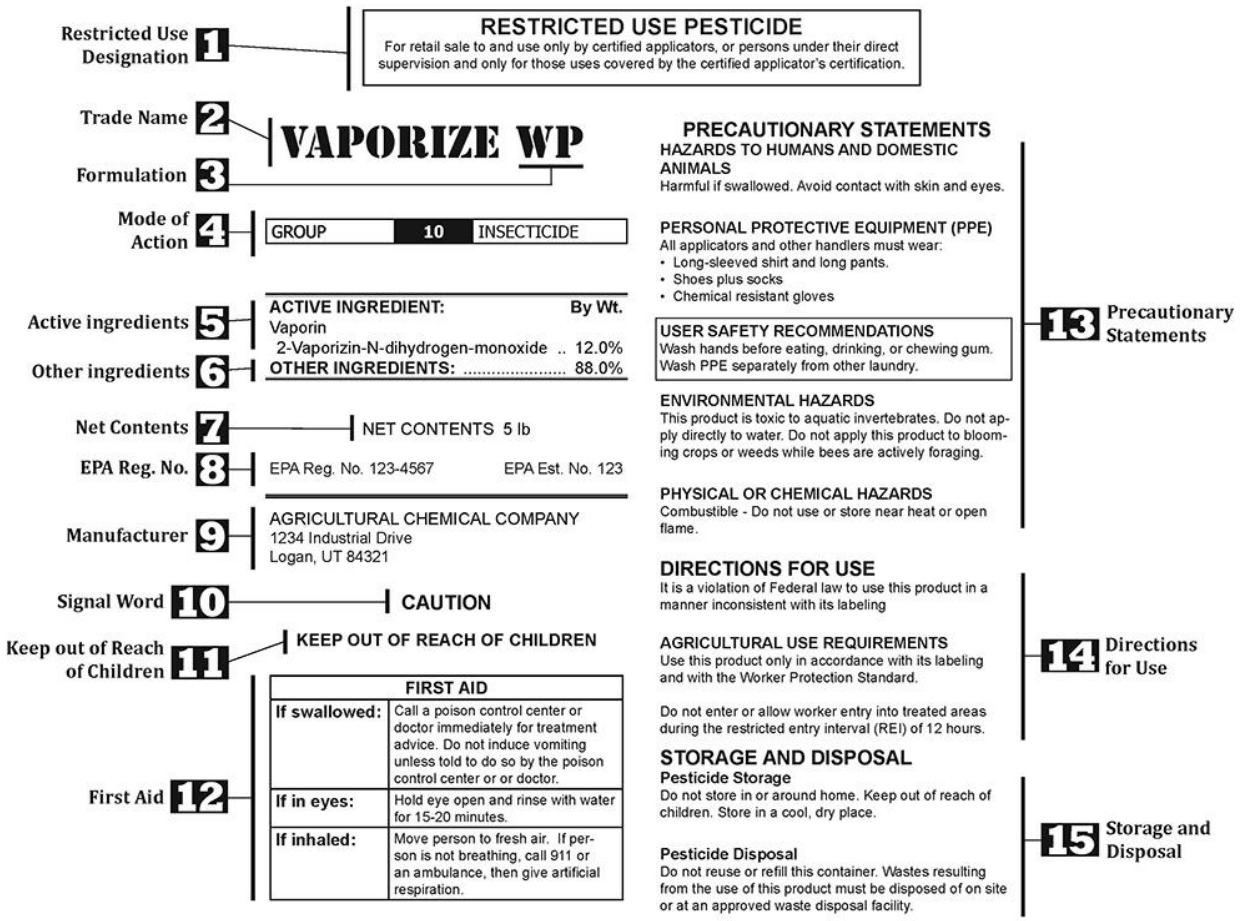

Figure 5. Understanding the components of a pesticide label. For more information about each section, go to https://intermountainfruit.org/pesticide-info/pesticide-label (Image Credit, Utah State University Extension IPM Program)

Only after extensive and long-term documentation of serious unintended side effects or consequences that were not discovered prior to marketing, can a pesticide have its use restricted or banned. This kind of data may not be available prior to sale, despite extensive pre-approval testing. Some medical and environmental consequences may take decades to surface, and not every type of toxicity is tested on every possible exposed species. As new issues are discovered, additional tests may be required. For example, the EPA has more recently started to require additional testing for endocrine impacts on humans and toxicity to pollinators.

Government Agencies, Oversight, and Regulations

Pesticides and other biocides are regulated at the federal, state, and local level. Chemicals or chemical formulations may be banned outright or allowed with only limited use. These limits may include restrictions on:

- Who can apply chemicals (e.g. licensed operators only)
- Application method (e.g. aerial spraying, manual spray)

- Timing of applications (e.g. only when plants are not flowering, only during certain times of day)
- Intended target (e.g. only for certain pests, despite being active against many pests)
- Intended protection (e.g. on which types of crops it may be applied)
- Location (e.g. requiring a buffer around schools or water sources)
- Who can be present during application (e.g. application exclusion zones)
- Weather conditions during application (e.g. wind or rain)
- Emergency use (e.g. for invasive species)
- Use only after other control methods have been exhausted (e.g. as with IPM)

Further requirements may include providing notice to people on or near the area where the chemical(s) are being applied.

Other laws limit how much pesticide can be present. For example, there are limits on how much of certain pesticides can be present in food, or how much can be present in surface or drinking water. Pesticides may be regulated as the specific chemical (e.g. glyphosate) or as a class of chemicals (e.g. organophosphates) or as a specific product (e.g. Roundup).

Regulations are designed to minimize risk to an acceptable level while taking into account economic benefits of pesticide use. Risk is a function of both hazard and exposure. Hazard is the inherent ability of a chemical or substance to cause harm; risk is the probability of harm occurring given certain exposure scenarios. The line between safe and dangerous is never perfectly defined in real life. Experiments result in different values for hazard. Different exposure models modulate risk differently. There may be unintended consequences previously undetected in lab and field test data used for risk assessment. There may be exposure scenarios that were not considered in the risk assessment. In addition to determining the dangers from a particular pesticide, we also need to ask which organisms - and how many - are at risk? Are we willing to accept the risks in order to obtain the perceived benefits?

Federal

Federal laws applying to pesticides are primarily managed by the EPA and the Food and Drug Administration (FDA). The United States Department of Agriculture (USDA) also completes some monitoring for pesticide residue, and the Department of Labor (DOL), under the Occupational Safety and Health Administration (OSHA), is also involved in worker health and safety.

The EPA administers the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA),the Food Quality Protection Act (FQPA), the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA) and Worker Protection Standard (WPS). The EPA was established in 1970 to protect human and environmental health by regulating the manufacture, processing, distribution and use of chemicals and other pollutants pursuant to federal laws established by Congress and subject to review by the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget. It administers and enforces these laws by carrying out environmental

research and critical environment assessment, education, requiring environmental licensing, waste management and radiological protection. It regulates water quality standards under the Clean Water Act, and has developed human health benchmarks for pesticides based on information available at the time the benchmarks were developed, to enable its partners to better determine whether the detection of a pesticide in drinking water, or in source waters for drinking water, may indicate a potential health risk, and to help them prioritize monitoring efforts.

The Federal Food, Drug and Cosmetic Act is administered by the Food and Drug Administration. The FDA is responsible for protecting public health by ensuring the safety, efficacy and security of human and veterinary drugs, biological products and medical devices. It ensures the safety of our nation's food supply, cosmetics, and products that emit radiation. It also regulates tobacco products.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA was first established in 1910 as the Federal Insecticide Act, which focused on protecting consumers from ineffective pesticides and deceptive labeling. The current FIFRA was enacted in 1947, but later amended in 1972 to the version that is in force today. It was enacted to protect applicators, consumers, and the environment, by regulating pesticides at the federal level. All pesticides sold in the USA must be registered with the EPA, and must bear the appropriate label.

As described in the section, *Life Cycle of a Pesticide*, any new pesticide must undergo numerous tests. These tests determine physicochemical properties of the pesticide, its toxicity, and its efficacy. EPA review is required at multiple points during the testing process. The company developing the pesticide pays a fee for the initial registration and all reviews. New tests are added over time as new impacts are discovered, and may be required of the company at review. For example, tests for impacts to pollinators are now required. This information is reviewed every 15 years and new tests may be required at this time. This process is so stringent and expensive that very few new pesticides come to market. This regulation only applies if the chemical is marketed as a pesticide (e.g. preventing, destroying, repelling or mitigating pests). *(Pesticide Labelling Questions and Answers, 2019)*

Based on these tests, a label is designed to communicate how to properly use the pesticide. For example, a label may require that the pesticide is only used on plants that are not currently flowering; this would reduce exposure for pollinators and may mitigate pollinator toxicity. The label is law and regulates how a pesticide may be stored, used and disposed of.

Monitoring and enforcement are done by the EPA's Office of Enforcement and Compliance Assurance (OECA). *(EPA, 2020a) (EPA, 2020b)* Inspections are carried out by qualified inspectors upon complaint. Their report and other required information from the individual or company being inspected are forwarded to the EPA for review. If necessary, civil actions like issuance of a notice of violation and an order directing the individual or company responsible to take action to come into compliance may occur. Further civil court judgments may take place which may involve settlements, civil penalties, injunctive relief or environmental cleanup projects

to remediate harm caused by the violation. Lastly, criminal penalties may be imposed that can levy federal fines or may include incarceration. Government funding, however, determines OECA personnel levels, which influences the agency's ability to provide oversight and enforcement. Reductions in funding can reduce the agency's ability to provide this oversight and enforcement.

When a currently registered pesticide is suspected of causing unpredicted toxicity, there is a process for challenging its registration. A complaint initiates this process. Complaints may come from those exposed, or may relate to new research (e.g. by academic researchers). This typically begins with an unofficial process that involves the EPA contacting the pesticide manufacturer and requesting that they investigate the issue and ameliorate the problem. If this fails, an official review process may be started that can result in the product being further restricted. For example, a pesticide may no longer be permitted on a certain crop. If this is insufficient to address the issue, the pesticide registration may be removed following the procedures outlined in Section 6 of FIFRA.

At any time, a company may voluntarily withdraw registration. This avoids a formal ban and leaves open the possibility of re-registration in the future. A formal ban can be challenging to overcome, while re-registration can be fairly straightforward. For example, Bayer Crop Sciences voluntarily withdrew aldicarb from the market in 2010 when facing a likely ban. Several years later, under a new administration, the EPA allowed its continued use. *(Ebersole, 2020)*

FIFRA regulates the sale and use of pesticides only in the USA. Companies can continue to manufacture and export pesticides outside of the country. This can include the out-of-country use of pesticides that are banned for all uses here in the USA, as well as out-of-country off-label use. *(Ebersole, 2020)*

Seed Treatment - A Potential Loophole in FIFRA

In 1988, the EPA established regulation 40, Code of Federal Regulations, which exempted seeds treated with pesticides from FIFRA regulation as long as they were treated by a pesticide already approved for that use, and as long as treatment was for the protection of the seed alone. Pesticides registered post implementation are not exempted for this purpose. Seeds were in general colored to indicate treatment to keep them out of livestock feed and food and oil production, but this does not protect wildlife from consuming such seeds once they are planted in fields (Figure 6). It is not clear how long the pesticide persists or remains in the plant after germination. The Federal Seed Act (1988) set out requirements for labeling treated seeds

Figure 6. Green bean seeds untreated (left) and treated (right).

transported across state lines which included the fact that the seeds were treated with pesticide, the common name of the pesticide and appropriate poison labeling.

Between 2012 to 2014, 90% of corn acres, 56% of winter wheat and 76% of soybean acres in the United States (U.S.) were grown from treated seeds. *(Hitaj, 2020)* Of the insecticides applied to seeds, neonicotinoids accounted for roughly 80%. However, farmers knew less about pesticides applied to their seeds than pesticides they applied in other ways. This is likely because seed is often sold with a 'default' treatment that contains a mix of different pesticides, and the treated seeds are exempt from some pesticide labeling requirements.

The EPA concluded that risks from exposure to treated seeds was covered by the registration process of the pesticide used for treatment. In 2016, a lawsuit was brought against the EPA to remove the exemption of pesticide treated seeds from FIFRA regulation. *(Science Daily, 2020)* A federal court in California sided with the EPA and let the exemption stand. At that time, however, the EPA put out a memorandum that gave refined guidance on the risk assessment process to include attention to soil incorporation and toxicity for birds and mammals. The memorandum did not include a discussion about increased health risks due to exposure during seed handling for farm workers and others. *(Penn State, 2020) (Health Canada, 2009) (Fang, L., 2020)*

Federal Food, Drug and Cosmetic Act (FFDCA)

The FFDCA was passed in 1938 to replace the Pure Food Act of 1906. It gave the Food and Drug Administration the authority to oversee the safety of food, drugs, medical devices and cosmetics. The act sets tolerances, or safe maximum residue limits, for pesticide residues on foods and allows for seizure if residues are found to be above those levels.

Food Quality Protection Act (FQPA)

The FQPA was passed in 1996 as an amendment to the FIFRA and FFDCA. It requires the EPA to include in its safety findings and risk assessments, with reference to pesticide tolerances, that all registered pesticides can be used according to the label instructions with “a reasonable certainty of no harm”. In addition, when reviewing pesticide tolerances, the special susceptibility of children must be accounted for by using a ten-fold safety factor when assessing these tolerances unless sufficient data has been collected to support a different safety factor.

