A Pilot Study: Railroad Right of Way Herbicides and Maine's Surface and Ground Water

The following is a summary of a pesticide and railroad right of way (ROW) pilot study, conducted by the Maine Board of Pesticides Control (BPC) during the summer of 2003.

I. Goal

The goal of this pilot project was to develop methods and begin to collect data that will help determine whether the existing 10-foot buffer between railroad ROW herbicide application areas and surface water bodies is adequate. Additionally, it is hoped that part of this study will begin to provide data on whether or not railroad ROW herbicides are leaching to groundwater.

II. Background

While roadside spray programs in the State of Maine must allow for a 50-foot buffer between herbicide application areas and surface water bodies, railroad ROW spray programs must allow for a 10-foot buffer. During the summer of 2002 the BPC directed its staff to gather information from other states regarding their buffers for the application of herbicides on railroad ROWs and any associated environmental monitoring that may have been done. It was determined that states vary in their requirements for buffer sizes from no required buffers in states such as Connecticut and Rhode Island to up to 500–foot buffers in certain places in Massachusetts. In addition, it appears that Vermont is the only state to have performed monitoring, and that monitoring is preliminary. The herbicides traditionally used on railroads and their leaching and runoff potentials without regards to buffers, according to the United States Department of Agriculture, Natural Resource Conservation Service, are displayed in Appendix A.

A railroad stakeholder group was subsequently formed to help clarify whether Maine's 10-foot buffer is adequate. Participants included officials from the Maine Department of Transportation (DOT), Guilford Rail, Safe Handling Rail, Saint Lawrence RR, RWC, Inc., DeAngelo Brothers, Inc., Maine Forest Service, Auburn Water District, Portland Water District, Federal Railroad Administration, as well as BPC staff. Meetings were held in December 2002 and January 2003, and the group recognized the need to maintain vegetation-free tracks to limit fire hazard, derailment potential, and to maintain general safety with regard to train operators being able to see signs and upcoming road crossings, etc. Options considered for controlling the vegetation included mechanical, biological and thermal measures, but the group members concluded that none were as effective and inexpensive as applications of herbicides. However, the group was unable to identify any evidence indicating the 10-foot buffer is, or is not, adequate. At the March 2003 BPC meeting, the Board members reacted by voting that they would not consider requests for variances in 2004 until railroad applicators developed and submitted a water quality monitoring plan for approval.

In the meantime, BPC staff began a small-scale water quality monitoring pilot study as described below.

III. Program Design

A. Site Selection

Sites in close proximity to Augusta were chosen so that BPC staff would be able to get to the sites within a reasonable time frame. This was especially important when samples were collected after rain events, when a delay in collection after a storm could affect the analytical results. Sites were chosen to represent a worse case scenario and tended to be where the tracks either cross or come very close to water.

Seven sites were sampled. One site was on the Kennebec River, on the Gardiner/ Richmond town line, where the tracks parallel the river. Three sites were on Damariscotta Lake in the town of Nobleboro where the tracks cross a small part of the lake on a causeway and also, where the tracks parallel the lake for a small distance. Two sites were located in the town of Burnham; one where the tracks go through a very small pond, and one site further down the tracks not near a water body. The latter site was chosen to get an idea of drift potential when railroad spray crews were not making adjustments for the protection of water. Finally, a well in Winthrop located about 70 feet from the tracks was sampled. The well is also located approximately 100 feet from Maranacook Lake. The latitude and longitude of all sites were recorded using a handheld Garmin Global Positioning System (GPS) 12XL Personal Navigator Unit. Table 1 in the Sample Results section displays additional site information, and Appendix B displays pictures of the sites that are not pictured in the Sample Results section.

