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GOVERNOR

STATE OF MAINE
MAINE DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY
BOARD OF PESTICIDES CONTROL
28 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0028

WALTER E. WHITCOMB
COMMISSIONER

HENRY S. JENNINGS
DIRECTOR

BOARD OF PESTICIDES CONTROL

August 8, 2014

AMHI Complex, 90 Blossom Lane, Deering Building, Room 319, Augusta, Maine

AGENDA

8:30 AM

1. Introductions of Board and Staff

2. Public Hearing on Proposed Rule Amendments to Chapters 20, 22, 28, 31, 32, 33, and 41

   The Board will hear testimony on the proposed amendments to the following seven rules:

   - ***Chapter 20*** **Special Provisions—**Add a requirement for applicators making outdoor treatments to residential properties to implement a system to positively identify application sites in a manner approved by the Board. This requirement is currently in policy.

   - ***Chapter 22*** **Standards for Outdoor Application of Pesticides by Powered Equipment in Order to Minimize Off-Target Deposition—**Improve the effectiveness of the rule by eliminating the requirement of identifying sensitive areas for commercial applications conducted under categories 6A (rights-of-way vegetation management), 6B (industrial/commercial/municipal vegetation management) and 7E (biting fly & other arthropod vectors [ticks]). Applications conducted under category 6A and to sidewalks and trails under category 6B will require the applicator to implement a drift management plan.

   - ***Chapter 28*** **Notification Provisions for Outdoor Pesticide Applications—**Add to the list of categories that require posting: 6B (industrial/commercial/municipal vegetation management) except when making applications to sidewalks and trails, and 7E (biting fly & other arthropod vectors [ticks]). Require advance notice be published in a newspaper for applications conducted under 6A (rights-of-way vegetation management), and to sidewalks and trails under 6B (industrial/commercial/municipal vegetation management). This aligns with the proposed amendments to Chapter 22, eliminating the requirement for mapping sensitive areas, in lieu of posting or public notice.

   - ***Chapter 31*** **Certification and Licensing Provisions/Commercial Applicators—**Three amendments are proposed:

     1. Clarify that certain applications are exempt from commercial licensing requirements. These are currently in policy:
        - Adults applying repellents to children with the written consent of parents/guardians;
        - Persons installing antimicrobial metal hardware.

2. Exempt aerial applicators certified in other states from passing a written regulation exam and allow for issuance of reciprocal licensing when the staff determines that an urgent pest issue exists and when staff verbally reviews pertinent Maine laws with the applicator.
3. Shorten the time period a person must wait before re-taking an exam they have failed to 6 days.

- ***Chapter 32*** **Certification and Licensing Provisions/Private Applicator**—Shorten the time period a person must wait before re-taking an exam they have failed to 6 days.
- ***Chapter*** **33 Certification & Licensing Provisions/Private Applicators of General Use Pesticides (Agricultural Basic License)—**Shorten the time period a person must wait before re-taking an exam they have failed to 6 days.
- ***Chapter 41*** **Special Restrictions on Pesticide Use—**Amend Section 3 to eliminate the restrictions on hexazinone relative to pesticide distributors and air-assisted application equipment.

3. Minutes of the June 27, 2014, Board Meeting

Presentation By: Henry Jennings
Director

Action Needed: Amend and/or Approve

4. Final Adoption of Amendments to Chapters 20, 22, and 51

The Board held a public hearing on proposed amendments to Chapters 20, 22, and 51 on March 1, 2013. The proposed amendments were intended to allow governmental entities to conduct public-health-related, mosquito-control programs in the event of an elevated mosquito-borne disease threat. The Board reviewed the comments on April 12, 2013, and provisionally adopted revised proposals on May 24, 2013. The Joint Standing Committee on Agriculture, Conservation and Forestry held public hearings and work sessions on the provisionally adopted rules on June 26, 2013 and January 14, 2014 and a work session on January 23, 2014. The Committee voted to recommend authorizing final adoption in a divided report on January 28, 2014, and three resolves became law on February 26, 2014. Since the resolves were not passed as emergency legislation, they did not become effective until August 1, 2014. The Board has 60 days from the effective dates of the resolves to finally adopt the rules.

Presentation By: Henry Jennings
Director

Action Needed: Final Adoption of the Rule, Basis Statement, Rulemaking Statement of Impact on Small Business, and Response to Comments for Chapters 20, 22, and 51

5. Consideration of a Board Policy Interpreting "Food Production" for the Purposes of Determining Applicability of Public Law 2011, Chapter 169

Public Law 2011, Chapter 169, "An Act To Require Certification of Private Applicators of General Use Pesticides," requires anyone who grows and sells more than $1,000 worth of edible plants annually to become certified if they use general-use pesticides in "food production." A number of questions have arisen about what constitutes "food production" for the purposes of the

licensing requirement. At the June 27, 2014, meeting, the Board reviewed questions and discussed what it thought the legislative intent was. After reaching consensus, the Board directed the staff to draft an interim enforcement policy for review at a future meeting. The staff has prepared a draft policy for the Board's consideration.

Presentation By: Henry Jennings
Director

Action Needed: Approve/Revise Draft Policy

6. Interpretation of CMR 01-01A, Chapter 24, Section 7(D)

Chapter 24, Section 7(D) requires that, "Any outdoor pesticide display area must be securely fenced and must have a roof to protect the material from the elements." When the original rule was adopted, the Board wanted to make sure that pesticides stored at distributors were protected from vandalism and the weather. Some questions have arisen about how this requirement should be applied in certain circumstances.

Presentation By: Raymond Connors
Manager of Compliance

Action Needed: Provide Guidance to the Compliance Staff

7. Interpretation of CMR 01-026, Chapter 31, Section 1(E)(IV)

Section 1(E) of Chapter 31 currently lists four "exemptions," presumably to the requirements for a commercial applicator's license. The fourth exemption reads, "Certified or licensed Wastewater or Drinking Water Operators." A question has arisen about the intended scope of this exemption.

Presentation By: Gary Fish
Manager of Pesticide Programs

Action Needed: Provide Guidance to the Staff

8. Other Old or New Business

a. ERAC sampling update—Mary Tomlinson
b. Variance permit to Urban Tree Service for control of poison ivy in York, Maine—H. Jennings
c. Variance permit to The Lawn Dawg for control of invasive plants in South Portland, Maine—H. Jennings

9. Schedule of Future Meetings

September 12, October 24, and December 5, 2014, are tentative Board meeting dates. The Board will decide whether to change and/or add dates.

Action Needed: Adjustments and/or Additional Dates?

10. Adjourn

NOTES

- The Board Meeting Agenda and most supporting documents are posted one week before the meeting on the Board website at www.thinkfirstspraylast.org.
- Any person wishing to receive notices and agendas for meetings of the Board, Medical Advisory Committee, or Environmental Risk Advisory Committee must submit a request in writing to the Board's office. Any person with technical expertise who would like to volunteer for service on either committee is invited to submit their resume for future consideration.
- On November 16, 2007, the Board adopted the following policy for submission and distribution of comments and information when conducting routine business (product registration, variances, enforcement actions, etc.):
    - *For regular, non-rulemaking business*, the Board will accept pesticide-related letters, reports, and articles. Reports and articles must be from peer-reviewed journals. E-mail, hard copy, or fax should be sent to the attention of Anne Bills, at the Board's office or anne.bills@maine.gov. In order for the Board to receive this information in time for distribution and consideration at its next meeting, all communications must be received by 8:00 AM, three days prior to the Board meeting date (e.g., if the meeting is on a Friday, the deadline would be Tuesday at 8:00 AM). Any information received after the deadline will be held over for the next meeting.
- During rulemaking, when proposing new or amending old regulations, the Board is subject to the requirements of the APA (Administrative Procedures Act), and comments must be taken according to the rules established by the Legislature.