Aggregate risk of exposure from all environmental sources (food, water, residential, and other non-occupational sources) must be considered as well as cumulative exposure to pesticides with common mechanisms of toxicity. Aggregate exposure only considers pesticides with the same mode of action. It also requires the review of pesticide registrations every 15 years to account for updated information that may affect usage and practices.

While the EPA establishes tolerances (maximum levels) for specific pesticides permitted on human or animal food, the FDA enforces these tolerances for domestic foods shipped in interstate commerce and foods offered for import into the U.S., except for meat, poultry, catfish, and certain egg products that are regulated by the U.S. Department of Agriculture. The FDA monitors a wide range of agricultural products for approximately 700 pesticide residues by selective testing. In addition, it monitors these residues in foods after they are prepared as they would be for consumption in its Total Diet Study program, which monitors contaminants and nutrients in the average US diet. It also carries out focused sampling surveys for specific commodities or selected pesticide chemical residues of special interest. Reports summarizing the test results are prepared and made available annually. The Pesticide Data Program (PDP) is managed by the USDA and maintains a searchable database of the results of sample tests for pesticides residues on many food crops. Where the EPA has not set a tolerance or an exemption for a tolerance, the FDA may set up an “action level” for a pesticide, which is a recommended level a contaminant not exceed. An action level may also apply to food or feed containing pesticide residue from sources of contamination that cannot be avoided, such as pesticides that persist in the environment. While the action level is not legally binding, the FDA may take enforcement action on a case-by-case basis. *(USGS, 2016) (Center for Food Safety and Applied Nutrition, n.d.)*

Clean Water Act (CWA)

The Federal Water Pollution Control Act of 1948 was significantly reorganized and expanded in 1972 to become the Clean Water Act. Water contamination by legacy pesticides (previously legal but no longer allowed pesticides) is managed under its regulations. It also regulates point source discharges of pesticides, both biological and chemical, that leave a residue in US waters. Where point discharges occur, operators are required to have permits under the National Pollutant Discharge Elimination System (NPDES) program. Under these regulations, permits are required for mosquito and other flying insect pest control, aquatic weed and algae pest control, and control of aquatic animal pests. The federal government sets minimum water quality standards for certain pesticide pollutants based on the toxicity of the pesticide and an acceptable risk level (e.g. a cancer risk of 1 in a million people). However, a very small percentage of all currently used pesticides have in-stream water quality standards. State and tribal governments may set more stringent standards. *(Riley, et al, 2011)*

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act (SDWA) applies to public water systems and their source waters. The EPA sets a Maximum Contaminant Level (MCL) if a contaminant meets the following criteria:

- It has an adverse effect on human health.
- It is known to occur or is likely to occur often enough and at levels of public health concern.
- Regulation presents an opportunity to improve public health (as determined by the sole judgement of the Administrator, the head of the EPA who is nominated by the President and confirmed by the Senate). *(EPA, 2020c)*

Public water systems must monitor for these contaminants and treat the water to remove them if they are found. Instead of setting a regulatory level, the EPA may set a non-enforceable health advisory. Private wells are not regulated by the SDWA.

Only 13 currently used pesticides are regulated with MCLs. *(Selvaggio, 2019)* An MCL requires that all water systems routinely test for the contaminant, adding an expense to maintaining the water system. Water systems are allowed to test for additional contaminants.

Worker Protection Standard (WPS)

The Worker Protection Standard (WPS) is the primary set of federal regulations intended to protect workers and their families from pesticide poisoning and injury. The WPS contains requirements for safety measures such as pesticide safety training for farmworkers, notification of pesticide applications, and emergency medical assistance. The program covers employees of farms, forests, nurseries and greenhouses who are occupationally exposed to agricultural pesticides and is managed by the EPA. *(Agricultural WPS, 2020)*

The protections were enlarged and updated in November of 2015. *(Agricultural WPS, 2015)* The changes increased the frequency and content of required training; included training recordkeeping requirements; adopted a minimum age limit (18 years) for handlers and early-entry workers; more closely aligned chemical hazard communication requirements (including a provision for a “designated representative” to access relevant records), eyewash requirements, and respiratory protection requirements with those enforced by federal OSHA; and introduced the concept of an “application exclusion zone” (AEZ), also known as a spray buffer zone. Only appropriately trained and equipped pesticide handlers can be present immediately in the treated or target area during pesticide application. *(Oregon OSHA, 2018a)* The AEZ expands the designated area within which other people cannot be present during application. *(Oregon OSHA, 2018b)* The AEZ surrounds and moves with spray equipment. The federal rules were phased in, with most of them taking effect January 1, 2017 and other provisions taking effect January 1, 2018. *(PERC, 2020)* For aerial spraying, if the applicator is required to use a respirator, workers are required to evacuate the area of application. If the applicator is not required to use a respirator, the workers can shelter in place. Depending on the quality of the shelter’s construction and maintenance, protection can vary a lot.

Despite all of the relevant provisions, the EPA has little ability to monitor how well regulations are working, and no way to determine, for example, how frequently agricultural pesticides drift onto, or otherwise make contact with, workers. *(Mayer, 2019)* An internal review by the EPA Inspector General in 2018 found that the Worker Protection Standard falls short in some areas:

- The EPA does not have the statutory responsibility or ability to collect data on incidents of agricultural pesticide exposure to measure the impact of the revised WPS rule among target populations. The agency does not receive funding, either for itself or states, to collect this data.
- The agency relies on information assessed during pesticide re-evaluations and from voluntary reporting databases.
- The EPA is working on improving its Incident Data System, but the agency stated that the improvements will not enable the collection of additional occupational exposure data. *(Brooks, 2018)*

As of 2015 the WPS requires that an agricultural employer display information at a central location readily accessible during normal work hours whenever a farmworker is present and within the past 30 days of a pesticide application or a restricted-entry interval for such a pesticide has been in effect. The information includes:

1. The name of the pesticide
2. The active ingredient(s)
3. The Restricted Entry Interval (REI) which is the time immediately after a pesticide application when entry to the treated area is restricted (can be minutes, hours or days)
4. The crop and the location and description of the site treated
5. The date and times the application started and ended
6. The hazard information contained on the OSHA Safety Data Sheet

In addition, they are required to:

1. Have updated emergency medical facility information with the posted information
2. Supplies for routine washing, immediate eye flushing and emergency decontamination must be provided to prevent or mitigate pesticide exposures
3. Keep records for 2 years from the expiration date of the restricted entry interval of the pesticide applied. These must be supplied upon request within 15 days of request.
4. Ensure all workers and pesticide handlers receive annual WPS training. *(Fults, 2016)*

In October 2020, however, the EPA finalized rules narrowing some of those regulations. *(EPA, 2020g)* The stated reason was to make the regulation more enforceable and reduce the burden of regulations on farmers. The changes rollback protections by amending the application exclusion zone requirements in the 2015 Agricultural Worker Protection Standard (WPS) rule. *(EPA, 2020d)* Among other things, the proposal would limit the AEZ to within the boundaries of the agricultural establishment so that the handler/applicator would not be responsible for implementing AEZ requirements off the establishment, where they lack control over persons in the AEZ. The reasoning behind those changes is that a regulatory requirement to keep individuals out of varying widths of areas surrounding treated areas was difficult for an agricultural employer to implement and next to impossible for a state trying to ensure compliance. *(Agricultural WPS, 2019)* However, applicators are still required to follow pesticide labels, which includes preventing drift off-site.

Agencies-Federal/State Interface

OSHA and the Army Corps of Engineers, while both federal agencies, work almost exclusively at the state level and in conjunction with state agencies.

Occupational Safety and Health Administration (OSHA)

OSHA is part of the Department of Labor and was created by Congress in 1970 under the Occupational Safety and Health Act. It provides enforceable standards to ensure safe and healthful working conditions for people in the American workforce and provides training, education and other assistance. It provides inspectors who assure compliance with all its regulations and covers most private sector employers and their workers as well as state and local government workers. Oregon OSHA administers and enforces WPS for Oregon.

Oregon OSHA has addressed certain issues (such as respirator requirements, eyewash requirements and chemical hazard communication) with more specificity than federal regulators. They adopted requirements that were essentially consistent with those imposed by both Oregon OSHA and the federal OSHA in non-agricultural workplaces. *(Oregon OSHA, 2018b) (Oregon OSHA, n.d.)*

In October of 2016, Oregon OSHA proposed WPS revisions to align with the new, more comprehensive, federal requirements. See the section on the *Worker Protection Standard* under Federal.

There are many issues that fall outside OSHA's authority and may not be well encompassed by any other agency. This includes the effect of pesticides on the broader community and general medical care among farmworkers. For medical care, OSHA has authority on the very limited situations related to workplace exposures, primarily related to medical screening and medical removal from the workplace.

U.S. Army Corps of Engineers (ACE)

The ACE has existed since 1775 and its mission has changed over time. Currently, in addition to its military missions, it plays major roles in dam maintenance and flood control, wetlands and invasive species management, decommissioning of nuclear power plants, and providing hydroelectric power. Management may include the use of pesticides. See section *Army Corps of Engineers-Oregon State Branch* information.

Agencies-State of Oregon

The Oregon Department of Agriculture (ODA) is the primary state agency involved in pesticide regulation. The Oregon Department of Forestry (ODF) uses pesticides in its role to protect, manage, and promote stewardship of Oregon's forests to enhance environmental, economic, and community sustainability. The Oregon Department of Environmental Quality (OR DEQ) also manages some permits and environmental pollution (see *Clean Water Act*), as does the Oregon

Department of Fish and Wildlife (ODFW). The Oregon Department of Transportation (ODOT) maintains roads, which may include the use of pesticides. The State Fire Marshall regulates storage of pesticides in relation to fire hazard. The Oregon State University (OSU) Extension Service is a combination of research and education efforts that support government agencies and the public.

While EPA is the primary regulator of pesticides, OR DEQ, ODOT, ODF, ODA, State Fire Marshal, ODFW and others all have a part, particularly OSHA (see section on *OSHA under Federal/State Interface*). They coordinate and enforce all the different rules and share investigative responsibilities.

Oregon Department of Agriculture (ODA)

ODA is the primary state agency responsible for pesticide regulation in Oregon.

Pesticide Registration, Rules, and Education

ODA defines a pesticide as anything that can kill, mitigate or control a pest. Pesticides that are approved by the EPA can be used in Oregon. Currently ODA has 14,000 registered pesticides listed in its database. It has contracts with Washington State University to maintain the Pesticide Information Center Online (PICOL, https://picol.cahnrs.wsu.edu/) which is the label database that can be searched for selected information on pesticide products registered in Oregon and Washington. All labeling is required to be compliant with federal labeling laws.

ODA sets the rules for pesticide application for agricultural, nursery and landscaping industries. It works within the framework of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which is a U.S. federal law that set up the basic U.S. system of pesticide regulation to protect applicators, consumers, and the environment. With FIFRA there is a risk-benefit analysis so that restricting one pesticide does not lead to use of a more toxic method to replace it. While ODA has a cooperative agreement with the EPA to regulate pesticides, its regulation can be stricter than the EPA regulations (but not more lenient). ODA reviews regulations as incidents occur which cause concern. Under the Oregon Pesticides Control Act, civil penalties can be levied against violators by these state agencies. The ODA also has the power to issue a Notice of Violation and may deny, suspend or revoke a pesticide applicator's license. *(Bond, 2020)*

In order to minimize pest infestations, like Japanese beetle or gypsy moth infestations, ODA may choose to apply pesticides in order to prevent them from spreading to larger areas in the state (Figure 7). ODA uses certified applicators for this. This proactive use of pesticides may minimize the total amount of pesticides needed by addressing the infestation while it is still small. It also minimizes negative impacts to food security and cost. *(ODA, n.d.-a)*

Figure 7. Invasive species of concern in Oregon in the Japanese beetle (left) and gypsy moth (right).

Where pesticides that are normally banned or restricted though FIFRA are deemed necessary for a specific pest by ODA, an emergency special needs application must be filed through FIFRA's section 18 for approval by the EPA before use. The application process may include a period for public comment if certain criteria are met. *(EPA, 2020e)*

ODA balances the safety of people, bees, ground water, etc. with agriculture, food security and food cost. Integrated Pest Management (IPM) is an effort to minimize pesticide use, as opposed to banning potentially harmful pesticides, while maintaining benefits. One example of the ODA's IPM efforts is its rule prohibiting applicators from using neonicotinoids on blooming linden trees, which are very attractive to bees. This rule comes with enforcement power. Another example is that all schools are required to have an IPM plan, with pesticides being used as a last resort. Low impact pesticides are spelled out in the criteria written by the legislature. This allows for pesticide use contingent on notification to parents and on-site warnings.

Pesticide Applicator Licensing

The ODA manages licensing for pesticide applicators. There are approximately 13,000 state certified applicators across the state. Certification requires education and the passage of various proficiency exams. Commercial and public applicators are required to pay renewal fees every year while private applicators must renew only every five years. Applicators take continuing education courses or must retest every five years after the initial exam as well. These courses may include Integrated Pest Management (IPM) training, one of the goals being the protection of pollinators, especially bees. Pesticide risk reduction training (e.g. off-target drift reduction) is also included in many of the courses offered to licensed applicators. In Oregon, California, and Washington, their training may also include respirator use (not an EPA rule). In Oregon, there is a 4-hour class on respirator use. Unfortunately, current applicator training is in English and not available in Spanish or other dialects, although there are efforts to change that.

Protection of Farmworkers

Regulations that protect farm workers are different than those that regulate residences, schools, etc. Also, ODF and OSHA regulations are different from ODA regulations. Most of the protections for farmworkers are under the Worker Protection Standard and OSHA. ODA

recommends early morning for spraying because there is less likelihood of drift. If the pesticide label lists a buffer zone, where no spraying is allowed, the label instructions must be followed.