B. Herbicide Application and Sample Collection

The tracks at all of the sampling sites except the northernmost Burnham site were treated with a mixture of two quarts glyphosate (Roundup) and one quart imazapyr (Arsenal) per 30 gallons of water per acre (0.68% solution of glyphosate and 0.23% solution of imazapyr or 1.89 lbs. of glyphosate and 0.57 lbs. of imazapyr per acre). The powered spray equipment, mounted on a hy-rail truck, treated only the ballast area, covering a width of 20 feet (10 feet on both sides from the center of the track). BPC staff was on site at the time of the application for most of the sampling sites and noted the weather was sunny and calm with temperatures in the upper seventies. A Kestrel 3000 Pocket Weather Meter measured wind speeds from 0.7 to 2.7 miles per hours (mph) with one reading of 5.3 mph on Damariscotta Lake. These readings were taken at about the same time the herbicides were being applied to the sampling sites.

On June 19, 2003 a background sample of water was collected at Damariscotta Lake, and four days later, the tracks along the Kennebec River and Damariscotta Lake were sprayed. Prior to treatment, a BPC employee had mounted a 185-millimeter diameter filter paper to a drift card stand at each site to catch any pesticide drift. The drift card and a water sample were collected shortly after the spray unit passed the location of the drift card. At the Kennebec River site (Figures 3-5) the drift card was accidentally dropped into the river while it was being collected. The tide rose higher than expected in the few hours that passed since the card was set up and this made collecting the card difficult. The card was immediately pulled from the water and placed in the amber jar. A water sample was not collected at this site.

On June 24, the spray crew shut off the spray as they moved through the pond area at northernmost Burnham site (Figure 9). This was not predicted by BPC, but the drift card was collected anyway. A water sample was not collected. The drift card at the southernmost Burnam site, located away from water, was directly sprayed with herbicide. This drift card was intended to be placed 10 feet from the spray zone, but due to the double tracks in this location, the drift card was in the spray zone (see Figures 1 and 2). The tracks near the well in Winthrop were also sprayed on June 24 and a well water sample was collected on June 30.

An attempt was also made to detect potential herbicide residues by collecting water samples at two of the Damariscotta Lake sites after significant rain events (see Figures 6 and 7). The plan was to sample after one inch of rainfall was received within a 24 hour period, but the staff experienced difficulty obtaining accurate rainfall information (see the Discussion and Conclusions section of this paper). After about a month and a half of very little rain since the herbicide application in June, two water samples were collected on Monday, August 4 after the area reportedly received almost 2 inches of rain the preceding Friday night and Saturday. It is expected that close to 48 hours elapsed from the end of that rain event to the time of sampling. Two more water samples were collected on August 12 after an undetermined amount of rain.

All of the water samples were collected in 950 ml amber glass jars (one jar per sample) and placed immediately in iced coolers, along with the drift cards that were also placed in amber glass jars. This was done to preserve the samples by preventing exposure to sunlight and maintaining cool temperatures. Samples were delivered to the University of Maine at Orono, Food Chemical Safety Laboratory within 96 hours of collection. BPC standard operating procedures for the collection of environmental samples and chain-of-custody procedures were observed throughout the sampling program.

C. Analytic Methodology

The University of Maine, Food Chemical Safety Laboratory performed the sample analyses but did not have the capability to detect glyphosate. The tracks were only treated with a mixture of imazapyr and glyphosate, but in addition to analyzing for imazapyr, the lab was also capable of analyzing the samples, at no additional cost, for bromacil, diuron, metsulfuron-methyl, and sulfometuron-methyl using high-performance liquid chromatography (HPLC) with a photodiode array. Although these additional active ingredients seemed unlikely to be found, the BPC staff requested readings for the additional herbicides since they may have been used on the railroads in previous years. It was also noted that they might be present in the sample of well water where pesticides have the potential to linger for longer periods of time in a cold dark environment. The limit of quantification (LOQ) was 1 part per billion (ppb), 0.5 ppb, 0.2 ppb, 0.5 ppb, and 0.5 ppb respectively for water samples. The LOQ for drift cards was 1 microgram.