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 20: SPECIAL PROVISIONS

SUMMARY: These provisions regulate the use, storage and disposal of pesticides with specific emphasis on registered pesticides, right of way and aquatic applications and employer/employee requirements.

Section 1. Registered Pesticides

A. The use of any pesticide not registered by the Maine Board of Pesticides Control in accordance with Title 7 M.R.S.A. §601 is prohibited except as otherwise provided in this chapter or by FIFRA, Section 2(ee).

B. The use of registered pesticides for other than registered uses, or at greater than registered dosages, or at more frequent than registered intervals is prohibited, provided that application or use of unregistered pesticides and unregistered applications or uses of registered pesticides may be made for experimental purposes if in accordance with requirements of the Maine Board of Pesticides Control, and the U.S. Environmental Protection Agency.

C. Retailers and end users of pesticides no longer registered in Maine may continue to sell and use those items provided they were properly registered when obtained and such distribution and use is not prohibited by FIFRA or other Federal law.

D. In conducting review of registration or re-registration pursuant to 7 M.R.S.A. §607-A, the Board may consider the potential for environmental damage by the pesticide through direct application on or off-target or by reason of drift. If the Board finds that the use of the pesticide is anticipated to result in significant adverse impacts on the environment, whether on or off-target, which cannot be avoided or adequately mitigated, registration or re-registration will not be granted unless the Board finds that anticipated benefits of registration clearly outweigh the risks. In any case where the Board may request data in connection with registration or re-registration of any pesticide, such data may include that concerning pesticide residues, propensity for drift and testing therefor. Such data, if requested, shall provide information regarding residues and residue effects on plant tissues, soil and water and other potential deposition sites, and shall take into consideration differences in plants, soils, climatic conditions at the time of application and application techniques.

Section 2. Right-of-Way

Deciduous growth over six feet in height and evergreen growth over three feet in height shall not be sprayed with a herbicide within the right-of-way of any public way except that deciduous

growth which has been cut to the ground and which has grown more than six feet during the growing season following the cutting, may be sprayed that following season. In addition, chemical pruning of single limbs of trees over the prescribed heights may be performed.

Section 3. Pesticide Storage and Disposal

A. Unused pesticides, whether in sealed or open containers, must be kept in a secure enclosure and otherwise maintained so as to prevent unauthorized use, mishandling or loss; and so as to prevent contamination of the environment and risk to public health.

B. Obsolete, expired, illegal, physically or chemically altered or unusable pesticides, except household pesticide products, shall be either:

1. stored in a secure, safe place under conditions that will prevent deterioration of containers or any contamination of the environment or risk to public health, or

2. returned to the manufacturer or formulator for recycling, destruction, or disposal as appropriate, or

3. disposed of in a licensed hazardous waste facility or other approved disposal site that meets or exceeds all current requirements of the Maine Department of Environmental Protection and the U.S. Environmental Protection Agency for facilities receiving such waste.

Section 4. Aquatic Applications

No person, firm, corporation or other legal entity shall, for the purpose of controlling aquatic pests, apply any pesticide to or in any waters of the state as defined in 38 M.R.S.A. §361-A(7) without approval of the Maine Department of Environmental Protection.

Section 5. Employer/Employee Requirements

A. Any person applying pesticide shall instruct their employees and those working under their direction about the hazards involved in the handling of pesticides to be employed as set forth on the pesticide label and shall instruct such persons as to the proper steps to be taken to avoid such hazards.

B. Any person applying pesticides shall provide and maintain, for the protection of their employees and persons working under their direction, the necessary safety equipment as set forth on the label of the pesticide to be used.

Section 6. Authorization for Pesticide Applications

A. Authorization to apply pesticides to private property is not required when a pesticide application is made by or on behalf of the holder of an easement or right of way, for the purposes of establishing or maintaining such easement or right of way.

B. When the Maine Center for Disease Control and Prevention (CDC) has identified that an organism is a vector of human disease and the vector and disease are present in an area, a government entity shall obtain authorization for ground-based applications by:

1. Sending a written notice to the person(s) owning property or using residential rental, commercial or institutional buildings within the intended target site at least three days but not more than 60 days before the commencement of the intended spray applications. For absentee property owners who are difficult to locate, mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice; and

2. Implementing an "opt out" option whereby residents and property owners may request that their property be excluded from the application by submitting written notice to the government entity at least 24 hours before spraying is scheduled to commence. Authorization is considered given for any property for which written notice was submitted and no "opt out" request was received by the sponsoring government entity.

C. When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government entities are not required to receive prior authorization to apply pesticides to private property, provided that the government entity sponsoring the vector control program:

1. Provides advance notice to residents about vector control programs using multiple forms of publicity which may include, but is not limited to, signs, newspaper, television or radio notices, direct mailings, electronic communication or other effective methods; and

2. Implements an "opt out" option whereby residents and property owners may request that their property be excluded from any ground based control program and the government entity makes a reasonable effort to honor such requests; and

3. If aerial applications are made, takes affirmative steps, to the extent feasible, to avoid applications to exclusion areas as identified by Board policy.

D. **General Provisions**. For any pesticide application not described in Chapter 20.6(A),(B) or (C), the following provision apply:

1. No person may contract with, or otherwise engage, a pesticide applicator to make any pesticide application to property unless that person is the owner, manager, or legal occupant of the property to which the pesticide is to be applied, or that person has the authorization of the owner, manager or legal

occupant to enter into an agreement for pesticide applications to be made to that property. The term "legal occupant" includes tenants of rented property.

2. No person may apply a pesticide to a property of another unless prior authorization for the pesticide application has been obtained from the owner, manager or legal occupant of that property. The term "legal occupant" includes tenants of rented property.

3. No commercial applicator may perform ongoing, periodic non-agricultural pesticide applications to a property unless:

   i. there is a signed, written agreement with the property owner, manager or legal occupant that explicitly states that such pesticide applications shall continue until a termination date specified in the agreement, unless sooner terminated by the applicator or property owner, manager or legal occupant; or

   ii. the commercial applicator utilizes another system of verifiable authorization approved by the Board that provides substantially equivalent assurance that the customer is aware of the services to be provided and the terms of the agreement.

Section 7. Positive Identification of Proper Treatment Site

A. Commercial applicators making outdoor treatments to residential properties must implement a system, based on Board approved methods, to positively identify the property of their customers. The Board shall adopt a policy listing approved methods of positive identification of the proper treatment site.