Inspections, Complaints, and Violations

There are routine and complaint-based inspections for any business “operators” applying pesticides in and around someone else’s property. Routine inspections are done every three years on a rotating basis and may include review of records of applications and amounts used. Records for restricted use pesticides are required to be kept for two years and inspections may include comparing purchase records with records of use. However, there is no ability to compare purchase records with records of use for general use pesticides because records for sales of general use pesticides are not required. ODA inspectors can go into a building and conduct sample testing to see that pesticide was applied in the correct area but can only determine the amount present at the time the sample was taken, not the amount initially applied.

Complaints are handled through the Pesticide Analytical and Response Center (PARC) system. *(PARC, 2018)* PARC was created by executive order in 1978 and reauthorized in 1991 under ODA as ORS 634.550. Both forestry and agricultural complaints (health and environmental) from neighbors suspecting pesticide rule violations can be made via a hotline. The board is composed of various experts from eight member agencies:

- Oregon Health Authority (OHA)
- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Department of Environmental Quality (DEQ)
- Oregon Department of Forestry (ODF)
- Oregon Occupational Safety and Health Administration (OR OSHA)
- Office of the State Fire Marshal (SFM)
- Oregon Poison Center (OPC)
- Oregon Department of Agriculture (ODA)

The board, which includes toxicologists, reviews the incidence reports to decide whether to conduct an investigation and to which agency the investigation should be assigned. The board consults with a toxicologist associated with OSU if additional expertise is required. However, PARC does not have regulatory authority. The investigating agency is responsible for enforcement.

While users are required by law to follow labelling instructions, some users, particularly unlicensed users, may not be careful about reading or following directions on pesticide containers. More than one-third of ODA investigations are based on homeowner complaints against neighboring homeowners, handled through PARC. First time offenses for improper use by a homeowner usually involves a friendly chat with ODA inspectors. They are given a letter of advisement so that there is documentation of a violation. Continuing violations can involve sample testing and fines for violators. ODA has provided funding ($50,000) to OSU to look into how people are making pesticide use decisions.

Exemptions and Inconsistencies

Other problem areas exist where regulations aren't nationally consistent. For instance, applicators for a multi-family dwelling like an apartment building are not required to have any training or licensing. Such an individual frequently does many other jobs. Oregon also has a provision in the statute that provides a landscaper exemption which allows this group to avoid licensing because they are considered "small amount" users who do not advertise or charge their customers separately for spraying pesticides. Finding ways to reach out to unlicensed users is difficult, especially since they may be acting legally but are not educated in proper use. Licensed applicators must compete against these unlicensed applicators. Some states do require licensing for these people, but Oregon does not.

Oregon Department of Forestry (ODF)

The Oregon Department of Forestry (ODF) regulates forestry spraying. Ninety percent of pesticides used by ODF are herbicides. In 1971, the Oregon Legislature adopted the Forest Practices Act (FPA), which was the first law of its kind in the U.S. to balance the needs for responsible forestry and protecting natural resources. In a process that incorporates public input, the Board of Forestry – a seven-member citizen board appointed by the governor and confirmed by the state Senate – approves detailed rules to implement the Act's requirements. PARC, as described in the ODA section, handles complaints.

The FPA set standards for building and maintaining roads, harvesting trees, applying pesticides, and replacing harvested trees. It has been modified many times since then to improve timber harvesting practices while protecting wildlife, soil, and water. FPA requires that timber clear cuts are replanted within two years, and that trees must be "free to grow" unencumbered by vegetation or other serious problems within six years. *(Perkowski, 2018)* Aerial pesticide spraying plays a key role in preventing weeds and other pests from dominating young trees.

Restrictions on mixing and application exist. *(Perkowski, 2018)* Pesticide preparation, including mixing and loading, must occur more than 100 feet from fish-bearing streams and those used for domestic water.

Oregon passed increased aerial spray restrictions in July 2020 with SB 1602. These new aerial spray restrictions are the result of a Memorandum of Understanding signed in February 2020 between conservation groups and timber industry representatives with the help of the governor's office. This legislation increased the buffer zone and strengthened reporting requirements and data access. (See *Conservation-Timber MoU and SB 1602*.)

Army Corps of Engineers-Oregon State Branch

The Army Corps of Engineers (ACE) has several project regions in Oregon including the Columbia River Basin, the Willamette River Watershed and the Umpqua River Basin. The ACE maintains many dams throughout the state including the John Day and Bonneville Dams and 13 dams in the Willamette Watershed as well as some land/habitat management and restoration

projects. It follows IPM practices that use pesticides as a last option and follows federal and state regulations.

Since IPM requires much more labor-intensive efforts, crews of high school students are often hired for the physical labor of weed removal and habitat restoration. One of the keys to their efforts is training staff for early detection of invasives. While it is clear that there is a strong effort to use IPM protocols, there was an acknowledgement that those practices mean different things to different people in different areas.

The Corps also has trained and licensed applicators and periodically hires outside professional applicators. The majority of the pesticides they use are herbicides much of it for noxious and invasive weed control. For insects and rodents, they use mechanical means.

Efforts are made for Early Detection Rapid Response (EDRR) as much as possible. The principle of EDRR is to detect pests as quickly as possible while the infestation remains small, and rapidly respond with pest control. This in turn minimizes effort needed for control of both aquatic and land-based weeds. While in general they do not use restricted use pesticides, if needed they have gotten special local needs permits to treat certain areas where they are working to restore native habitat. After weed removal they reseed with native, locally grown fescue grass seed to prevent return of the tall grass invaders. They predominantly use glyphosate and a newer choline formulation of triclopyr that has reduced volatility, making it safer for applicators.

State regulations are not consistent, and ACE must follow these state by state. One example of variation by state is pesticide application along the Columbia River, typically done near their dams. They must report any applications closer than 3 feet to the water on the Oregon side but closer than 10 feet on the Washington state side because of differences in state regulations. Further research should consider whether the buffer distance for reporting alters pesticide use. For example, is it common to apply up to 10ft on the Washington side and up to 3ft on the Oregon side?

Oregon Department of Environmental Quality (OR DEQ)

The Oregon Department of Environmental Quality (OR DEQ) is charged with restoring, maintaining and enhancing the quality of Oregon's air, land and water. It monitors water and ambient air quality by testing for levels of pesticides and other pollutants to minimize the risk of exposure to toxics for Oregonians. 120-140 pesticides and break down products are tested for in surface and groundwater, and attention is paid to the cumulative risk of the toxics detected.

However, approximately 90% of current-use pesticides do not have Clean Water Act (CWA) criteria set by the Office of Water division of the EPA. The CWA criteria set by the EPA is reviewed by OR DEQ and then accepted or set as more stringent; these criteria are regulatory and can be enforced. CWA criteria are scientifically based, considering the inherent hazard of the toxic substance and likely exposures. The most vulnerable aquatic species are considered, with data on multiple trophic levels (fish/vertebrates, invertebrates, and algae). There is a lag

time between when research reveals toxicity and when EPA sets criteria due to the time needed to review the science. There is another lag time between when EPA determines CWA criteria and when the state adopts it; this is reliant on OR DEQ having the resources (funding) to evaluate the EPA CWA criteria and determine if the values Oregon adopts should be the same or more stringent. In some cases, tribal governments may accept or set more stringent standards.

While pesticide registration requires many toxicology assessments, it does not necessarily cover all of the assessments necessary to set CWA criteria and EPA does not set CWA criteria for all registered pesticides. However, most current-use pesticides do have aquatic life and human health benchmarks set by the Office of Pesticides division of the EPA. The benchmarks set by the Office of Pesticides are non-regulatory guidance values, and may not include all aquatic species evaluated for CWA criteria. These can be used under the general mandate that no one may pollute Oregon's waters with toxic chemicals. *(Chapter 468B, 2019)*

While monitoring point sources like effluent from pipes or smoke stacks is in general straightforward, monitoring non-point sources is more complex. Most non-point sources are from farm runoff and drift, and forest or roadside spraying but, especially in urbanized areas, storm drain runoff is also a non-point source. While individuals using pesticides on their lawns or around their buildings may be abiding by labeling instructions, the cumulative runoff to storm drains in densely populated areas may exceed permitted benchmark water levels. Routine inspections are in general not carried out although specific sites of certain facilities may be tested. In general testing occurs as the result of the filing of a complaint.

Much of the effort to control non-point sources involves the Pesticide Stewardship Partnership (PSP) Program, a voluntary collaboration between pesticide applicators/users, local watershed organizations (e.g., soil and water conservation districts, watershed councils), state agencies (DEQ, ODA, ODF, OHA), tribal governments and OSU Extension Service.

The program intends to identify potential water quality concerns and improve water quality affected by pesticide use through monitoring of water contamination, and, when found, encouraging voluntary changes in pesticide use and crop management. The partnership produces a biennial report that documents test findings, strategies for change and demonstrated improvements in water quality that result.

About 70% of PSP monitoring sites found to be contaminated have seen reductions in these levels between the 2015-17 Biennium and the 2017-19 Biennium using recommended voluntary management changes. Examples of these efforts to affect change are training users to minimize erosion of contaminated soil into bodies of water and efforts to prevent pesticide drift over communities. Reduction efforts are most effective in areas where there is less diversity in crops because it is easier to pinpoint the source of pesticide contamination. *(Cook & Masterson, 2019)*

While the DEQ does not deal with complaints for incidents like over the fence drift onto a neighbor's property, it does investigate releases of high concentrations of pesticide or

hazardous waste onto property that not only contaminates land but possibly water and air. This is viewed as a spill and can require clean-up under EPA and state regulations.

The DEQ also investigates incidents of community wide contamination/exposures. It acts through PARC in collaboration with the ODA, ODF, OHA, Oregon OSHA and several other state agencies to investigate and collect data from pesticide-related incidents that have suspected health or environmental effects. Regulatory authority, however, rests not with PARC but with its partner agencies.

Certain pesticides like malathion and chlorpyrifos have been found in surface water that exceeds permitted state water quality criteria in agricultural areas. In some instances, spiking levels are sporadic, as opposed to continuous. Under the Clean Water Act there are mechanisms for the DEQ and the EPA to implement quality management plans in waters that exceed total maximum daily loads of pesticides (or other regulated pollutants) if voluntary efforts like the PSP program do not sufficiently reduce the loading. In urban areas, herbicides like Roundup (glyphosate) have been found at high frequencies, but usually not above EPA's non-regulatory benchmark levels in streams.

The DEQ also develops and implements pesticide water quality "general" permits under the federal Clean Water Act (National Pollutant Discharge Elimination System, NPDES) permitting authority. Specifically, OR DEQ requires a permit for any pesticide application in, over, or within three feet of water. General permits include requirements that all covered dischargers must follow, although site or operator-specific plans are often a required element of these types of permits. The pesticide general permits include discharge limitations, minimum monitoring and reporting requirements, and compliance conditions and schedules.

Pesticide collection events are held by ODA and DEQ periodically through the Pesticide Stewardship Partnership Program to reduce risks of pesticide releases to surface and groundwaters, as agency funding permits. These events are helpful in removing older unused or unusable stocks of pesticides from properties, especially after a registered pesticide has been further restricted or banned from sale. At those times the EPA usually gives leeway for continued use of stockpiles of already sold pesticide until a certain date after which it cannot be used. One example of this was azinphos-methyl (Guthion) which was a broad-spectrum organophosphate insecticide that was phased out by the EPA over the course of 12 years from 2001 to its total ban in 2013. It was initially restricted to fewer and fewer crops until its ban, but excess could not be resold by farmers who were no longer allowed to use it to farmers who were still permitted its use.

Without in-stream water quality standards, there is no mechanism to enforce control of pesticide levels found in water. Thus, as the majority of pesticides lack these standards, voluntary collaborations with users are the only option for most pesticides. The Oregon Water Quality Pesticide Management Team (WQPMT) designates pesticides that pose concerns in Oregon waters for monitoring, evaluation, and stewardship outreach and assistance. These designations are based on the concentrations of pesticides relative to EPA benchmarks and the

frequency of detection of pesticides. The WQPMT is an interagency group that facilitates and coordinates water quality activities that not only include monitoring, analysis and interpretation of data, but also effective response measures and management solutions. The initial goal of the WQPMT was to develop and implement a statewide pesticide management plan (PMP), which was approved by EPA in 2011. This team now also oversees the statewide implementation of the PSP Program. *(Masterson, personal communication, 2020, August) (EPA, 2006) (ODA, n.d.-d)*

Oregon Department of Transportation (ODOT)

ODOT is responsible for maintaining over 19,000 miles of highway and 50,000 acres of right-of-way. Vegetation is managed to prevent its encroachment on the highway; maintain adequate sight distance around curves; increase sign visibility; minimize potential for falling trees; reduce animal vehicle collision rates; reduce fire fuels; and allow proper drainage off the highway which, in addition to improving safety, also preserves pavement longevity. It currently does this by a combination of mechanical, chemical, cultural (e.g. influencing behavior and habits) and biological methods to control noxious and non-noxious vegetation along highways. Between 2010 and 2015 it reduced its use of herbicide by about 44 percent by use of these integrated vegetation management methods. However, there have still been incidents like the old growth tree die-off near Sisters and another incident where herbicides used near La Pine accidentally killed hundreds of trees and contaminated the drinking water in the area. This suggests the need for more detailed regulation of pesticide use and training of the applicators ODOT uses. *(ODOT, 2016)*

OSU Extension Service/Oregon State University

The OSU Extension Service runs two key education and training programs. The Pesticide Safety Education Program (PSEP) provides safety training for farm workers and employers, and training and re-certification training for licensed pesticide applicators. The Pesticide Educational Resource Collaborative (PERC) supplies training manuals to agricultural employers, workers and trainers of those workers.