D. Quality Assurance/Quality Control Procedures

The University of Maine, Department of Food Science Laboratory maintains a quality assurance project plan (QAPP) with QA/QC protocols for the Board of Pesticides Control and the United States Environmental Protection Agency for the analysis of

samples used in the enforcement of state and federal pesticide regulations. This plan is updated biennially. In addition, all related BPC standard operating procedures were followed, including the collection of field blanks and sample duplicates on a 1 in 20 basis.

IV. Sample Results

The results from this study are displayed in Table 1 below. Other than glyphosate, which the lab was unable to analyze for, imazapyr was the only active ingredient sprayed at sampling sites during 2003. The lab was also able to analyze for bromacil, diuron, metsulfuron-methyl, and sulfometuron-methyl, but, as could be expected, none of the samples had positive detections for these active ingredients.

Table 1. Results

Site ID	Site Description	Buffer Type	Sample ID and Date of Collection	Sample Type	Weather*	Imazapyr Results**
12BPCS001	Kennebec River	25 ft.- thin high and low veg. on steep bank	030623HPJ01 6/23/03	Drift card	Sunny, temp. in 70's, wind 1.2 mph	ND
08BPCS009	Damariscotta Lake southernmost site	10 ft. – low veg. on steep bank	030623HPJ07 6/23/03	Drift card	Sunny, temp. in 70's, wind 1.2 mph	ND
			030623HPJ08 6/23/03	Water		ND
			030623HPJ09 6/23/03	Water- duplicate of 030623HPJ08		ND (QA/QC)
08BPCS008	Damariscotta Lake middle site	7-10 ft. – rock riprap with little veg.	030623HPJ04 6/23/03	Drift card	Sunny, temp. in 70's, wind 0.7 to 5.3 mph	ND
			030623HPJ05 6/23/03	Drift card duplicate of 030623HPJ04		ND (QA/QC)
			030623HPJ06 6/23/03	Water		ND
			030804HPJ02 8/4/03	Water – rain event sample collected 48 hrs. after 2 in.	Foggy, hot	ND
			030812HPJ02 8/12/03	Water – rain event sample collected after unknown amount of rain	Sprinkling	ND

08BPCS007	Damariscotta Lake northernmost site	17 ft. – thin veg. on steep slope	030619HPJ01 6/19/03	Water-background sample (pre-spray)	Fair	ND (QA/QC)
			030623HPJ02 6/23/03	Drift card	Sunny, temp. in 70's, wind 2.6 mph	ND
			030623HPJ03 6/23/03	Water		ND
			030804HPJ01 8/4/03	Water – rain event sample collected 48 hrs. after 2 in.	Foggy, hot	ND
			030812HPJ01 8/12/03	Water – rain event sample collected after unknown amount of rain	Sprinkling	ND
15BPCS010	Burnham northernmost site on unnamed pond	12 ft. – low veg. on steep slope	030624HPJ02 6/24/03	Drift card	Sunny, temp. in 70's, wind 1 mph	ND - this site was not sprayed
15BPCS011	Burnam southernmost site	no buffer	030624HPJ01	Drift card field blank	Sunny, temp. in 70's, wind 1 mph	ND (QA/QC)
			030624HPJ03	Drift card		384.8 micrograms
06BPCG048	Winthrop well	70 ft. - mostly wooded	030630HPJ01	Well water	Fair	ND

* A Kestrel 3000 Pocket Weather Meter measured wind speeds
** The LOQ for drift cards was 1 microgram
ND = Not Detected

Sample 030624HPJ03 was positive for imazapyr with 384.8 micrograms on the drift card. This sample was taken in the town of Burnham, not near a water body. It was intended that this card be placed 10 feet away from the spray zone to get an idea of any drift that may be occurring when spray crews are not using precautions for water. Due to the double tracks however, more area was sprayed than was anticipated, and the card was directly sprayed with the glyphosate/imazapyr mixture when the spray truck's booms were lifted (see Figures 1 and 2). This sample may be useful in the future as a quick comparison to other cards with positive detections that may show lesser degrees of herbicide residue.