STATUTORY AUTHORITY: Title 22 M.R.S.A., Chapter 258-A

EFFECTIVE DATE:
July 6, l979

AMENDMENT EFFECTIVE:
April 1, 1985
January 1, 1988
May 21, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
May 7, 1997 - Section 5

CONVERTED TO MS WORD:
March 11, 2003

CORRECTED HEADER CHAPTER NUMBER:
January 10, 2005

AMENDED:
January 1, 2008 – new Sections 6 and 7, filing 2007-65
September 13, 2012 – Section 6(E) and references added, filing 2012-270 (Emergency – expires in 90 days unless proposed and adopted in the meantime as non-emergency)
December 12, 2012 – emergency filing expires, chapter reverts to January 1, 2008 version
September 13, 2012 – Section 6(E) and references added, filing 2012-270 (Emergency – expires in 90 days unless proposed and adopted in the meantime as non-emergency)
December 12, 2012 – emergency filing expires, chapter reverts to January 1, 2008 version
June 12, 2013 – Emergency major substantive filing 2013-134

CORRECTIONS:
February, 2014 – agency names, formatting

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 22: STANDARDS FOR OUTDOOR APPLICATION OF PESTICIDES BY POWERED EQUIPMENT IN ORDER TO MINIMIZE OFF-TARGET DEPOSITION

SUMMARY: These regulations establish procedures and standards for the outdoor application of pesticides by powered equipment in order to minimize spray drift and other unconsented exposure to pesticides. The primary purpose of these regulations is to implement the legislative mandate of the Board, as expressed by 7 M.R.S.A. §606(2)(G), to design rules which "minimize pesticide drift to the maximum extent practicable under currently available technology."

SECTION 1. EXEMPTIONS

The regulations established by this chapter shall not apply to pesticide applications in any of the following categories:

A. Applications of pesticides confined entirely to the interior of a building;

B. Applications of pesticides by non-powered equipment;

C. Applications of pesticides exclusively in granular or pelletized form;

D. Applications of pesticides injected underground or otherwise injected directly into the target medium. Such applications must involve no spraying of pesticides whatsoever.

SECTION 2. STANDARDS OF CONDUCT FOR PESTICIDE APPLICATIONS

All pesticide applications subject to these regulations shall be undertaken in compliance with the following standards of conduct:

A. **Equipment**

I. Pesticide spray equipment shall be used in accordance with its manufacturer's recommendations and instructions, and shall be in sound mechanical condition, free of leaks and other defects or malfunctions which might cause pesticides to be deposited off-target.

II. Pesticide spray equipment shall be properly calibrated consistent with Board or University published guidance. Sufficient records to demonstrate proper calibration must be maintained and made available to representatives of the Board upon request.

III. Pesticide application equipment shall have properly functioning shut-off valves or other mechanisms which enable the operator to prevent direct discharge and minimize drift to non-target areas. Spray equipment designed to draw water must also have a properly functioning antisiphoning device.

B. **Weather Conditions**

I. Spray applications shall not be undertaken when weather conditions favor pesticide drift onto Sensitive Areas or otherwise prevent proper deposition of pesticides on target.

II. Pesticide application must cease immediately when visual observation reveals or should reveal that spray is not being deposited on target.

III. Without limitation of the other requirements herein, under no circumstances shall pesticide application occur when wind speed in the area is in excess of 15 miles per hour.

C. **Identifying and Recording Sensitive Areas**

I. Prior to spraying a pesticide, the applicator must become familiar with the area to be sprayed and must identify and record the existence, type and location of any Sensitive Area located within 500 feet of the target area. Applicators shall prepare a site map or other record, depicting the target area and adjacent Sensitive Areas. The map or other record shall be updated annually. The site map or other record shall be retained by the applicator for a period of two years following the date of applications and shall be made available to representatives of the Board upon request.

II. This requirement shall not apply to commercial applications <u>conducted under</u> categories 3A (<u>outdoor</u> ornamental ~~tree and plant~~), 3B (turf), <u>6A (rights-of-way vegetation management), 6B (industrial/commercial/municipal vegetation management),</u> ~~or~~ 7A (structural general pest control applications)<u>, or 7E (biting fly & other arthropod vectors [ticks])</u>.

III. <u>Applications conducted under category 6A (rights-of-way vegetation management) and to sidewalks and trails under category 6B (industrial/commercial/municipal vegetation management) require the applicator to implement a drift management plan.</u>

D. **Presence of Humans, Animals**

Pesticide applications shall be undertaken in a manner which minimizes exposure to humans, livestock and domestic animals.

The applicator shall cease spray activities at once upon finding evidence showing the likely presence of unprotected persons in the target area or in such proximity as to result in unconsented exposure to pesticides.

E. **Other Requirements**

These regulations are intended to be minimum standards. Other factors may require the applicator to take special precautions, beyond those set forth in these regulations, in order to avoid adverse impacts on off-target areas and to protect public health and the environment.

SECTION 3. STANDARDS FOR AERIAL APPLICATION OF PESTICIDES

A. **Positive Identification of the Target Site**

The person contracting for an aerial pesticide application shall ensure that the application site (i.e., target area) is positively identified prior to application, using a unique and verifiable method, including;

I. An onboard, geo-referenced electronic mapping and navigation system (e.g., GPS); or

II. Effective site markings visible to the applicator; or

III. Other method(s) approved by the Board.

B. **Site Plans Required**

Prior to spraying by aerial application within 1,000 feet of a Sensitive Area Likely to Be Occupied, the person contracting for the application shall provide to the applicator a site plan that includes:

I. a site map drawn to scale that:

(i) delineates the boundaries of the target area and the property lines;

(ii) depicts significant landmarks and flight hazards;

(iii) depicts the type and location of any Sensitive Area Likely to Be Occupied within 1,000 feet of the target area; and

(iv) depicts other Sensitive Areas within 500 feet of the target area.

II. If applicable, a school bus schedule shall accompany the site map.

III. The site plan and site map with identified sensitive areas required under Section 3(B) shall be retained by the applicator for a period of two years following the date of applications and shall be made available to representatives of the Board upon request.

IV. Compliance with this section satisfies the requirements of Section 2(C).

C. **Site-Specific Application Checklist**

Prior to conducting an aerial pesticide application within 1,000 feet of a Sensitive Area Likely to Be Occupied, the applicator shall complete a Board-approved pre-application checklist for each distinct field or target site. The checklist shall be maintained by the applicator for a period of two years and shall be available for inspection by representatives of the Board at reasonable times, upon request. The checklist shall include, at a minimum, the following elements:

I. The date, time, description of the target site and name of the applicator;

II. Confirmation that the notification requirements contained in CMR 01-026, Chapters 28 and 51, have been carried out;

III. Confirmation that the target site has been positively identified;

IV. The location of where weather conditions are measured and a description of the equipment used to measure the wind speed and direction;

V. Confirmation that conditions are acceptable to treat the proposed target site, considering the location of any Sensitive Area Likely to Be Occupied and current weather conditions;

VI. Wind speed and direction;

VII. The measures used to protect all Sensitive Areas;

VIII. Confirmation that there are no humans visible in or near the target area.

D. **Buffer Zones for any Sensitive Area Likely to Be Occupied**

Aerial applicators shall employ site-specific buffer zones adjacent to any Sensitive Area Likely to Be Occupied sufficient to prevent unlawful pesticide drift, unless consent has been granted by the landowner, lessee and occupant (when applicable), consistent with the provisions of Section 4(C) of this rule.

E. **Wind Speeds for Aerial Applications**

Unless otherwise specified by the product label, an applicator may not conduct an aerial application of pesticides within 1,000 feet of a Sensitive Area Likely to Be Occupied unless the wind speed is between 2 and 10 miles per hour.