Several faculty in the Department of Agricultural Science also work out of the Extension service which provides information and expertise focused on maintenance of healthy agriculture and forestry practices that protect the community, economy and natural ecosystems. Currently Associate Professor (Practice) Kaci Buhl is the PSEP Director and the PERC Deputy Director and oversees dissemination of information about hazards of 70,000 pesticide products (and 1100 active ingredients) to the public on a phone line. People who have questions or concerns about the impact of possible exposure to pesticides they have used can call the line to get relevant information.

Professor Jeffrey Jenkins is an Agricultural Experiment Station researcher, Extension Specialist, and Director of the National Pesticide Information Center at OSU. His expertise encompasses analytical and environmental chemistry, ecotoxicology, watershed scale modeling, and human and ecological risk assessment. His outreach and research interests focus on the use of

chemicals in agriculture and forestry. He works with producers, regulators, and stakeholders to balance goals related to production and environmental protection at the local, state, national, and international levels. He has worked with the UN Food and Agricultural Organization, the USDA Foreign Agricultural Service, and NGOs on capacity building for food safety, security, and rural livelihoods in the developing world.

There are also other faculty who carry out research studying the effects of pesticide use on people, animals, specifically pollinators, and the environment. One example is Professor Andony Melathopoulos who studies pollinator health statewide. This work includes not only honeybees but all populations of native bees (several hundred species). He is attempting to set up a group that counts bee populations in the same way the Audubon Society does bird counts so that he can have a more scientific method of following bee population declines as a metric for pollinator health. Much of his and others' work gives state agencies and the public new methods to diminish the negative impact of pesticide use on the environment and direct best practices and regulations. Some examples are planting corridors of bee attracting plants like vetch, clover and hedgerows near but outside of pesticide sprayed crops may help lessen and mitigate the effects of their exposure to pesticides. Spraying at times bees are inactive, like evenings and cooler temperature periods, is another way to mitigate the effects of spraying. Specific timing of seasonal spraying can also impact pollinator health. Linden trees are very attractive to bees while they are flowering but much less so after the bloom is done. Avoiding spraying linden trees at bloom time lessens danger to bees (Figure 8). This is related to the Wilsonville incident of 2013. This is probably true for other plants as well. Not drenching the soil around the base of trees with pesticide is also something Melathopoulos recommended. Sometimes just spraying the perimeter of a crop field is as protective against plant pests as spraying the whole field.

a): *b):*

Figure 8. (a) A bee harvesting nectar from a linden tree flower. (b) A beekeeper holding dead bees.

Several faculty stated that paying attention to using the least damaging pesticide necessary to achieve crop protection is an important aspect of Integrated Pest Management. One example spoken of was the fact that cyano-group neonicotinoids (e.g. acetamiprid) seem to be less toxic to pollinators than the nitro-group neonicotinoids (e.g. imidacloprid, clothianidin). This kind of information is critical to development of best practices rules for pesticide use.

Together, the research, cooperation, and knowledge of professionals at the OSU extension service allow stakeholders to make thoughtful decisions about ways to mitigate hazards of pesticide use and may inform future legislation to improve outcomes.

State Fire Marshal

The State Fire Marshal (SFM) requires information about the quantity of and location of a pesticide's storage at a facility if reportable amounts are present. The Fire Department, as a first responder agency, may be called into a pesticide related incident where they need to know what kinds of hazards their Hazardous Materials Response Teams (HAZMAT) may face fighting a fire where hazardous materials are present. They also need to know what steps need to be taken to protect people and the environment in such an area. The Fire Marshal's Office also helps PARC investigate such incidents. *(Heffner, n.d.*)

Oregon Department of Fish and Wildlife

The Oregon Department of Fish and Wildlife's (ODFW) mission is "To protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations." The ODFW is the agency that issues permits for wildlife control operators to control furbearers, unprotected mammals (excluding moles) and western gray squirrels causing damage, creating a public nuisance or posing a public health or safety concern in incorporated city limits and associated urban development areas. The use of pesticides in natural habitats is also a concern for ODFW, as even low concentrations of pesticides may have the potential to directly and indirectly affect fish, wildlife and their habitats. Impacts to the food web and changes to the ecosystem over time are of special concern, as well as disturbance to wildlife as a result of frequent surveillance or treatments. As a result, ODFW encourages least harmful alternatives for vector control as part of an Integrated Pest Management (IPM) Plan while recognizing that, given a disease outbreak, additional means of control may be used to contain it and prevent any escalated harm to human health. The ODFW also has a Guidance Document that outlines ODFW's recommended treatment protocol for sensitive areas of the State in order to provide protections for ODFW's statutory mandates. *(ODFW, n.d.) (Faucera, 2014)*

Oregon State Regulation updates

In the last several years several state laws and rules changes have been proposed and/or enacted. See Appendix 1 for an overview.

Oregon Counties and Cities

Pesticide use practices by county government departments vary from county to county. While all counties must follow federal and state regulations, each implements pesticide policy in their own way. In each county the Departments of Public Works, which includes road maintenance crews, Parks Departments, and Departments of Public Health have responsibilities that may require the use of a pesticide or biocide. Like counties, cities and towns are required to follow all federal and state regulations as well as county ordinances. With a few exceptions they do not make

their own regulations dealing with pesticides. See Appendix 2 for examples of the different ways Oregon counties and cities implement government regulations.

Impacts of and Issues Surrounding Pesticide Use

Because pesticides are essentially chemical poisons or biological agents that make compounds toxic to certain species, their use must be considered in the light of their overall effects. In this section we discuss aspects of their use and regulation with that fact in mind. While pesticides are brought to market after extensive research and testing, we constantly learn new information about environmental ecosystems and human and animal physiology that may cause us to reexamine how, when or if they should be used. As human populations have increased, the need to develop a safe and stable supply of food and non-food crops has also grown. Control of disease carrying insects and animal carriers is increasingly necessary, especially as the global climate changes. These benefits must be balanced with the potential harm their use may cause.

Environmental Groups

Much of the research and data collection following the effects and impacts of pesticide use is fostered by environmental groups and conducted by scientific faculty at universities and agricultural extension services. These groups and researchers have voiced concerns about the negative impacts of pesticide use for many years and have worked to elucidate the effects and suggest practices and legislative remedies to protect people, animals and the environment. See the work of Beyond Toxics, Save the Bees, and the Xerces Society in Appendix 3.

Farming and agriculture

Farmworkers and their families

An estimated 1.1 billion pounds of pesticides are applied to crops in the U.S. each year. *(Atwood, 2017)* An increasing number of U.S. consumers have reduced their consumption of foods grown with pesticides in order to protect their family's health, *(Gelski, 2019*) but farmworkers are regularly exposed to high levels of toxic pesticides where they work and live. That level of exposure can be many times greater than consumers' exposures to pesticides. The work environment contributes to the difficulty in ascertaining health status and their association with pesticide exposure. *(McCauley, 2006)*

In 2018, Oregon OSHA reviewed scientific records and reached the following conclusions about the general risks faced by farmworkers and their families in relation to pesticides:

- Pesticides, as a group, represent a hazard to those exposed to them, although the exact nature of those hazards – as well as the degree of certainty about those hazards – varies from pesticide to pesticide (and particularly between classes of pesticides).
- Farmworkers, in particular, remain at meaningful risk of exposure to pesticides in the workplace.

- Off-target pesticide drift remains a genuine risk to farmworkers and their families, even if its extent cannot be fully enumerated.
- Existing rules do not fully eliminate the risks or provide workers with the necessary information to do so. *(Oregon OSHA, 2018b)*

Pesticide exposure causes farmworkers to suffer more chemical-related injuries and illnesses than any other workforce nationwide. *(Calvert, 2008) (Hansen, 2003)* According to estimates from an EPA report from 1992, occupational exposure to pesticides poisons as many as 20,000 farmworkers every year. *(EPA, 1992)* Those figures are probably far too low. Many factors contribute to the underestimation of the problem, including medical misdiagnosis, affected workers unable or unwilling to get medical care, and the lack of a coordinated national incident reporting system.

Pesticides can present a hazard to applicators, to field workers reentering a sprayed field, to family members because of take-home contamination, and to rural residents via air, ground water and food. Workers may be exposed to pesticides in a variety of ways, including: working in a field where pesticides have recently been applied; breathing in pesticide "drift" from adjoining or nearby fields; working in a pesticide-treated field without appropriate PPE; eating with pesticide-contaminated hands; eating contaminated fruits and vegetables; and eating in a pesticide-contaminated field. Workers may also be exposed to pesticides if they drink from, wash their hands, or bathe in irrigation canals or holding ponds, where pesticides can accumulate. *(US-OSHA, n.d.)*

Even when not working in the fields, farmworker families, especially children, are also at risk of elevated pesticide exposure. Workers bring pesticides into their homes in the form of residues on their tools, clothes, shoes, and skin. They can inadvertently expose their children through a hug if they cannot shower after work. *(Lu, 2006)* The vehicle used to transport workers to and from the fields serves dual purpose as the family vehicle as well and is often contaminated. The close proximity of agricultural fields to residential areas results in aerial drift of pesticides into farmworkers' homes, schools, and playgrounds. *(Goldman, 2009)* Often housing for farmworkers and their families is located adjacent to orchards or crops that are routinely sprayed with pesticides, some as close as only 15 feet away.

Figure 9. Farmworker housing in Oregon, 2017. Credit: Beyond Toxics

In Oregon, as the cost-of-living increases, workers often find that the only affordable housing that is available to them are units offered by

their employers and tends to be close to the orchards and fields where they work (Figure 9). This means that farmworkers and their families are more likely to be exposed to pesticides at home. Given that a substantial proportion of farmworker housing is often old, not well sealed from the outside and sometimes not fully enclosed, a shelter-in-place option is not necessarily protective. *(Burns, 2018)* A number of studies in homes near treated fields have shown "concentrations of agricultural pesticides in carpet dust are higher in residences closer to treated fields and in farm homes" *(Gunier, 2011)* than in other residences, which suggests that drift and other unintentional pathways result in higher pesticide exposures. The data on actual health effects from such exposures is less clear. Most workers and worker representatives advocate that the option to shelter in place should never be available. *(Oregon OSHA, 2018b)* Alternatives could include shelters that are outside the AEZ, or workers could be required to leave the shelters and go outside of the AEZ.

ODA recommends early morning spraying due to a decreased likelihood of drift. In recent years, growers and their representatives have raised concerns about the impact on farm workers and their families (and on the entire operation) if the rule were changed to require removal of workers and their families from housing in the AEZ in order to apply pesticides, especially during the late night and early morning hours. A review of the federal record makes it reasonably clear that the EPA had not specifically considered the implementation of the rule in relation to worker housing located in or near orchards and other agricultural operations. Some grower and grower representatives also raised concerns about the impact on packing and other processing operations that would fall within the AEZ. *(Oregon OSHA, 2018b)*

Farmers are usually only responsible for notifying their own workers that a pesticide will be sprayed in the field in which they are working. The law doesn't always require companies to warn surrounding farms of aerial spraying. Advocates claim that penalties for pesticide poisoning offenses are toothless, and that there is little accountability. Some schoolyards are directly adjacent to fields of crops that are sprayed with pesticides. *(Foy, 2019)*

Rural communities also face a greater potential exposure to pesticides via mechanisms similar to those exposing farmworkers and their families at their homes. Residences near treated fields have higher concentrations of agricultural pesticides than other residences. *(Arcury, 2006) (Salvatore, 2008) (Dereumeaux, 2019) (Foy, 2019)*

In addition to the acute consequences of pesticide poisoning, pesticide exposure can lead to chronic health problems, including cancer, respiratory disorders, infertility, and neurological disorders. *(Exposed and Ignored, 2013)* These chemicals can also contaminate the air and water, a burden disproportionately borne by these rural communities. Conclusions of studies and reports usually concern the rate of acute illness rather than addressing the effects of chronic exposure.

Weakness in the Exposure Reporting Systems

The EPA Pesticide Incident Monitoring System was in existence for a decade until 1981 when it was closed down within the first year of the Reagan Administration. After its closure any kind of

information gathering about adverse effects from pesticide exposure/poisoning relied upon the states. In Oregon, the Pesticide Exposure, Safety, and Tracking (PEST) Program handles tracking of health effects related to pesticide exposure. The National Pesticide Information Center (NPIC) describes the current procedure when a suspected pesticide poisoning/exposure occurs as:

1. Call the Poison Control Center.
2. Report the exposure to the state pesticide regulatory agency. In several states, law requires physicians and health care providers to report pesticide-related illnesses.
3. Consider reporting the incident to the manufacturer who is required to submit an adverse effects report to the EPA.

This puts the onus on patients and their doctors to understand that the ill-effects they are experiencing are from pesticide exposure. In a blatant case of acute exposure, that may be possible but is highly unlikely in the case of low-level, long-term exposures. There is no central database of incidents and effects at the national level to which doctors may refer for information about symptoms and treatments for such exposure/poisonings. A few states, like California, have instituted statewide databases of pesticide exposure incidents. For federal involvement, it requires that the manufacturers, those with the least benefit from such reporting, are responsible for notifying the EPA.