Figure 1. Burnham southernmost site
N44°39’11.1”
W69°23’09.2”

Figure 2. Spray truck on tracks applying glyphosate/imazapyr mixture in Burnham

It is worth noting that at the other Burnham site (northernmost site, see Figure 9 in Appendix B) the spray truck did not spray as it went by this small ponded area, thus, the drift card at this site was not expected to have, and did not have any positive detections.

Initially, the lab reported a positive detection for imazapyr on the drift card at the Kennebec River site. However, the lab later realized that an error had been made. When rechecking the chromatograms, it was discovered that there was an artifact peak which eluted before imazapyr would have.

V. Discussion and Conclusions

While this pilot study did not find evidence of imazapyr drifting to nearby waterbodies, one can not conclude that drift during RR ROW herbicide applications does not happen. There are many variables that could cause drifting including weather and herbicide choice. More data is needed.

More data is also needed from rain event sampling to determine if herbicides are reaching water from runoff or even leaching. The timing of such sampling is critical, and the creation of methodology to optimize this timing is needed. The results from this study indicate that one is unlikely to find imazapyr, at the rate used here, in lake water if a month and a half has elapsed since time of application and if 48 hours has elapsed since a significant rainfall. Ideally, a future study should continue to attempt to find the worse case scenario by sampling after minimizing the time since application and the time since the significant rain event.

A problem encountered with this study was gathering rainfall data and getting to the site in a timely manner to collect rain event samples. When the Damariscotta Lake sites were treated in June, it wasn't until August when rain event samples were collected. This is because there were either no rain events large enough (assumed to be 1 inch in 24 hours) or those rain events happened at a time when BPC staff was not readily available for sampling. The drive from Augusta to the Damariscotta Lake sites is about an hour making it hard to efficiently use a rain gauge so that it is emptied regularly. Rain events during the summer of 2003 tended to be spotty. For example a rain event in Augusta did not mean that it was likely to be raining in nearby areas. A Department of Agriculture Employee volunteered to keep a rain gauge at her house that was located approximately five miles from the Damariscotta Lake sites. This was helpful in that on August 4 she was able to relay information to the BPC that she received almost two inches of rain on the previous Friday night and Saturday. A sample was collected that Monday, however, approximately 48 hours had elapsed since the rain event. Even if herbicides had washed into the lake, they may have been diluted or degraded by the time the sample was collected.

The Maine Forest Service (MFS) records rainfall at 33 locations around the state. One of these locations is in Jefferson, about 6 miles from the Damariscotta Lake sites. Two water samples were collected at two of the sites on Damariscotta

Lake (one sample per site) on August 12 after rain was predicted for the area and after Augusta had received a lot of rain. However, the MFS does not release their rain reports until mid afternoon each day, and it was discovered later that day that the MFS site in Jefferson only received 0.2 inches of rain. It is unknown how much rain the actual sampling sites received. Future rain event sampling projects should take additional measures to ensure that samples are taken as close as possible to the time the runoff is reaching the water body of interest.

Another difficulty encountered during this project was that it was discovered too late that glyphosate was going to be the main herbicide applied at the sampling sites. Although glyphosate binds to soil and may not typically be found in water for that reason, most of the sampling sites in this project consisted of a steep bank with rock or low vegetation between the tracks and the water, and in this setting it might be possible for glyphosate to reach water. If there is concern or questions to whether glyphosate has the ability to do harm in the aquatic environment then it is possible to send future samples to another lab, such as the Vermont State Pesticide Lab. The laboratory method is difficult to run because it is hard to separate glyphosate from other naturally occurring compounds.

The well that was sampled in Winthrop should be resampled during the winter when pesticides tend to be most easily detected in ground water. Additional wells could be sampled, particularly wells near diuron and/or bromacil application areas to sample over a period of years.

It is difficult to make many definitive conclusions from the data obtained from this study. More data will need to be collected to help determine whether Maine's existing 10 foot buffer between surface water bodies and herbicide applications on railroad ROWs is adequate.