SECTION 4. GENERAL STANDARDS FOR OFF-TARGET PESTICIDE DISCHARGE AND RESIDUE

A. **Prohibition of Unconsented, Off-Target Direct Discharge of Pesticides**

Pesticide applications shall be undertaken in a manner which does not result in off-target direct discharge of pesticides, unless prior authorization and consent is obtained from the owner or lessee of the land onto which such discharge may occur in a manner consistent with the pesticide label.

B. **Standards for Unconsented, Off-Target Drift of Pesticides**

I. **General Standard**. Pesticide applications shall be undertaken in a manner which minimizes pesticide drift to the maximum extent practicable, having due regard for prevailing weather conditions, toxicity and propensity to drift of the pesticide, presence of Sensitive Areas in the vicinity, type of application equipment and other pertinent factors.

II. **Prima Facie Evidence**. Pesticide residues in or on any off-target Sensitive Area Likely to Be Occupied resulting from off-target drift of pesticides from a nearby application that are 1% or greater of the residue in the target area are considered prima facie evidence that the application was not conducted in a manner to minimize drift to the maximum extent practicable. The Board shall review the site-specific application checklist completed by the applicator and other relevant information to determine if a violation has occurred. For purposes of this standard, the residue in the target area, and the residue in the Sensitive Area Likely to Be Occupied, may be adequately determined by evaluation of one or more soil, foliage or other samples, or by extrapolation or other appropriate techniques.

III. **Standard of Harm**. An applicator may not apply a pesticide in a manner that results in:

(i) Off-target pesticide residue detected in or on any nearby crop which violates EPA tolerances for that crop, as established under 40 CFR, Part 180.

(ii) Off-target pesticide residue detected in or on any nearby organic farm or garden which causes the agricultural products thereof to be excluded from organic sale in accordance with 7 CFR, Part 205, Section 205.671.

(iii) Off-target pesticide residue detected on any nearby persons or vehicles using public roads.

(iv) Documented human illness. For this standard to be met, the Board must receive verification from two physicians that an individual has experienced a negative health effect from exposure to an applied pesticide and that the effect is consistent with epidemiological documentation of human sensitivity to the applied pesticide.

(v) Off-target damage or injury to any organism.

IV. **Enforcement Considerations**. The Board shall consider the particular circumstances of violations arising from Subsections 4(B)(I) and (III) in determining an appropriate response, including, but not limited to:

(i) The standard of care exercised by the applicator;

(ii) The degree of harm or potential harm that resulted from or could have resulted from off-target drift from the application;

(iii) The risk (toxicity and exposure) of adverse effects from the pesticide applied.

C. **Consent**

I. **Consent, How Given**. Authorization and consent by the owner or lessee and occupant (when applicable) of land receiving a pesticide discharge or drift in a manner consistent with the pesticide label may be given in any manner, provided that the consent is reasonably informed and is given prior to the onset of the spray activity in question. The burden of proof shall be upon the applicator to demonstrate that requisite authorization and consent has been given. For this reason, applicators are encouraged to obtain such consent in writing and to maintain records thereof.

II. The residue and harm standards in Sections 4(B)(II) and (III) for off-target drift do not apply where the owner, lessee and occupant (when applicable) of the off-target area receiving the pesticide drift have given authorization and consent as prescribed in Section 4(C).

III. Except with the prior written approval of the Board, no authorization or consent may be given with regard to off-target direct discharge or off-target drift of pesticides upon any bodies of water or critical areas as defined in CMR 01-026, Chapter 10, "Definitions; Sensitive Area."

SECTION 5. VARIANCES FROM STANDARDS

A. **Variance Permit Application**

An applicator may vary from any of the standards imposed under this chapter by obtaining a permit to do so from the Board. Permit applications shall be made on such forms as the Board provides and shall include at least the following information:

I. The name, address, and telephone number of the applicant;

II. The area(s) where pesticides will be applied;

III. The type(s) of pesticides to be applied;

IV. The purpose for which the pesticide application(s) will be made;

V. The approximate date(s) of anticipated spray activities;

VI. The type(s) of spray equipment to be employed;

VII. The particular standards from which the applicant seeks a variance;

VIII. The particular reasons why the applicant seeks a variance from such standards, including a detailed description of the techniques to be employed to assure a reasonably equivalent degree of protection and of the monitoring efforts to be made to assure such protection;

IX. The names and addresses of all owners or lessees of land within 500 feet of the proposed spray activity, and evidence that such persons have been notified of the application. The Board may waive this requirement where compliance would be unduly burdensome and the applicant attempts to notify affected persons in the community by another means which the Board finds reasonable.

B. **Board Review; Legal Effect of Permit, Delegation of Authority to Staff**

I. Within 60 days after a complete application is submitted, the Board shall issue a permit if it finds that the applicant will achieve a substantially equivalent degree of protection as adherence to the requirements of this chapter would provide and will conduct spray activities in a manner which protects human health and the environment. Such permit shall authorize a variance only from those particular standards for which variance is expressly requested in the application and is expressly granted in the permit. The Board may place conditions on any such permit, and the applicant shall comply with such conditions. Except as conditioned in the permit, the applicant shall undertake spray activities in accordance with all of the procedures described in the application and all other applicable legal standards. Permits issued by the Board under this section shall not be transferable or assignable except with further written approval of the Board and shall be valid only for the period specified in the permit.

II. The Board may delegate authority to review applications and issue permits to the staff as it feels appropriate. All conditions and limitations as described in Section 5(B) I shall remain in effect for permits issued by the staff. If the staff does not grant the variance permit, the applicator may petition the Board for exemption following the requirements set forth in 22 MRSA §1471-T, “Exemptions.”

SECTION 6. EMERGENCIES

A. In the event that severe pest or weather conditions threaten to cause a significant natural resource and/or economic loss, as determined by the Commissioner of the Maine Department of Agriculture, Conservation and Forestry, the requirements contained in Section 3 of this Chapter shall be waived, subject to the following conditions:

I. The severe pest and/or weather conditions must necessitate immediate wide-scale aerial application of pesticides.

II. The immediate need for aerial pesticide application does not provide sufficient time to complete the requirements of Section 3 of this Chapter,

III. Prior to any aerial application, the Commissioner shall issue a press release notifying residents of affected regions about the emergency, the likelihood of aerial application in the affected regions and the approximate dates that the emergency may continue.

IV. The Commissioner, in consultation with the Board's staff, shall specify the requirements in Section 3 that will be waived.

V. Land managers and aerial applicators shall make good faith efforts to comply with the intent of Section 3 and minimize off-target drift to Sensitive Areas.

B. When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government sponsored vector control programs are exempt from Sections 2C, 2D, 3B, 3C, 3D, 3E and 4 of this chapter, provided that reasonable efforts are made to avoid spraying non-target areas.