In addition to the lack of reliable statistics on pesticide use and pesticide-related farmworker injuries, there is insufficient research on pesticides' impact on farmworkers' health. Government funding limitations continue to restrain regulation, enforcement, and research on the issue. For instance, the 2008 Farm Bill included language authorizing a pesticide research program, which would conduct longitudinal studies of farmworkers' and their families' increased risk of cancer or birth defects from pesticide exposure. Congress never appropriated funding for this important research. The Farm Bill that passed the Senate in 2012 no longer contains any mention of pesticide research.

Recent budget proposals seek to provide less funding for such information. The federal budget for President Obama's fiscal year 2013 eliminated funding for several programs aimed at gathering data on pesticide use and preventing occupational exposure to farmworkers including:

1. The Pesticide Recordkeeping Program (PRP) at the USDA, which is the sole federal recordkeeping tool for pesticide applications. It required certified restricted-use pesticide applicators to maintain records of what pesticide is used, when, and where. The data gathered under this program is used by health professionals providing treatment to persons with known or suspected exposure to pesticides.
2. The Education Research Centers (ERCs) established to help develop and expand existing occupational health and safety training programs and to provide continuing education courses for healthcare specialists practicing in the field. These centers offered an important training forum for clinicians to address occupational health and safety.
3. The Agricultural, Forestry, and Fishing (AgFF) program within the National Institute for Occupational Safety and Health (NIOSH) was established to identify the most critical

> issues in workplace safety and health within the industrial sector and to develop goals and plans for addressing those needs.

However, congress did include funding for these programs in the final budget.

Given the scarcity of current research efforts on farmworker health, programs of this nature should be expanded and fully funded to provide adequate information that will allow the EPA to make informed decisions during the risk assessment process *(Exposed and Ignored, 2013)*. There are still some important studies that have been done and are ongoing with important implications for human health. One is the UC Berkeley Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) Study started in 1999 that is a longitudinal study of the effects of pesticide exposure on 600 pregnant farm workers and the children they gave birth to. It followed their growth, health and development assessing them every 1-2 years until adulthood. It has produced almost 150 publications shedding light on the impact of these exposures. *(Freinkel, 2015)*

In Oregon, pesticide poisoning is a reportable condition by state law that requires all healthcare providers and laboratories to report suspected and confirmed pesticide-related illnesses within 24 hours. The PEST Program, under the Oregon Health Authority (OHA), tracks and investigates health effects reported by people exposed to pesticides. *(OHA, n.d.) (CDC, 2017)*

Pesticide poisonings are thought to be more widespread than what is officially reported, especially with regards to farmworkers. Many researchers believe that the number of pesticide poisonings is much larger than that actually reported. One reason for that is there is no national recording or monitoring system for exposure-related injuries. While 30 states require health professionals to report pesticide poisonings, only 12 have the resources and capacity to actively investigate, classify, and document reported cases. *(Exposed and Ignored, 2013)*

The EPA has indicated that up to 95 percent of pesticide exposure incidents involving farmworkers or pesticide handlers are not reported. According to the EPA's Economic Analysis of the Agricultural Worker Protection Standard Revisions, if even just 10 percent of acute poisonings are reported, the quantifiable benefits of the revised WPS would be about $2.6 million annually, due to avoiding medical costs and productivity losses. While they were unable to quantify benefits due to a reduction in chronic exposure to pesticides, the EPA observed that farmworkers and families have higher incidences of six chronic conditions, ranging from asthma to cancer, and a mere 0.8% reduction in these incidences would generate significant benefits, readily covering the costs of the WPS revisions. *(Office of Pesticide Programs, 2015)*

Documented Adverse Human Health Outcomes

While more research is needed to fully understand the potential for adverse human health outcomes from real-word pesticide exposure, there are some documented examples of adverse medical outcomes. These are most evident in highly exposed or vulnerable populations, such as farmworkers and their children.

Organophosphate and N-methyl carbamate pesticides are two particularly dangerous classes of pesticides. Washington State University has a study looking at levels of cholinesterase activity in farm workers exposed to pesticide. Cholinesterases are a class of enzymes that affect neurotransmitter function and therefore the ability to transmit nerve impulses. Organophosphate and N-methyl carbamate pesticides are insecticides, which cause toxicity both in the pest and in non-pest species (such as humans) by inhibiting acetylcholinesterase. They inhibit the enzyme by binding to its active site and are among the most toxic substances produced by modern chemical technology. Depending on exposure levels symptoms can be anywhere from mild, such as tiredness, blurred vision and headache, to severe including difficulty breathing, low blood pressure, tremors, slow heartbeat, and even death.

The CHAMACOS study found an adverse effect of organophosphate pesticides on neural development and the IQ of children of farmworkers. Studies have demonstrated that children exposed prenatally to the organophosphate chlorpyrifos have lower IQs (3 - 5.3 percentage points, depending on age and exposure). This kind of small shift in IQ can have an outsized effect when viewed at the population level; a 5-point decrease in IQ across a population doubles the number of children with an IQ <70, with a corresponding decrease in children with an IQ >130. *(Lanphear, 2015)* Considering that chlorpyrifos is one of many chemicals implicated in developmental neurotoxicity, the overall impact to each individual child and to society are likely even greater. Another study in progress is recruiting pregnant women near agricultural fields to study the effects of glyphosate on their children comparing results to pregnant women recruited from urban areas. *(Cuthbert, 2018)*

In employment sectors other than crop production, medical monitoring of workers who handle these pesticides is routine, recommended, and often mandatory. *(US-OSHA, 2009)* California and Washington have mandated a system to monitor the blood of workers who regularly handle these types of pesticide, *(Exposed and Ignored, 2013)* but Oregon has not. While Oregon does have a Pesticide Exposure, Safety and Tracking Program (PEST) run by the Oregon Health Authority, it is investigative, after the fact, and not a surveillance program. In California, the law requires physicians to report any illness known or suspected to be caused by pesticide exposure. California County Agricultural Commissioners investigate the exposure circumstances within the state. California's Department of Pesticide Regulation's (CA DPR) Illness Surveillance Program collects and evaluates incident reports. The program then reviews the collected information and enters it into a database. California's program makes illness monitoring a priority. CA DPR officials said they plan to develop a mobile phone application that will encourage agricultural workers, pesticide handlers, and the general public to report suspected pesticide poisonings and injuries. *(Brooks, 2018)*

By periodically measuring nervous system effects of exposure to organophosphate and N-methyl carbamate pesticides, excessive exposure can be detected before symptoms appear. Establishing a national requirement to monitor the exposure levels of workers who regularly handle such pesticides would provide information about occupational pesticide poisonings. Medical monitoring not only protects workers by alerting them to overexposure before overt symptoms present; it also helps to capture pesticide exposure incidents that might otherwise go

unreported. *(Messages from Monitoring, 2005) (For Public Health and Healthcare Providers, n.d.)*

While we have identified some specific pesticides and their impacts on human health here, this information is not exhaustive and does not cover all potential human health impacts of all pesticides, legacy or in use. The examples given here are to help inform policy decisions. *(Konkel, 2011)*

Pesticide resistant crop seeds

Widespread use of Genetically Modified Organisms (GMOs) presents unique issues. While not all GMOs provide pesticide resistance, some, like Round-up Ready crop seeds, have genes incorporated that encode for resistance to a specific pesticide or pesticide class. This allows the use of a pesticide that normally could not be used on that crop to kill weeds while leaving the crop undamaged. This has potential to result in increased use of these pesticides, especially as weeds develop natural resistance to that pesticide. In turn this can result in increased drift or pesticide contamination onto neighboring areas, in some cases causing damage to crops in adjacent non-GMO fields or adjacent organic farm crops.

For example, dicamba is used on GMO soybean crops that are designed to be resistant to it (Figure 10). The need for dicamba stemmed from the use of glyphosate resistant GMO soybean crops; heavy use of only glyphosate resulted in the development of glyphosate-resistant weeds. Unfortunately, dicamba is known for drift issues, resulting in its presence on fields neighboring those where it was applied. Non-GMO soybean crops are very susceptible to dicamba. In 2018, the USDA estimated that 4% of soybean crops were damaged by off-target dicamba drift. *(Wechsler, 2019)*

Figure 10. Dicamba-resistant soybean crops thrive after pesticide application while weeds wither.

Bacillus thuringiensis (Bt) is a bacterium that interferes with the ability of Lepidoptera (moth and butterfly) larvae to feed. It has been considered less toxic than some chemical pesticides, and used effectively to kill some pests, including gypsy moths in forests. However, its genes have been inserted into some crop species, such as corn, to create genetically modified organisms (GMOs). Lepidoptera larvae feeding on such crops will die, but they may also die from ingesting the pollen from those crops that has drifted onto other, off-target plant species. This may be contributing to the decline in populations of the Monarch Butterfly and other off-target Lepidoptera that act as pollinators and are important in the food chain for birds and bats.

Food Security

Figure 11. Grapes infected with gray mold.

Feeding the world's population is a daunting task. Recent estimates suggest that 690 million people worldwide are chronically undernourished despite sufficient global food production *(FAO, 2015)*. The World Research Institute's July 2019 report, *Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050*, estimates that we need to increase global food production by 50% in order to meet demand by 2050 *(Searchinger, 2019)*. The use of pesticides may increase crop yield *(FAO, 2017; Weller, 2014)* and may be necessary for achieving sufficient food production to feed the world's population *(Weller, 2014)*. Up to 30% of crop yield may be lost to pests *(Weller, 2014)* (Figure 11). Some studies dispute the increased crop yield from pesticide use, suggesting it may be more dependent on the attention paid to the crops and the land used as well as which crop is used than the use of pesticide itself *(Searchinger, 2019)*. Climate change, which will shift the range in which specific crops may grow as well as which pests impact crops, will further exacerbate food insecurity.

Impacts on the Environment and Wildlife

Pesticides are designed to be highly toxic to specific pests but do show off-target effects. During pesticide registration, some research is completed to identify some of these off-target effects and to determine optimal usage that maximizes pest toxicity while minimizing known off-target effects. The research being carried out by scientists at universities and extension services has identified additional off-target effects of many pesticides. Sometimes this research has led to newer regulations affecting pesticide use.

In 2009, carbofuran was banned due to extreme off-target toxicity; birds and mammals are both susceptible to this insecticide. However, many farmers and other individuals and businesses may still have some carbofuran that was legally purchased before it was pulled from the market. It is not illegal to possess and safely store a banned pesticide, only to use it or sell it. *(Soares, 2019)* In some cases, legally stored carbofuran has been used to illegally, intentionally poison birds like hawks and eagles, protecting animals such as lambs, or to kill nuisance animals such as foxes and raccoons; some carbofuran poisonings have been reported as recently as 2019. *(Holcombe, 2019)* EPA take-back events can help with proper disposal, though this requires funding. Carbofuran has also been used by illegal cannabis growers to protect their camps from large mammals, such as bears, with some even targeting law enforcement. Given the labels on

some of the containers of carbofuran found by law enforcement, these growers are likely smuggling it in from Mexico as opposed to using legacy pesticide. *(Ebersole, 2020)*

Atrazine, a triazine pesticide, has been shown to cause endocrine disruption at very low doses and has caused a ten-fold drop in the testosterone levels of male frogs which is a level lower than that in normal female frogs. This reproductive impairment is ravaging their populations. Further research has shown it to be in drinking water supplies throughout many parts of the U.S. and findings suggest that its ability to block estrogen production in humans may affect fertility by altering hormone levels, affecting onset of puberty and causing menstrual irregularities and pregnancy loss in humans. While atrazine is banned in Europe, it is still used in the US on crops such as sugarcane, sorghum, and corn. The EPA runs the Atrazine Ecological Exposure Monitoring Program in which waterways near high-use areas are monitored for atrazine. If the atrazine level is high enough, the atrazine registrant is required to initiate mitigation activities, which mostly consist of education and outreach to atrazine users. While 33 sites have entered the program with high levels, there were only nine watersheds in the monitoring program as of 2015. *(EPA, 2020f)* Recently, the EPA has increased the amount of atrazine permitted in waterways. *(Wozniacka, 2019) (Hayes, 2010)*

As populations of pollinators, especially bees, have declined in recent decades, research into the cause or causes of this decline have been studied. Because pollinators are so important to the agricultural industry, these studies have taken on added urgency. Indications are that among other impacts, pesticides may damage neurological systems and especially visual and olfactory nerves in bees. Odor discrimination plays a role in homing, orientation, defense, search for pollen and mating. Visual cues based on color are also necessary for normal foraging and pesticides appear to cause reduced production of two visual proteins, opsin and rhodopsin. Neonicotinoids are one class of pesticides that is particularly concerning for bee populations. This has led to some label restrictions on when to use these pesticides, such as after sunset, when the temperature is below 55°F, or when blooming is not occurring (and all petals have fallen). These restrictions may not always be followed. (See the *June 2013 Wilsonville Bumblebee Die-Off incident* in *Appendix 4: Notable Pesticide Events*.)

Imidacloprid is a neonicotinoid insecticide that was recently found to suppress bird appetite and delay migration *(Eng, 2019)*. Neonicotinoids are commonly used for seed treatment, and birds that forage in agriculture areas may be exposed by eating treated seeds. A delay in migration can have serious reproductive consequences, and it is hypothesized that the use of pesticides like imidacloprid may be a significant contributor to the decline in certain migratory bird populations, alongside habitat loss and disruption. Without tests for appetite suppression and migration delay in birds, this toxicity was not known when imidacloprid was originally registered in the 1990s and was thus not considered for mitigation by restricting use.