Note: EPA's Health Advisory for drinking water containing glyphosate is 700 ppb. There is no established guideline for surface water, and there are no established guidelines for imazapyr.

Appendix A. Leaching and Runoff Potentials of Herbicides Used on Railroads

Leaching and Runoff Potentials for Active Ingredients **[Pesticide Interaction Loss Potential with Soil Type = Gravel pits (GRX-S 85%)]** USDA Natural Resources Conservation Service (2002) WIN-PST Database				
Active ingredient	Leaching Potential	Solution Runoff Potential	Adsorbed Runoff Potential	Buffer on label
Bromacil	High **[High]**	High **[Intermediate]**	Intermediate **[Low]**	no
Dicamba, diglyocamine salt	High **[High]**	Intermediate **[Low]**	Low **[Low]**	
Diuron	Intermediate **[High]**	High **[Intermediate]**	Intermediate **[Low]**	no
Fosamine ammonium	Low **[Intermediate]**	Intermediate **[Low]**	Low **[Low]**	no
Glyphosate	Very low **[Low]**	High **[Intermediate]**	High **[Intermediate]**	no product
Glyphosate Isopropylamine salt	Very low **[Low]**	High **[Intermediate]**	High **[Intermediate]**	no
Imazapyr	High **[High]**	High **[Intermediate]**	Intermediate **[Low]**	no product
Imazapyr Isopropylamine salt	High **[High]**	High **[Intermediate]**	Intermediate **[Low]**	no
Metsulfuron - methyl	High **[High]**	High **[Intermediate]**	Intermediate **[Low]**	no
Sulfometuron-methyl	Intermediate **[High]**	High **[Intermediate]**	Low **[Low]**	no
Triclopyr, butoxyethyl	Intermediate **[High]**	High **[Intermediate]**	Intermediate **[Low]**	

Appendix B. Additional Site Photos

Figure 3. Kennebec River sampling site
N44°09’13.3”
W69°46’00.8”

Figure 4. Kennebec River sampling site looking down slope from tracks

Figure 5. Kennebec River sampling site after spraying and before card collection

Figure 6. Damariscotta Lake northernmost site (picture taken from tracks)
N44°06'16.9"
W69°28'18.1"