June 12, 2009 amendments become effective on January 1, 2010

STATUTORY AUTHORITY: 7 M.R.S.A. §606(2)(G):
22 M.R.S.A. §1471-M(2)(D)

EFFECTIVE DATE:
January 1, 1988

AMENDED:
October 2, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
September 22, 1998 - also converted to MS Word
January 4, 2005 – filing 2004-603 affecting Section 3.B.II.(iii)
January 1, 2010 by request of agency in filing 2009-252
June 12, 2013 – filing 2013-135 (Emergency major substantive)

CORRECTIONS:
February, 2014 - formatting

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 28: NOTIFICATION PROVISIONS FOR OUTDOOR PESTICIDE APPLICATIONS

SUMMARY: These regulations establish procedures and standards for informing interested members of the public about outdoor pesticide applications in their vicinity. This chapter sets forth the requirements for requesting notification about pesticide applications, for posting property on which certain commercial pesticide applications have occurred and also establishes the *Maine Pesticide Notification Registry* structure and fees.

Section 1. Requesting Notification About Outdoor Pesticide Applications

The purpose of the following notification requirement is to enable individuals an opportunity to obtain information regarding outdoor pesticide application activities in their vicinity.

A. Requests for Notification; How Made

The owner, lessee or other legal occupant of a sensitive area may make a request to be notified about any outdoor pesticide application(s) which may occur within 500 feet of that sensitive area and any aerial application(s) which may occur within 1,000 feet of the sensitive area.

1. The request may be made in any fashion, so long as it is effective in informing the person receiving the request of the name, address, telephone number, and interest in receiving notification of the person making the request.

2. The request for notification should be made to the person responsible for management of the land on which the pesticide application will take place. If the person making the request for notification is uncertain as to the identity of the person to whom the request should be made, he/she may make the request for notification to the person who owns the land involved, as such ownership is ascertainable from the tax records of the municipality. That landowner shall then be responsible for assuring compliance with provisions of this section.

B. Procedure of Notification

Once a request for notification has been made as provided in Section 1(A), the person receiving the request shall cause notification to be given as follows:

1. General notification of intent to apply pesticides out-of-doors shall be given to the person making the request for notification. Such general notification may be given in any fashion, provided that it is effective in informing the person receiving the notice of the following:

a. the approximate date(s) when pesticide(s) may be applied;

b. the pesticide(s) which may be applied;

c. in general terms, the manner of application; and

d. the name, address and telephone number of a person responsible for the pesticide application from whom additional information may be obtained.

e. If requested, the person responsible for managing the land shall make reasonable efforts to supply a copy of the MSDS(s) and/or the pesticide label(s). However such requests for additional information will not delay nor prohibit the intended pesticide application.

Where feasible, such general notification shall be given within one week after the request for notification is received and at least one day before any pesticide application is to occur. Such notification may cover outdoor pesticide applications which are planned over a period of up to one growing season.

2. If, following receipt of the general notification as provided by Section 1(B)(1) above, the person seeking notification believes there is a need for additional or updated information regarding impending pesticide application activities, he/she may make a further request for additional information from the person identified in the general notification. This request for additional information must specify the type of information needed, including, for example, more specific information regarding the date or dates on which pesticides will be applied when known. The person responsible for the notification shall make reasonable efforts to comply with such request for additional information.

3. If any person is dissatisfied with the efforts made by any other person at complying with these notification provisions, a complaint may be filed with the Board. The Board shall then make efforts to attempt to reach a reasonable and fair resolution between the parties.

Section 2. *Maine Pesticide Notification Registry* for Non-Agricultural Pesticide Applications

The Board shall maintain a list of individuals who must be notified of outdoor, non-agricultural pesticide applications in their vicinity. This list shall be referred to as the *Maine Pesticide Notification Registry*.

A. Individuals to be Included on the Registry

1. Individuals requesting to be listed on the *Maine Pesticide Notification Registry* shall pay all appropriate fees and provide the following information on forms supplied by the Board:

a. Name;

b. Mailing address;

c. Listed registry residence, including street or road address and city;

d. Daytime and evening telephone number(s), one of which is designated as the primary contact number; and

e. The names and addresses of all landowners or lessees within 250 feet of the boundary of the listed registry residence.

2. Individuals may register more than one residence by completing additional forms and paying all appropriate fees.

3. The effective period of the registry will be from March 1 to February 28 of the following year. Individuals must submit their request for inclusion on the next effective registry by December 31. All submissions received after that date will be included on the following registry. Individuals may notify the Board at any time of changes in their listed registry residence, however, changes will not take effect until the following registry. An individual will not be considered officially included on the *Maine Pesticide Notification Registry* unless their name appears on the current effective registry.

4. The Board shall mail renewal notices to individuals listed on the *Maine Pesticide Notification Registry* on or before November 1 of each year. An individual must re-apply and pay all appropriate fees annually to remain on the registry for the next twelve month period.

B. **Alerting Neighbors to the Presence of an Individual on the Registry**

1. All individuals on the *Maine Pesticide Notification Registry* shall annually provide a letter to all landowners and lessees within 250 feet of their property boundary from whom they want to receive notification.

2. This letter, approved and supplied by the Board, must inform neighbors of the existence of the *Maine Pesticide Notification Registry*, the individual's request to be notified in the event of an outdoor pesticide application, the distance from the property boundary which shall cause notification to be given for non-agricultural pesticide applications, and the notification requirements of this chapter.

3. The individual on the registry requesting notification bears the burden of proof for demonstrating that this provision has been met.

4. Failure to distribute the letter will not prohibit an individual from being added to or remaining on the registry.

C. **Registry Provided to Commercial Applicators**

The *Maine Pesticide Notification Registry* shall be printed and distributed annually to affected licensed Commercial Master Applicators on or before its effective date of March 1. Newly licensed Commercial Master Applicators will be provided a copy of the current effective registry upon licensing.

D. **Notification to Individuals on the *Maine Pesticide Notification Registry***

1. Commercial applicators shall notify an individual listed on the registry when performing an outdoor, non-agricultural pesticide application that is within 250 feet of the property boundary of the listed registry residence.

2. A person who receives a letter in accordance with Section 2(B) and who performs any outdoor, non-agricultural pesticide application within 250 feet to the property boundary of the listed registry residence shall notify the individual from whom the letter was given or sent.

3. Notification must consist of providing the following information to the individual on the registry:

   a. The location of the outdoor pesticide application;

   b. The date and approximate start time of the pesticide application (within a 24 hour time period) and, in the event of inclement weather, an alternative date or dates on which the application may occur;

   c. The brand name and EPA registration number of the pesticide product(s) which will be used; and

   d. The name and telephone number of the person or company making the pesticide application.

4. An individual on the registry who receives notification may request a copy of the pesticide product label or Material Safety Data Sheet. The person or company performing the pesticide application shall make reasonable efforts to comply with such request for additional information. However, such requests for additional information will not delay nor prohibit the person or company from performing the pesticide application as scheduled.

5. Notification must be received between 6 hours and 14 days prior to the pesticide application.

6. Notification must be made by telephone, personal contact or mail.

   a. In cases where personal contact with the individual listed on the registry is not achieved, notification requirements are met via telephone if:

i. the information is placed on a telephone answering device activated by calling the individual's primary contact telephone number; or

ii. the information is given to a member of the household or workplace contacted by dialing the primary contact telephone number.

b. If notification cannot be made after at least two telephone contact attempts and personal contact is not feasible, notification may be made by securely affixing the notification information in written form on the principal entry of the listed registry location.

7. The person or company performing the pesticide application bears the burden of proof for demonstrating that they have complied with this section.