Off target effects are of concern when addressing pesticide use. This is not just an issue for off target insects like bees. One example is the recent banning of M44 bait stations that were meant to target coyotes (Figure 12). The device shoots sodium cyanide into the mouth of any animal biting into the bait, however it has been documented to kill pet dogs that found the bait. This led to a ban on their use, though they have since been re-authorized. *(Carlisle, 2019)* The reauthorization increased buffer distances from private landowners and public paths and roads. These bait stations are also a hazard to unintended wildlife, such as skunks, raccoons, and bears. *(BBC, 2019)*

Figure 12. An installed M44 bait station.

Forestry

As vast tracts of forestland have been converted to mono-cultures of loggable lumber species, herbicides have been used to control competing vegetation, which would otherwise use up nutrients, water and light needed by the crop trees. This has increased the overall yield in these managed forests. However, mono-cultures have the disadvantage of increased susceptibility to disease and insect pests because of the density of only one species (Figure 13). While insecticides are used much less frequently than herbicides, their effect on off-target insects, birds and wildlife can be more problematic and inappropriate use has led to tree die-off. (See Appendix 4, *Old tree die-offs near roadways in 2013*.)

Figure 13. Spruce killed by bark beetle infestation.

The aerial spraying of these forests can affect water sources and any human habitation within the areas unless sufficient exclusion zones are enforced to protect them. *(Sanchez-Bayo, 2011)*

Climate Change

With increasing temperatures and shifts in typical seasonal weather, climate change alters growing conditions for both desired crops and pests. It is anticipated that climate change will increase certain pest populations and result in migration or increased regions of habitat. In turn, this increase in pests is anticipated to result in increased pesticide use.

Pesticides may be used more frequently, earlier in the season, and in different regions than they were previously.

One documented example of this is in the almond industry. Dr. Katie Fellows, while a graduate student at the University of Washington School of Public Health, investigated the impact of climate change on two pests that plague almond trees. *(Fellows, 2019)* For both of the investigated pests, it was found that climate change will not only increase the number of generations of the pests per growing season, but that the pests will begin emerging earlier in the season. By 2050, it was predicted that one to two additional generations of pests can be expected, with pests emerging approximately two weeks earlier than historical averages. The main driver of this finding was the increase in minimum temperatures over the last century and projected to the end of this century. It would then be presumed that insecticide use would reflect these changes in pest dynamics, showing earlier applications of insecticides as well as potentially more frequent applications in greater amounts, in order to counteract larger populations of pests. Data also suggested that those most likely to be adversely affected by this increased use would be the most vulnerable populations living in the areas impacted by this increased use.

There is concern for, and multi-state attention (in ID, CA, OR and WA) is being paid to, potential variation in pest problems caused by climate change. For example, increases in rodent and bark beetle populations are anticipated. Special attention is being paid to what is happening in CA since they are south of us and will probably face some of these issues first. Advance planning permits ODA to identify an IPM approach that minimizes use and negative impacts from pesticides.

Other Concerns

Adaptive Management

As the speed with which scientific advances has accelerated, revealing new environmental realities, they have outpaced current regulatory practices. Currently, pesticide regulation practices in the US and EU lag behind scientific knowledge in multiple ways, including risk assessments based on a single pesticide’s effect on one specific crop, misrepresentation of affected species population dynamics, inaccurately modeling toxicology in complex, dynamic ecosystems, and overlooking pesticides’ indirect effects throughout the ecological web and food chains.

Regulatory decisions need new tools like richer data sets and the ability to model complex systems that will help keep pace with current research. A regulatory and management model that allows for monitoring and assessment of outcomes to determine if current regulations are having the desired effect, and the ability to rapidly alter rules and protocols to address failings could improve results. *(Topping, Aldrich & Berny, 2020)* This “adaptive management” would allow for more targeted and sustainable use of pesticides and foster improved use of IPM.

Synergistic or Antagonistic Interactions of Combined Pesticides

There are concerns for increased toxicity to the environment or the public when pesticides are combined. However, there is no specific restriction against this at the state or federal level. There are instances where mixed pesticides have synergistic or antagonistic effects which can either make the combination more deadly to plants or other organisms, or reduce or eliminate their activity, or affect volatility of the mixture, or increase toxic effects to the applicator. When such interactions are documented, the ODA sends out advisory information and includes the information in its newsletters. One example is the mixture of acid or phosphate pesticides with lime sulfur (a fungicide). This mixture can produce hydrogen sulfide which is toxic to humans. Another example is the combination of glyphosate and dicamba. Mixing these pesticides generates heat, and this increased temperature leads to increased atmospheric concentrations of dicamba causing increased drift that has killed surrounding broadleaf crops.
There are documented examples of pesticide mixtures with increased off-target toxicity as well. The synergistic effect of combining malathion and diazinon causes increased neurological toxicity in salmon when compared with either alone at equivalent concentrations. The same is so for the combination of chlorpyrifos and malathion. Bees were also more adversely affected by combinations of pesticides than they were by individual ones. *(Laetz, 2009) (Zhu, 2017) (Chakrabarti, 2015) (Chakrabarti, 2019)*

There are several studies, like one of milkweed grown in California, which showed that 25 different pesticides were found in and on the plants. Only some of those were intentionally used. It was unclear what sources the others came from, whether drift or watering. Unfortunately, because of current privacy laws, studies like this can only be carried out in a couple of states.

Other Ingredients in Pesticide Formulations

This report has focused on the pesticides themselves. However, pesticides are used in formulations that contain other ingredients, and these ingredients may be independently toxic. EPA divides the ingredients in a pesticide into two categories:

- Active ingredients: US EPA defines pesticides as
  1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest,
  2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and
  3) any nitrogen stabilizer (7 U.S.C. § 136(u) (2013))
- Inert ingredients: All other ingredients in the formulation are considered inert. *(EPA, n.d.)*

These “inert” ingredients are not necessarily inert or inactive, nor are they necessarily non-toxic. Formulators are given some amount of discretion in what chemicals are considered active or inert based on the intended use of the chemical. Active ingredients are publicly disclosed on the label, while inert ingredients may be kept as a trade secret. EPA does complete a review of the toxicity of inert ingredients, including a consideration of whether or not the pesticide formulation is designed to be used on food.

The EPA review does not preclude the use of toxic chemicals. Many required tests for registering a pesticide are done on the active ingredient alone, not the formulation and not individual inert ingredients. *(Cox, 2006)* Some inert ingredients include benzene and naphthalene, both highly toxic. Some glyphosate formulations have been shown to contain polyethoxylated amine (PEOA), which is more toxic than glyphosate. *(Mesnage, 2019)* This has been phased out in at least some formulations, but there is no way for a user to know given the product label.

Just as combinations of different pesticide formulations may alter toxicity or impact how the pesticides drift, inert ingredients can alter the properties of the active ingredient. For example, the insecticide bifenthrin in formulations is toxic to rodent nerve cells, but the active ingredient alone is not. *(Tran, 2006)*

The inert ingredients may include chemicals with significant persistent and bioaccumulation concerns. For example, per- and poly-fluoroalkyl substances (PFASs) are used in some pesticide formulations. *(Gluge, 2020)* PFASs are extremely persistent and toxic chemicals that have contaminated many groundwater sites across the USA. Many PFASs have bioaccumulative properties, meaning that even small, seemingly insignificant quantities present in the environment may build up in humans or other species over time, leading to a significant quantity in the organism. Recent testing by both Public Employees for Environmental Responsibility (PEER) and the Massachusetts Department of Environmental Protection found PFASs in ANVIL 10+10, a mosquito control pesticide that is sprayed directly into the environment. *(Hogue, 2020)* The containers in which this pesticide product is stored were treated with a fluorinated substance. Without transparency in trade secret ingredients throughout the supply chain, it is not possible for governments, businesses, or individuals to make an informed decision to avoid chemicals of concern.

The issue of disclosure of hazardous inert ingredients was previously brought to court. *(Tickell, 2017)* In this case, the judge ruled that EPA is not mandated to require disclosure of hazardous inert pesticide ingredients. However, the ruling also included that the EPA may require that disclosure.

Recommendations and Conclusions

This report has covered many aspects of how and why pesticides are developed and used, along with both the positive and negative impacts that are a consequence of that use. In the process of interviewing for and writing this report, the authors became aware of the potential for improvements in the way that biocides are used and regulated. We are mindful that food security for a growing world population is essential and that a reduction in food production would especially impact the most vulnerable. Climate change may continue to exacerbate pest threats by bringing new invasive species to areas where they have not previously been seen. In some cases, pesticide use may currently be the best, although not the only option.

Our recommendations stem from the realization that some changes can be made at the level of individual use, some at city, county and state levels, and some can only be affected by changes at the federal level. Different regions of the country face different pest challenges depending on crops grown, climate, and the presence (or absence) of different types of native and invasive pests. As a result, some policies necessitate more local reach, while others are more appropriate at the federal level. Agencies should work together, harmonizing regulations and avoiding duplication of efforts.

Decisions, especially at the federal level, are sometimes made based on political and economic considerations as well as on toxicity data and risk. Each of these factors are balanced when making decisions about whether and how to regulate. Different administrations come to different conclusions about where the balance is. Unfortunately, this may lead to a yo-yo effect where policies can be put in place by one administration and overturned in the next. This state of affairs is currently playing out with several eleventh-hour regulation rollbacks that the outgoing Trump administration is rushing into place and which will likely be reversed by the next administration. The only way to ensure stability is to base policy on good science.

Another important factor in the decision-making process is who is brought to the table when developing policy. Many groups that have a vested interest in the outcomes of pesticide use have historically been excluded or marginalized in the process. Pesticide manufacturers have the largest influence on policy while those who are most likely to be exposed to pesticides and may be adversely affected have much less influence.

Presently, if unanticipated adverse effects are discovered for an already marketed pesticide, rather than face increased restrictions or an outright ban, a manufacturer may voluntarily withdraw registration. This withdrawal allows for possible resubmission of the registration if a less stringent administration comes into power. This insertion of politics can cause decisions to be based on matters other than scientific data. This practice should not be permitted. Once enough documentation of adverse effects is obtained, imposition and enforcement of increased restrictions or bans should be permanent and should include all applicable products, including other brands.

While sale of remaining stockpiles of such pesticides are forbidden, use is not. In some cases, large amounts are used for years after bans are in place. The Waste Pesticide Collection Program (WPCP) should be enlarged in scope to increase the number of collections for disposal of pesticide and pesticide waste, and should be well publicized.

Education, training, and labeling

The most powerful tool at our disposal may be improved education and training for the public, pesticide users, farmworkers and policy makers. Training and labels must be available in multiple languages, especially those used predominantly by farmworkers. Improvements in pesticide container labeling and labeling of pesticide treated seeds to more simply and accurately describe proper handling and health risks may be warranted. Some recommended

changes are as simple as larger fonts and more intuitive pictograms. Professionals at the University of Washington are working on an app that would provide translated labels; this should be expanded to Oregon. Also training about and promoting an Integrated Pest Management model for the use of pesticides, especially the ones with long term and more off target effects, can be a practical tool for reducing their use and impact.

Given the incidents of misapplication and probable inappropriate release of pesticides over residential areas (see Appendix 4), training and licensing for applicators and especially aerial applicators must be robust, continuing, and include review of previous accidents and their causes. Policies for licensing and license renewals should be uniform. Currently commercial applicators require renewals every year however public employees only require renewals every five years. The landscaper exemption for pesticide certification should be eliminated and training should be required for applicators at multi-family dwellings, as it is in other states.

Educating the public and pesticide users is also an effective way to impact the way pesticides are handled by individuals. Currently, many users get most of their information from pesticide manufacturers and vendors who have a vested interest in selling more pesticide and may not volunteer alternatives that minimize or eliminate pesticide use. A thorough understanding of available scientific data about impacts of pesticide use is critical at all levels of government and public discourse and can inform judicious and effective decision-making.

Occupational and environmental medical training needs to be improved to include physician training about how to look for the causes as well as the symptoms of both acute and chronic pesticide poisoning cases. Finding any pesticides in human populations should trigger an automatic review into practices involving that pesticide and study of potential adverse consequences of such exposures, which could lead to changes in laws and regulations.

The inadequacy of current penalties in the face of harm leaves little incentive for violators to take corrective actions, so having more robust deterrents in place may be one means of minimizing further violations.

Transparency and Information Gathering

Government should be responsible for information gathering related to pesticide use, pesticide contamination, and potential adverse effects of pesticide exposure. This should include the establishment and maintenance of information databases of residue contamination from pesticide use, medical and environmental adverse effects and contaminated sites to help medical professionals and researchers understand and follow the impacts of their use. This is especially important for ensuring farmworker health. Accurate documentation of use should be required including GPS information when aerial spraying is carried out to document application locations, route taken to and from these locations, and adherence to exclusion zones. This information should be publicly available and transparent. One possibility is modeling this program off of California’s Pesticide Use Reporting System.

Many groups advocate for public disclosure of all ingredients of pesticide formulations, not just "active" ingredients. This would identify the "inert" ingredients, many of which are not inert nor non-toxic. This would allow everyone to make fully informed decisions about pesticide policies and empowers the public to advocate for safer formulations. Pesticide manufacturers prefer to consider many ingredients trade secrets, and only disclose their identity to regulators as required. How do we balance the impact disclosure may have on the business with the public's interest in understanding these ingredients and their potential impacts on themselves, their community, and the environment? Does the public have a right to know ingredients in products like pesticides?

Funding, research, and evaluation

Federal and state funding sources to develop safer more targeted pesticides, effects of pesticides in combination and the effects of pesticide use on the environment, wildlife and human populations should also be considered and advocated for. There is already an infrastructure for dispensing such funding through Ag Schools and the Extension Services already incorporated into their agricultural science departments. This type of research would complement work already being done in such institutions and, as with other areas of academic research, federal funding frequently acts as a stimulus for funding from other, non-governmental sources, including interested industries. When such products are discovered and patented, licensing fees can frequently bring windfalls for both the researchers and the universities and help further fund such research.