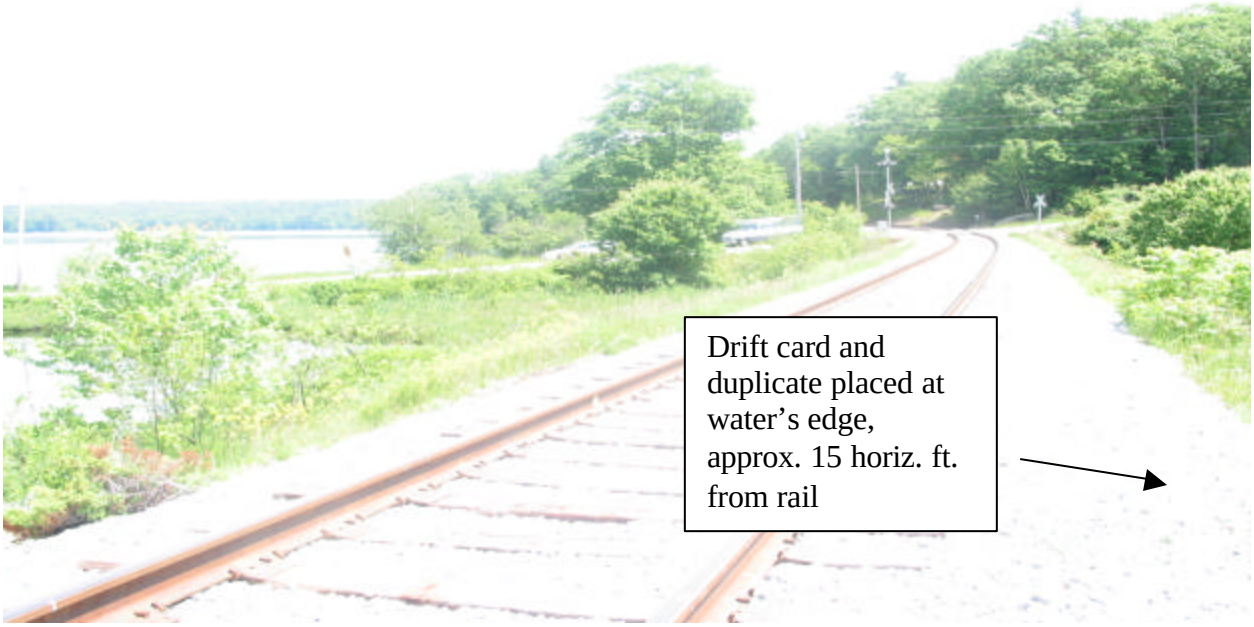

Figure 7. Damariscotta Lake middle site (water on both sides of track)
N44°06'15.6"
W69°28'24.1"

Figure 8. Damariscotta Lake southernmost site
N44°06'14.8"
W69°28'28.5"

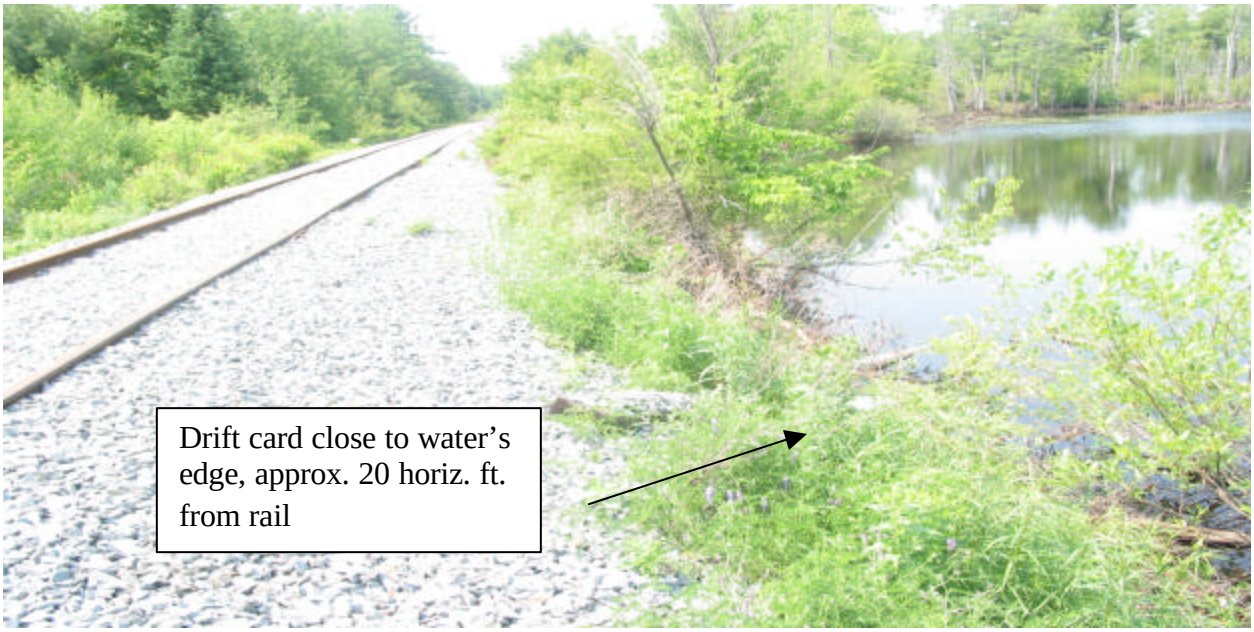

Figure 9. Burnham northernmost site (water on both sides of track)
N44°39'16.3"
W69°23'15.5"
The spray truck did not spray as it went by this small area. Thus, the drift card at this site was not expected to have, and did not have any positive detections.