E. **Exceptions**

1. Any person providing written notices to property owners in accordance with Chapter 51, "Notice of Aerial Pesticide Applications," shall be exempt from this section.

2. The following types of pesticide applications do not require notification under this section:

a. The application of pesticides indoors;

b. Agricultural pesticide applications;

c. The outdoor commercial application of pesticides to control vegetation in rights-of-way in certification and licensing categories ~~VI(A) –~~ 6A (utility rights-of-way), ~~VI(B) –~~ and 6B (roadside vegetation management~~), and VI(C) – 6C (railroad vegetation management)~~;

d. The outdoor commercial application of pesticides in certification and licensing category ~~VII(a) –~~ 7A (structural general pest control) within five (5) feet of a human dwelling, office building, institution such as a school or hospital, store, restaurant or other occupied industrial, commercial or residential structure which is the intended target site;

e. The application of general use pesticides by hand or with non-powered equipment to control stinging insects;

f. The placement of pesticidal baits;

g. The injection of pesticides into trees or utility poles;

h. The placement of pesticide-impregnated devices on animals, such as ear tags and flea collars;

i. The application of pesticidal pet supplies, such as shampoos and dusts;

j. The application of disinfectants, germicides, bactericides and virucides, such as bleach. The use of disinfectants in the pressure-washing of the exterior of buildings is not exempt under this section;

k. The application of insect repellents to the human body;

l. The application of swimming pool products;

m. The application of general use paints, stains, and wood preservatives and sealants applied with non-powered equipment or by hand or within an enclosure which effectively prevents the escape of spray droplets of the product being applied; and

n. The injection of pesticides into wall voids.

F. **Exemption from this section**

If an individual on the current effective registry and a person or company performing pesticide applications subject to this rule can reach an agreement on notification provisions acceptable to both parties other than those described herein, then the requirements as described in this section may be waived. For such an exemption to be in effect, the details of the notification agreement must be placed in writing and signed by both parties. Either party may terminate the notification agreement with a 14-day, written notice.

G. **Fee**

The annual application fee for an individual requesting to be on the registry will be $20.00. The Board may waive the fee for individuals who demonstrate an inability to pay, or where other extenuating circumstances exist which justify granting a waiver. Evidence of an individual's inability to pay shall include, but not be limited to, the individuals participation in any of the following programs:

1. Food Stamps

2. Temporary Assistance for Needy Families (TANF)

3. Supplemental Security Income (SSI)

4. Social Security Disability (SSD)

5. Maine Care (Medicaid)

Requests for a fee waiver must be in writing and be made by the individual at the time of application for listing on the registry. The written request must contain sufficient information for the Board to determine that a basis for granting a fee waiver has been demonstrated in accordance with this rule.

Section 3. Posting and Public Notice Requirements for Pesticide Applications in Certain Commercial Licensing Categories

A. **Signs**

1. Categories Requiring Posting

a. 3A (outdoor ornamentals),
b. ~~III(b) –~~ 3B (turf), ~~and VII(a) –~~
c. 6B (industrial/commercial/municipal vegetation management), except applications to sidewalks and trails
d. 7A (structural general pest control)
e. 7E (biting fly & other arthropod vectors [ticks])

2. Posting Requirements

~~Where outdoor commercial pesticide applications in certification and licensing categories III(a) - Outdoor Ornamentals, III(b) - Turf, and VII(a) - Structural General will take place, the area~~ Areas treated under the categories listed in Section 3A(1) shall be posted in a manner and at locations designed to reasonably assure that persons entering such area will see the notice. Such notice shall be posted before application activities commence and shall remain in place at least two days following the completion of the application. The sign shall be sufficient if it meets the following minimum specifications:

~~A.~~a. The sign must be at least five (5) inches wide and four (4) inches high;

~~B.~~b. The sign must be made of rigid, weather resistant material that will last at least forty-eight (48) hours when placed outdoors;

~~C.~~c. The sign must be light colored (white, beige, yellow or pink) with dark, bold letters (black, blue or green);

~~D.~~d. The sign must bear:

~~1.~~i. the word CAUTION in 72 point type;

~~2.~~ii. the words PESTICIDE APPLICATION in 30 point type or larger;

~~3.~~iii. the Board designated symbol;

~~4.~~iv. any reentry precautions from the pesticide labeling;

~~5.~~v. the name of the company making the pesticide application and its telephone number;

~~6.~~vi. the date and time of the application; and

~~7.~~vii. a date and/or time to remove the sign.

B. **Public Notice**

Advance notice must be published in a newspaper of general circulation in the affected area at least three but no more than 30 days prior to applications conducted under category 6A (rights-of-way vegetation management) and to sidewalks and trails under category 6B (industrial/commercial/municipal vegetation management)**,**

~~E.~~C. **Exemption from this section**

1. The placement of marked bait stations in outdoor settings shall be exempt from this section.

2. Any person providing notice in accordance with Chapter 51 - Notice of Aerial Pesticide Applications, Section III. - Ornamental Plant Applications, shall be exempt from this section.

STATUTORY AUTHORITY: 22 MRSA §1471-M(2)D

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01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 31: CERTIFICATION AND LICENSING PROVISIONS/COMMERCIAL APPLICATORS

SUMMARY: These regulations describe the requirements for certification and licensing of commercial applicators.

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1. Individual Certification and Company/Agency Licensing Requirements

A. Any commercial applicator must be either:

I. licensed as a commercial applicator/master; or

II. licensed as a commercial applicator/operator; or

III. supervised on-site by either a licensed commercial applicator/master or a commercial applicator/operator who is physically present on the property of the client the entire time it takes to complete an application conducted by an unlicensed applicator. This supervision must include visual and voice contact. Visual contact must be continuous except when topography obstructs visual observation for less than five minutes. Video contact does not constitute visual observation. The voice contact requirement may be satisfied by real time radio or telephone contact. In lawn care and other situations where both the licensed and unlicensed applicator are operating off the same application equipment, the licensed applicator may move to an adjoining property on the same side of the street and start another application so long as he or she is able to maintain continuous visual and voice contact with the unlicensed applicator.

B. All commercial applicator licenses shall be affiliated with a company/agency and shall terminate when the employee leaves the employment of that company or agency.

C. Individuals certified as commercial applicators are eligible to license with one or more companies/agencies upon submission of the application and fee as described in Section 6 of this regulation. The individual's certification remains in force for the duration of the certification period as described in Section 5 of this regulation.

D. Each branch office of any company, agency, organization or self-employed individual ("employing entity") required to have personnel licensed commercially under state pesticide law shall have in its employment at least one master applicator. This Master must be licensed in all categories which the branch office of the company or agency performs applications and any Operators must also be licensed in the categories in which they perform or supervise pesticide applications. This master applicator must actively supervise persons applying pesticides within such employing entity and have the ability

to be on site to assist such persons within six (6) hours driving time. Whenever an out-of-state employing entity is conducting a major application project they must have a master applicator within the state.

E. **Exemptions**

I. Employing entities only performing post harvest treatments to agricultural commodities are exempt from master licensing requirements.

II. Persons applying pesticides to household pets and other non agricultural domestic animals are exempt from commercial applicator licensing.