Having the majority of research carried out by pesticide manufacturers has not been broad enough to find all such impacts, especially long term and off-target effects. Examples of the consequences when adequate research is not done can be seen with the adverse outcomes for human health from the use of organophosphate and N-methyl carbamate pesticides and such compounds as atrazine and chlorpyrifos.

Reviewing the science and claims from interested parties requires staff time, which requires funding. If the relevant state and federal agencies are insufficiently funded, these reviews will take longer and changes to the rules or labels will be delayed. This can delay state adoption of federal regulations. Currently, pesticide registration is reviewed every 15 years at the federal level; shortening this interval would provide more opportunities to integrate the latest research. This would require additional funding, potentially from fees, to cover the staff necessary to complete the reviews more frequently.

Burden of Proof and the Precautionary Principle

One important factor in addressing policymaking is the basic idea of how we consider risk in the absence of complete information. Do we work from a principle that if there is no current evidence that a product/pesticide is harmful, we can assume it is safe? In the case of pesticides this is a significant assumption, given that all pesticides are poison for some living thing. Do we work on a principle that everything about the effects of a chemical must be completely

understood in order to regulate it and allow its use, or is basing rulemaking on best current evidence of its impact sufficient? How often should this information and new data be reviewed?

In the European Union (EU) pesticides are required to be effective and have no harmful effects. Decisions about pesticide use are based on the “precautionary principle”. The precautionary principle, proposed as a new guideline in environmental decision making, has four central components:

- taking preventive action in the face of uncertainty,
- shifting the burden of proof to the proponents of an activity,
- exploring a wide range of alternatives to possibly harmful actions, and
- increasing public participation in decision making.

This is not currently the practice that the US federal agencies take when making decisions about pesticide use. After initial approval, the burden of proof predominantly rests with the opponents, frequently with years of documenting the adverse effects of use required before any mitigating action can be proposed. Uncertainty here tends to favor use rather than precaution. By then, there is a potential for much harm to have been done. While use of IPM is becoming more prevalent it is by no means universal, varies in actual practice and is fostered more at state and local levels than as federal policy.

Registering a new pesticide requires the investment of hundreds of millions of dollars before profit is seen. Only large companies can afford to take this risk on a product that may ultimately not be marketable. Every new test raises the barrier and reduces the incentive for companies to develop novel pesticides. However, as research continues, more knowledge about how to develop safer pesticides exists. What is the balance between sufficient knowledge about a product before it goes to market, sufficient safety when the product goes to market, and encouraging innovation? Federally funded research that is then licensed to companies may be one way to encourage innovation while maintaining safety. Streamlining existing testing requirements, developing cheaper and faster testing methods, and improving computational predictions of toxicity and function can all help reduce the burden of safety testing.

Adaptive Management and Integrated Pest Management

Adaptive management is “a system of management practices based on clearly identified outcomes and monitoring to determine whether management actions are meeting desired outcomes; and if not, facilitating management changes that will best ensure that outcomes are met or re-evaluated.” Adaptive management addresses the fact that our knowledge of natural systems is incomplete, and uncertainty often exists with respect to whether actions will achieve desired outcomes. Through use of adaptive management, it is possible to adjust management actions over time as knowledge of the natural system is gained through monitoring, thereby allowing management actions to more fully achieve the intended results. While regulation is often viewed as a one-time decision, under this model “adaptive regulation” could be viewed as an ongoing process with sequential decisions based on monitoring, review and adjustments or revisions of policy as more information becomes available to reach the desired outcome.

This allows for improved use of IPM policies. IPM is widely adopted, but interpretations of what is and isn't appropriate for IPM vary greatly. In some cases, business as usual is simply labeled as IPM. Ideally, IPM should prioritize mechanical and cultural methods of pest management, and only use pesticides with the least possible impacts if those methods fail. Adaptive management adds a layer of monitoring outcomes and altering policy over time depending on the results.

The EU has established an adaptive management framework of sustainable pesticide use to reduce the risk to human populations and the environment by promoting IPM and use of other non-chemical alternatives. The US uses an adaptive management style in some agencies as well, such as the National Park Service. *(National Park Service NEPA Handbook, 2015) (European Union, 2017) (A short introduction to 'Planned Adaptive Regulation', 2015)*

Conclusion

In 2000, the LWVOR produced a study about farmworkers in Oregon. In that study some of the same issues were discussed, including concerns about their protection from pesticide exposure and recommendations for steps to mitigate that exposure. Only a few of the recommendations that were suggested at the time have since been implemented, including improvements to warning signage, buffer zones, protective equipment and record keeping of pesticide use by farm owners. Now, with 20 years of new information about the impact of pesticide use from many sources available, the authors recommend updating League positions in order to better advocate for improved pesticide policy. *(Erbach, 2012) (Skevas, 2012) (Kriebel, 2001) (Oregon OSHA, 2018b) (Hettinger, 2020)*

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Interviews

September 2019 Melanie O'Hare, Lane County Public Works, Road Work Division (PG)
September 2019 Todd Bowen, Parks Supervisor, Lane County Parks Department (PG)
September 2019 Brian Johnson and Phebe Howe, Lane County Environmental Health Division of Department of Public Health (PG)
September 17, 2019 Dr John Jachette, Emeritus Global Regulatory Leader for Range, Pasture and Industrial Vegetation Management, Dow AgroSciences LLC (all interviewers at webinar presentation)
October 3, 2019 Lisa Arkin, Beyond Toxics (DM & PG)
October 4, 2019 Dr. Harper Keeler, Director, Urban Farm Program. (DM & PG)
October 14, 2019 Rose Kachadoorian, Natural Resources Program Manager, ODA. Michael Odenthal, Lead Pesticide Investigator, ODA. Garnet Cooke, Pesticide Coordinator, OSHA. (PG & KH)
October 24, 2019 Lena Tucker, State Deputy Forester and Kyle Abraham, Chief Forester, Oregon Department of Forestry (JK &DG)
October 29, 2019 Master Gardener with Master Gardener Volunteer Program (DM)
October 22, 2019. Lynne Fessenden, Director, Save the Bees. (DM & PG)
October 28, 2019 Megan Donne, Northwest Center for Alternatives to Pesticides (NCAP) (DM & PG)
November 19, 2019 Dr Jeffrey Jenkins, Department of Environmental and Molecular Toxicology, OSU, National Pesticide Information Center, Integrated Plant Protection Center, USDA Western Region Integrated Pest Management Center;
Ms. Kaci Buhl, Department of Agricultural Sciences, OSU, Director, Pesticide Safety Education Program (PSEP), Assistant Director, National Pesticide Information Center (NPIC) Deputy Director, Pesticide Educational Resources Collaborative (PERC);
Dr. Antony Melathopoulos, Department of Agricultural Sciences, OSU (PG & KH)
December 5, 2019 Garret McGraw and Chad Wright, Douglas County Department of Public Works, Operations and Maintenance Division (JC)
December 6, 2019 Aimee Code, Xerces Society (DM & PG)
February 12, 2020 Even Kruse, Kruse Farms owner and manager (JC)
February 20, 2020 Wes Messinger, Army Corps of Engineers, Fern Ridge Project Office (PG)
March 16, 2020 Mary Ann Cooper, VP of Public Policy and Jenny Dresler, Director of Grass Roots, Oregon Farm Bureau (PG)
April 24, 2020 Tomas Bartolo, Pineros y Campesinos Unidos del Noroeste (PCUN) (JK)
April 27, 2020 Larry Treleven, Oregon Pest Control Association (PG)

April 27, 2020 Oregon Marijuana Growers Association (PG)
May 6, 2020 Ben Bowell, Oregon Tilth Education Specialist (PG)
May 22, 2020. Rose Kachadoorian, Natural Resources Program Manager, ODA (SM)
June 9, 2020 Dominica Navarro, Northwest Center for Alternatives to Pesticides, Healthy People and Communities Coordinator (JK)
June 10, 2020 Nick Racine, Army Corps of Engineers, Portland/Columbia Gorge Office (PG)
June 17, 2020 Ann Ketter, Enforcement Case Reviewer, Oregon Department of Agriculture (SM)
August 19,2020 Kevin Masterson of Oregon DEQ (PG) and November 6, 2020 (AN)
October 6, 2020 Dr. Richard Fenske, Professor Emeritus, Environmental and Health Sciences, University of Washington School of Public Health (PG)

Interviewers:
Jennifer Carloni (JC)
Debby Garman (DG)
Paula Grisafi (PG)
Kathleen Hersh (KH)
Josie Koehne (JK)
Susan Mates (SM)
Donna Michel (DM)
Amelia Nestler (AN)

Appendix 1: Recent Oregon Pesticide Legislation and Rules

SB 863

Senate Bill 863 went into effect October 8, 2013. It reserves regulation of agricultural seed, flower seed, nursery seed and vegetable seed and products of agricultural seed, flower seed, nursery seed and vegetable seed to the state. It precluded efforts underway in Benton and Lane counties from restricting GMO seeds. *(Zheng, 2013)* The ban in Jackson county was already underway and was exempted. *(Keeler, personal communication, 2019)* This protects Monsanto's GMO seeds that include a resistance gene to the pesticide glyphosate (Roundup Ready seeds), which explains why Monsanto and Syngenta spent nearly $500,000 to lobby the legislature to pass the bill. *(Keeler, personal communication, 2019)*

2018 State WPS Rules Update

In June of 2018, Oregon OSHA proposed additional rules for the Worker Protection Standard that provide an added measure of protection against the risk of pesticide drift. *(Oregon OSHA, 2018a)* These took effect January 1, 2019. *(ODA, n.d.-c)* The new regulations establish zones

around pesticide applications that workers cannot enter. It also allows workers the choice to take shelter in housing or other structures instead of moving away. These new rules offer stronger protections for farm workers than federal regulations, and those standards will hold despite what happens nationally. *(Burns, 2018)* See *WPS* under EPA and the *OSHA* section for more information about WPS.

Conservation-Timber MoU and SB 1602

In early February 2020, a major compromise deal between conservation groups and the timber industry was tentatively agreed upon with a Memorandum of Understanding (MOU). Following the guidelines set by the memorandum, in June of 2020, SB 1602 was passed. It strengthens the state's aerial pesticide spray regulations and will set the stage for fundamental reform of the Oregon Forest Practices Act. Included are modifications to ODF's existing Forest Activity Electronic Reporting and Notification System (FERNS). This is an opt-in program one can sign up for to be notified when an aerial spray or other forest operation is to take place nearby.

Prior to any logging or spraying, operator/timber owners must sign up in FERNS within 90 days before they plan to operate in an area. SB 1602 requires that concerned Oregonians who have signed up in the system who live within one mile of a planned helicopter aerial spray operation be notified the evening before by email through the FERNS system, including the list of chemicals to be used. Afterwards, applicators/owners must report within 24 hours each unit sprayed in ODF's FERNS system.

In addition, state agencies, law enforcement, and licensed health care providers may request daily spray records and geographic information system data concerning a pesticide application by helicopter to forestland from the Pesticide Analytical Response Center (PARC). There is a $1000 fine per request for failure to provide the requested information.

Helicopter pesticide application buffer zones are increased from 100 to 300 feet around inhabited dwellings, schools, and drinking water sources. For streams, a 50-foot buffer zone near non-fish bearing streams, and 75 to 100 foot buffer zones near domestic-use and fish-bearing streams are now required. These more stringent spray restrictions should reduce potential damaging effects to water and human health going forward.

In addition, a Habitat Conservation Plan proposal passed in September 2020 that will prevent logging close to the terrestrial and riparian habitats of endangered species on state-managed forestlands. Pesticide use is proposed as a covered activity, which will require consideration of how pesticide use impacts threatened and endangered species. This plan must still pass federal approval after review.

Chlorpyrifos Rules Update

In December 2019, ODA convened a work group to discuss potential restrictions on the use of chlorpyrifos in Oregon. *(Plaven, 2020)* Rules were proposed in July 2020 and public comment

was accepted through mid-October 2020. As of November 2020, ODA was in the process of finalizing new rules limiting the use of chlorpyrifos in Oregon. The current proposal would *(Kachadoorian, 2020)*:

- Classifies all chlorpyrifos products as restricted use. Currently, licensed applicators may supervise non-licensed applicators who are applying it. If these rules are adopted, all applicators must be licensed. Updates respirator protections for applicators.
- Bans certain uses in fall 2020: on golf courses, for vector control, and many greenhouse uses.
- Limits use on Christmas trees to between April 1 and June 15.
- Increases time delay before farmworkers can enter application area without protection equipment from 24 hours to 4 days
- Requires a large buffer between application areas and sensitive areas, which include farmworker housing, and permanent waterways.
- Bans all uses of chlorpyrifos as of December 31st, 2023, except:
    - Cattle ear tags
    - Granular formulations and seed treatments
    - When a pest emergency is declared by order of the Director of ODA.

Interestingly, the agency estimates that passage of these rules will result in savings of $60,000-$75,000 per year on chlorpyrifos investigations and lab expenses, with a reduction in pesticide registration fees of only $13,120. *(Plaven, 2020)*

Appendix 2: Counties, Cities, and Towns

Lane County

Lane County Public Works (LCPW) road division is responsible for maintaining the county's over 1400 miles of roads. Its manual is available online. The department formally adopted the Oregon guidelines in 2004. The guide details the protocols that maintenance crews use to conduct a wide variety of routine maintenance activities. Activities that have the potential for pesticide use include ditch maintenance and roadway vegetation management. In 1990 LCPW adopted an Integrated Vegetation Management (IVM) Program. The term vegetation is preferred since the "pest" in this instance is unwanted vegetation. Where there is an open water connection to a creek, pond, or wetland a call to the Environmental Permits Team for assessment and plan approval is required.