III. Swimming pool and spa operators that are certified by the National Swimming Pool Foundation, National Spa and Pool Institute or other organization approved by the Board are exempt from commercial applicator licensing. However, these persons must still comply with all provisions of C.M.R. 10-144, Chapter 202 – Rules Relating to Public Swimming Pools and Spas Administered by the Maine Bureau of Health.

IV. Certified or licensed Wastewater or Drinking Water Operators

V. Adults applying repellents to children with the written consent of parents/guardians.

VI. Persons installing antimicrobial metal hardware.

2. Categories of Commercial Applicators

A. All commercial applicators shall be categorized according to the type of work performed as outlined below:

I. **Agricultural Animal and Plant Pest Control**

a. **Agricultural Animal** - This subcategory includes commercial applicators using or supervising the use of pesticides on animals and to places on or in which animals are confined. Doctors of Veterinary Medicine engaged in the business of applying pesticides for hire as pesticide applicators are included in this subcategory; however, those persons applying pesticides as drugs or medication during the course of their normal practice are not included.

b. **Agricultural Plant** - This subcategory includes commercial applicators using or supervising the use of pesticides in the production of crops including blueberries, orchard fruit, potatoes, vegetables, forage, grain and industrial or non-food crops.

Option I - Limited Commercial Blueberry - This option includes commercial applicators using or supervising the use of pesticides in the production of blueberries only.

Option II - Chemigation - This option includes commercial applicators using or supervising the use of pesticides applied through irrigation equipment in the production of crops.

Option III - Agricultural Fumigation - This option includes commercial applicators using or supervising the use of fumigant pesticides in the production of crops.

Option IV - Post Harvest Treatment - This option includes commercial applicators using or supervising the use of pesticides in the post harvest treatment of food crops.

II. **Forest Pest Control**

This category includes commercial applicators using or supervising the use of pesticides in forests, forest nurseries, Christmas trees, and forest seed producing areas.

III. **Ornamental and Turf Pest Control**

a. **Outdoor Ornamentals** - This subcategory includes commercial applicators using or supervising the use of pesticides to control pests in the maintenance and production of outdoor ornamental trees, shrubs and flowers.

b. **Turf** - This subcategory includes commercial applicators using or supervising the use of pesticides to control pests in the maintenance and production of turf, such as at turf farms, golf courses, parks, cemeteries, athletic fields and lawns.

c. **Indoor Ornamentals** - This subcategory includes commercial applicators using or supervising the use of pesticides to control pests in the maintenance and production of live plants in shopping malls, businesses, residences and institutions.

IV. **Seed Treatment**

This category includes commercial applicators using or supervising the use of pesticides on seeds.

V. **Aquatic Pest Control**

a. **General Aquatic** - This subcategory includes commercial applicators using or supervising the use of pesticides applied directly to surface water, including but not limited to outdoor application to public drinking water supplies, golf course ponds, rivers, streams and wetlands. Excluding applicators engaged in public health related activities included in categories VII(e) and VIII below.

b. **Sewer Root Control** - This subcategory includes commercial applicators using or supervising the use of pesticides applied to sewers to control root growth in sewer pipes.

VI. **Right-Of-Way Vegetation Management**

a. **Rights-of-Way Vegetation Management** - This subcategory includes commercial applicators using or supervising the use of pesticides in the management of vegetation on utility, roadside and railroad rights-of-way.

b. **Industrial/Commercial/Municipal Vegetation Management** - This subcategory includes commercial applicators using or supervising the use of pesticides in the management of vegetation on industrial, commercial, municipal or publicly owned areas including, but not limited to, industrial or commercial plants and buildings, lumber yards, airports, tank farms, storage areas, parking lots and sidewalks.

VII. **Industrial, Institutional, Structural and Health Related Pest Control**

a. **General** - This subcategory includes commercial applicators using or supervising the use of pesticides in, on or around human dwellings, office buildings, institutions such as schools and hospitals, stores, restaurants, industrial establishments (other than in Category 6) including factories, warehouses, food processing plants, food or feed transportation facilities and other structures, vehicles, railroad cars, ships, aircraft and adjacent areas; and for the protection of stored, processed or manufactured products. This subcategory also includes commercial applicators using or supervising the use of pesticides to control rodents on refuse areas and to control other pests, including but not limited to birds and mammals.

b. **Fumigation** - This subcategory includes commercial applicators using or supervising the use of fumigants or fumigation techniques in any type of structure or transportation device.

c. **Disinfectant and Biocide Treatments** - This subcategory includes commercial applicators using or supervising the use of pesticides to treat water in manufacturing, swimming pools, spas, industrial cooling towers, public drinking water treatment plants, sewers and air conditioning systems.

d. **Wood Preserving** - This subcategory includes commercial applicators using or supervising the use of restricted use pesticides to treat lumber, poles, railroad ties and other types of wooden structures including bridges, shops and homes. It also includes commercial applicators applying general use pesticides for remedial treatment to utility poles.

e. **Biting Fly & other Arthropod Vectors** - This subcategory includes commercial applicators and non-public health governmental officials using or supervising the use of pesticides in management and control of biting flies & other arthropod vectors of public health and public nuisance importance including, but not limited to, ticks, mosquitoes, black flies, midges, and members of the horsefly family.

f. **Termite Pests** - This subcategory includes commercial applicators using or supervising the use of pesticides to control termites.

VIII. **Public Health Pest Control**

a. **Biting Fly Pests** - This subcategory includes governmental officials using pesticides in management and control of potential disease vectors or other pests having medical and public health importance including, but not limited to, mosquitoes, black flies, midges, and members of the horsefly family.

b. **Other Pests** - This subcategory includes governmental officials using pesticides in programs for controlling other pests of concern to public health including, but not limited to, ticks and birds and mammal vectors of human disease.

IX. **Regulatory Pest Control**

This category includes governmental employees using pesticides in the control of pests regulated by the U.S. Animal and Plant Health Inspection Service or some other governmental agency.

X. **Demonstration and Research Pest Control**

This category includes all individuals who (1) demonstrate to the public the proper use and techniques of application of pesticides or supervise such demonstration, (2) conduct field research with pesticides, and in doing so, use or supervise the use of pesticides . Individuals who conduct only laboratory-type research are not included. Applicants seeking certification in this category must also become certified in whatever category/subcategory they plan to make applications under; e.g., Categories I - IX.

XI. **Aerial Pest Control**

This category includes commercial applicators, including pilots and co-pilots, applying or supervising the application of pesticides by means of any aircraft. Applicants seeking certification in this category must also become certified in whatever category/subcategory they plan to make applications under; e.g., Categories I - IX.

3. Competency Standards for Certification of Commercial Applicators

A. Applicants seeking commercial certification must establish competency in the general principles of safe pest control by demonstrating knowledge of basic subjects including, but not limited to, pesticide labeling, safety, environmental concerns, pest organisms, pesticides, equipment, application techniques and applicable laws and regulations. (Core Exam).