Best Practices Management (BPM) uses equipment such as mowers, after which a biological approach, such as the Cinnabar Moth to control tansy ragwort, may be taken. The next step would be incorporating native plants in an attempt to out-compete the problematic vegetation. If that fails, an herbicide may be used. Agents must be approved by the Public Health Advisory Committee (PHAC) once a year. For selection of herbicides to use LCPW suggests five or six herbicide products for review by the PHAC and they select what they deem safe. Currently only three herbicides are in use: Vastlan (triclopyr choline), Milestone (aminopyralid), and Ecomazapyr (imazapyr).

All crew who apply the herbicides are licensed by the state. Seven-day advance notice of spraying is posted on the roadway and on the website. Landowners along the roadway can opt out via LC's No Spray Area Program. Applicants can fill out an online application or call 541-682-8521. School bus stops can also be enrolled in the No Spray Area Program. Areas enrolled in this program are typically mowed instead of sprayed.

The Lane County Parks Department maintains 73 parks. Currently it has no state certified pesticide applications specialists since giving up its license over five years ago. The department does use yellow jacket traps but otherwise contracts with local pest control companies, when needed, such as when two of its buildings required treatment for termites and carpenter ants.

The Lane County Public Health Department does not have a Vector Control Board so they do not spray, nor do they have any other formal pest control processes in place and have not for ~30 years, although some Oregon counties do. They do not monitor for pesticide contamination unless there is some specific incident, like at Triangle Lake where there was over-spraying by forestry. There the county helped the state DEQ collect samples. The county is however responsible for monitoring water quality for small source ground water (for between 10-3000 people) and some "standard" organics are tested for. State DEQ tests large ground water sources and surface water that serves 3000 or more people. There is no requirement to monitor private wells for pesticides. Some contaminants in private wells must be tested for on point of sale, but this does not include pesticides. The website, https://yourwater.oregon.gov allows residents to check results of water quality tests across the state. *(O'Hare, Bowen, Johnson and Howe, personal communication, 2019)*

Douglas County

Douglas County Public Works Department uses their own licensed pesticide applicators and does not contract out spraying. A consultant, Wilber-Ellis, is used to advise what pesticide to spray and sprays are changed every five years to avoid development of tolerance in plants. The process for removing a biocide is handled by the consultant in accordance with state and federal regulations.

While residents are not notified in advance of roadside pesticide spraying, they are allowed to opt out if they sign a contract agreeing to clear vegetation from the edge of the asphalt to the edge of their property to a "bare-ground" condition. Only herbicides are used and roadsides are sprayed with Round-Up (glyphosate) to kill grass and other weeds. Vastlan (triclopyr choline) is sometimes used specifically for control of broadleaf species. They don't spray in standing water, or within three feet of a water source. They don't spray if rain is forecast to fall before the spray would dry.

Alternatives to spraying, such as mowing, are also implemented in certain locations. There are also instances where state and federal assistance has allowed for the use of rusts, other fungi, and mites, and other insects for weed control.

The Douglas County Parks Department has no apparent policies regarding biocide use, nor does it keep records of what is sprayed where and by whom. It sometimes logs the parks, and then the land is treated according to forest practices. The Douglas County Department of Public Health has no routine testing system in place and all reports go directly to the state. *(McGraw and Wright, personal communication, 2019)*

Cities and Towns

One example of increased oversight in some cities comes in the form of the Bee City USA program. The Bee City USA program is a voluntary program committing cities and other participants to improve pollinator habitat. Among other requirements, participants must create and adopt an IPM plan, which involves reviewing current pesticide use and planning to reduce pesticide use. *(Bee City USA, 2020a)* On July 23, 2018, the Eugene City Council unanimously passed Resolution #5240 to become a Bee City USA. In addition to adopting policies that promote a healthy pollinator environment, the city has banned neonicotinoid use on city property and maintains pesticide-free parks while striving to create additional pesticide-free parks. As of January 2020, eleven Oregon cities were registered as Bee Cities: Ashland, Eugene, Gold Hill, Hillsboro, Medford, Newport, Phoenix, Talent, Tualatin, West Linn, and Wilsonville. *(Bee City USA, 2020b)*

The same organization runs the Bee Campus program; as of January 2020, five campuses in Oregon were registered: Lane Community College (Eugene), Portland Community College (Portland), Portland State University, (Portland), Southern Oregon University (Ashland), University of Oregon (Eugene). *(Bee City USA, 2020c)* More information about the program, including annual reports from participants, can be found at www.beecityusa.org.

Appendix 3: Environmental Groups

The Xerces Society

The Xerces Society works to protect invertebrates, especially pollinators like bees and butterflies, from the effects of pesticide use.

There is some evidence the more we use pesticides, the more reliant we become on them because they not only they kill the plant pests, but also the beneficial insects that might compete with them and help control them. Best practices to minimize pesticide use depend on keeping plant crops healthy, unstressed and resilient, and limit the size of monoculture farming. Increasing the variety of plants in a given area helps both with crop health and pollinator health. One example is California wine growers have a larger burden of grape vine pests than we do in Oregon because Oregon vineyards are smaller and spaced out with other crops. Although Oregon has a much lower incidence of such pests, that may change as wine growers convert more and more land to viniculture.

Making sure there are pesticide free corridors and islands with a variety of species that allow for protected pollinator movement will be especially important as climate change causes habitat to change. Currently Xerces is working with some government agencies to help make roadway side-paths more friendly to pollinators, thereby creating more of these safe corridors.

While Integrated Pest Management is a somewhat malleable concept, it is designed to break the cycle of continuous use of high levels of pesticide. IPM trains users to first keep the plants healthy and monitor for pests. If pests are present, they consider whether pest levels will be controlled by their natural enemies or if levels have reached a threshold where they warrant treatment for control. If available, non-pesticide control methods are used first. If not, they apply the least harmful pesticide at the lowest amounts. If necessary, increasing amounts of pesticide and increasingly harmful pesticides are used as a last resort. Attention must also be paid to the effect of banning certain pesticides that could lead to the use of even more harmful ones.

Much of the information disseminated to farmers about pesticide use is through the pesticide companies who have a vested interest in higher usage. Xerces is attempting to be an alternate voice in the discussion. Unfortunately, most studies about the effects of pesticides are funded by the major companies because not much is funded through the government. These companies can, therefore, limit the scope of what studies are funded. Xerces has helped fund a faculty position at the OSU School of Agriculture to help widen the scope of these studies. *(Code, personal communication, 2019)*

Save the Bees

Save the Bees has directed its efforts to lobby for passage of the 2 bills: one to ban neonicotinoids, and one to restrict their use, both of which died in committee in spring 2019. While honey producers, beekeepers and organic farmers supported such legislation, much of the opposition to the legislative restrictions and bans came from large scale farmers like wheat producers. The organization puts forth the concept of precautionary policies when it is clear that not enough information is available about the safety and effects of use of certain pesticides. *(Fessenden, personal communication, 2019)*

Data from scientific research describe the impact/mode of action of the pesticides indicated that bees are being exposed to chronic sub-lethal doses because the pesticide becomes systemic in the plants, including in their nectar, and spreads from crops to other nearby plants through the soil. This leads to immune damage, increased sterility, and nerve system damage in bees. This, along with the impact of varroa mite infections that damage the organ in bees which is equivalent to the liver is adding to the overall process of colony collapse. Some of this data is coming from the Bee Lab of Priya Chakrabarti Basu at OSU.

Anywhere from 15-45% of bee colonies are dying off per year in Oregon depending on the sector of the industry. Efforts to reverse these numbers are being made by, for example, recommending the planting of hedgerows around fields to give bees another source of food.

Currently the EPA is working to register new uses for the insecticide sulfoxaflor, which is a neurotoxic systemic insecticide that kills sap feeding insects like bees. Beyond Toxics has initiated a letter, signed by the several state legislators and promoted by Save the Bees, that has been sent to the EPA requesting reconsideration of its use. In an effort to help the Oregon company, GloryBee is using its advertising power by putting “Save the Bees" stickers on all its products. Some other companies that use honey in their products, like bakeries are following suit.

Beyond Toxics

Beyond Toxics’s efforts have been directed toward regulation of usage of pesticides on and near school grounds, and toward protecting farm workers from exposure to pesticides sprayed on crops. They had limited success but were able to keep pesticides to control ants, spiders, and rodents from being applied in schools while students were present, and to require an attempt using other non-chemical controls before pesticides were employed (e.g. sealing ingress points and cleaning food use and storage areas). Their efforts to protect farm workers prompted rules that required there be 100 ft space between workers, worker housing and aerial sprayers for nonvolatile pesticides and 150 ft for volatile pesticides in July 2018.

They also fostered efforts to require a space buffer between aerial spraying and schools and residences from no buffer at all to 60 ft in 2015, and supported 2020 legislation to restrict or ban certain pesticides, as did SB 853 and HB 3058, both of which would ban chlorpyrifos and restrict use of neonicotinoids. Both bills died in committee in spring of 2019. Beyond Toxics was one of many environmental groups that were signatories of the MoU (see *Conservation-Timber MoU and SB 1602*).

They work to publicize incidents like the death of old growth trees up to 75 ft from application of the pesticide aminocyclopyrachlor (ACP) by the ODA, likely because it leached into the surface water that supplied the trees to affect change and inform future legislation.

Besides their legislative efforts they work with local governments and enterprises like golf courses to help them “go organic”. They have had successes with Eugene, Junction City, Ashland and Talent along with the Laurelwood Golf Course in Eugene. *(Arkin, personal communication, 2019)*

Appendix 4: Notable Pesticide Events

June 2013 Wilsonville Bumblebee Die-off

In June 2013, customers noticed thousands of dead bees in a Target parking lot in Wilsonville. *(Hall, 2013)* This was traced to the illegal application of the neonicotinoid dinotefuran by landscaping company Collier Arbor Care of Clackamas, a licensed pesticide applicator. *(The*

Spokesman, 2014) The pesticide was applied to flowering Linden trees to control aphids, which can be a nuisance to parked cars due to a sticky substance they secrete. $555 fines were issued to the company as well as the two applicators because application to blooming plants is prohibited by the product label. According to Mace Vaughan of the Xerces Society, this is the largest documented bumblebee poisoning ever. *(Hall, 2013)*

October 2013 Cedar Valley Incident

In October 2013, Curry County residents complained to ODA about pesticide exposure by a helicopter. *(ODA, 2014)* This helicopter was later identified as belonging to Pacific Air Research, a licensed pesticide applicator. ODA concluded that they applied pesticides to unintended sites, applied pesticides at a rate above the maximum allowed, and provided false records about the actual products used. *(ODA, 2014)* It seemed likely that herbicides intended to kill vegetation in nearby industrial forest may have been sprayed unintentionally over residential areas due to an equipment failure that resulted in a leak, sickening about 40 residents of the area, although this was never verified by state investigators. This resulted in changing the licensed pesticide applicator training to include more about maintaining equipment. *(Shick, 2020)*

Triangle Lake

For years, residents of the Triangle Lake area, in the Coast Range west of Eugene in Lane County, complained of adverse health effects they suspected were due to forestry-related herbicide spraying. In 2011, urine tests showed the presence of the herbicides 2,4-D and atrazine in samples from 43 residents. The Oregon Health Authority, the EPA, and the Agency for Toxic Substances and Disease Registry (a division of the CDC) began an investigation.

An analysis of state documents showed that the amount of herbicide sprayed by private timber companies had increased during the 2009-2011 time period. The industry claimed to be in compliance with all state and federal laws.

Results of the investigation were inconclusive. Recommendations included:

- Implementing better data collection and analysis,
- Determining best practices for protecting human populations from pesticide exposure, including notification of residents in advance when spraying is planned, and
- Tasking ODA and ODF with improving the record-keeping by pesticide applicators so that data is accurate and usable. *(Barnard, 2013) (Lobet,2012)*

Old Growth Tree Die-off near Roadways in 2013

In 2013 the pesticide aminocyclopyrachlor (ACP) was used to treat a right of way along Highway 20 near Sisters, OR by the ODOT. Subsequently, approximately fifteen hundred old growth ponderosa pines were found dead or dying near the application area. Toxic levels of ACP, which is a known tree-killer, were still found in area trees six years after the nearby

spraying. A similar incident occurred in LaPine, OR causing a smaller tree die-off and included water contamination.

Originally, ACP was sold by DuPont under the brand name Imprelis. When Imprelis came on the market in late 2010 more than 30,000 customers complained of dead trees, and DuPont estimated that its liabilities would be in the hundreds of millions of dollars. It soon yanked Imprelis off the market, shortly before the EPA banned the herbicide in 2011. But DuPont had also registered the same tree-killing chemical under a different brand name, Perspective. Perspective, which was later sold to Bayer, stayed on the market in part because it has different label instructions, which warn against spraying it near the root systems of “desirable” trees.

In May 2019 the ODA restricted ACP use where the roots of nontarget trees or shrubs may extend and on the inner or outer banks of ditches or canals. It prohibits all aerial application of any product containing ACP. It also prohibits allowing or providing plant materials (including sawdust, bark or other byproducts from trees) that have been treated with or otherwise exposed to ACP for use in compost or mulch, or in animal bedding that is subsequently used for compost or mulch. *(Oblinger, 2018) (Hamway, 2020)*