B. Applicants seeking commercial certification must demonstrate competency in each applicable category or subcategory. (Category Exam). Competency in the applicable category or subcategory shall be established as follows:

I. **Agricultural Animal and Plant Pest Control**

a. **Agricultural Animals**. Applicants seeking certification in the subcategory of Animal Pest Control as described in Section 2(A)(I)(a) must demonstrate knowledge of animals, their associated pests, and methods of pest control. Areas of practical knowledge shall include specific toxicity, residue potential, relative hazards of different formulations, application techniques, and hazards associated with age of animals, stress, and extent of treatment.

b. **Agricultural Plant**. Applicants seeking certification in the subcategory of Plant Pest Control as described in Section 2(A)(I)(b) Options I - IV must demonstrate practical knowledge of the crops grown and the specific pests of those crops on which they may be using pesticides. Areas of such practical knowledge shall include soil and water problems, preharvest intervals, reentry intervals, phytotoxicity, potential for environmental contamination, non-target injury, and community problems related to pesticide use in certain areas. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

II. **Forest Pest Control**

Applicants seeking certification in the category of Forest Pest control as described in Section 2(A)(II) must demonstrate practical knowledge of forest vegetation management, forest tree biology and associated pests. Such required knowledge shall include population dynamics of pest species, pesticide-organism interactions, integration of pesticide use with other pest control methods, environmental contamination, pesticide effects on non-target organisms, and use of specialized equipment. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

III. **Ornamental and Turf Pest Control**

a. **Outdoor Ornamentals**. Applicants seeking certification in the Outdoor Ornamental subcategory as defined in Section 2(A)(III)(a) must demonstrate practical knowledge of pesticide problems associated with the production and maintenance of trees, shrubs and floral plantings. Such knowledge shall include potential phytotoxicity, undue pesticide persistence, and application methods, with particular reference to techniques used in proximity to human habitations. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

b. **Turf**. Applicants seeking certification in the Turf subcategory as described in Section 2(A)(III)(b) must demonstrate practical knowledge of pesticide problems associated with the production and maintenance of turf. Such knowledge shall include potential phytotoxicity, undue pesticide persistence, and application methods, with particular reference to techniques used in proximity to human habitations. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

c. **Indoor Ornamentals**. Applicants seeking certification in the Indoor Ornamental subcategory described in Section 2(A)(III)(c) must demonstrate practical knowledge of pesticide problems associated with the production and maintenance of indoor ornamental plantings. Such knowledge shall include pest recognition, proper pesticide selection, undue pesticide persistence, and application methods with particular reference to techniques used in proximity to human presence.

IV. **Seed Treatment**

Applicants seeking certification in the category of Seed Treatment as described in Section 2(A)(IV) must demonstrate practical knowledge of seed types and problems requiring chemical treatment. Such knowledge shall include seed coloring agents, carriers and binders which may affect germination, hazards associated with handling, sorting, and mixing in the treatment process, hazards of introduction of treated seed into food and feed channels, and proper disposal of unused treated seeds.

V. **Aquatic Pest Control**

a. **General Aquatic** - Applicants seeking certification in the subcategory of General Aquatic as described in Section 2(A)(V)(a) must demonstrate practical knowledge of proper methods of aquatic pesticide application, application to limited area, and a recognition of the adverse effects which can be caused by improper techniques, dosage rates, and formulations. Such knowledge shall include basic factors contributing to

the development of nuisance aquatic plant growth such as algal blooms, understanding of various water use situations and potential downstream effects from pesticide use, and potential effects of various aquatic pesticides on plants, fish, birds, insects and other organisms associated with the aquatic environment. Also required shall be an understanding of the Department of Environmental Protection laws and regulations pertaining to aquatic discharges and aquatic weed control and a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

b. **Sewer Root Control** - Applicants seeking certification in the subcategory of Sewer Root Control as described in Section 2(A)(V)(b) must demonstrate practical knowledge of proper methods of sewer root control pesticide application, application to pipes, and a recognition of the adverse effects which can be caused by improper techniques, dosage rates, and formulations. Such knowledge shall include potential effects on water treatment plants, movement of pesticides into off target pipes or buildings and the hazards of sewer gases.

VI. **Right-of-Way Vegetation Management**

Applicants seeking certification in the subcategories under Right-of-Way Vegetation Management as described in Section 2(A)(VI) (a-b) must demonstrate practical knowledge of the impact of right-of-way pesticide use on a wide variety of environments. Such knowledge shall include an ability to recognize target organisms and circumstances specific to the subcategory, awareness of problems of runoff, root pickup and aesthetic considerations associated with excessive foliage destruction and "brown-out", and an understanding of the mode of action of right-of-way herbicides, and reasons for the choice of particular chemicals for particular problems, importance of the assessment of potential impact of right-of-way spraying on adjacent public and private properties and activities, and effects of right-of-way spraying on fish and wildlife species and their habitat. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

VII. **Industrial, Institutional, Structural and Health Related Pest**

a. **General**. Applicants seeking certification in the subcategory of General Pest Control as described in Section 2(A)(VII)(a) must demonstrate a practical knowledge of a wide variety of pests and methods for their control. Such knowledge shall include identification of pests and knowledge of life cycles, formulations appropriate for various indoor and outdoor uses, methods to avoid contamination of food and feed, and damage to structures and furnishings, avoidance of risk to humans,

domestic animals, and non-target organisms and risks to the environment associated with structural pesticide use.

b. **Fumigation**. Applicants seeking certification in the subcategory Fumigation as described in Section 2(A)(VII)(b) must demonstrate a practical knowledge of a wide variety of pests and fumigation methods for their control. Such knowledge shall include identification of pests and knowledge of life cycles, fumigant formulations, methods to avoid contamination of food and damage to structures and furnishings, and avoidance of risks to employees and customers.

c. **Disinfectant and Biocide Treatments**. Applicants seeking certification in the Disinfectant and Biocide Treatments subcategory described in Section 2(A)(VII)(c) must demonstrate practical knowledge of water organisms and their life cycles, drinking water treatment plant, cooling water and pool or spa system designs, labels and hazards of disinfectants and biocides and proper application techniques to assure adequate control while minimizing exposure to humans and the environment.

d. **Wood Preserving**. Applicants seeking certification in the Wood Preserving Subcategory described in Section 2(A)(VII)(d) must demonstrate practical knowledge in wood destroying organisms and their life cycles, nonchemical control methods, pesticides appropriate for wood preservation, hazards associated with their use, proper handling of the finished product, proper disposal of waste preservatives, and proper application techniques to assure adequate control while minimizing exposure to humans, livestock and the environment.

e. **Biting Fly and Other Arthropod Vector Pests**. Applicants seeking certification in the subcategory of Biting Fly and Other Arthropod Vector Pest control as described in Section 2(A)(VII)(e) must demonstrate a practical knowledge of the species involved, their potential roles in disease transmission, and the use of pesticides in their control. Such knowledge shall include identification of and familiarity with life cycles and habitat requirements, special environmental hazards associated with the use of pesticides in control programs, and knowledge of the importance of integrating chemical and non-chemical control methods. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

f. **Termite Pests**. Applicants seeking certification in this subcategory must demonstrate a practical knowledge of Termite pests and methods for their control. Such knowledge shall include identification of termites and knowledge of life cycles, formulations appropriate for various indoor and outdoor uses, methods to avoid contamination of food and feed, and damage to structures and furnishings, avoidance of risk to humans,

domestic animals, and non-target organisms and risks to the environment associated with structural pesticide use.

VIII. **Public Health Pest Control**

a. **Biting Fly and Other Arthropod Vector Pests**. Applicants seeking certification in the subcategory of Biting Fly and Other Arthropod Vector Pest Control as described in Section 2(A)(VIII)(a) must demonstrate a practical knowledge of the species involved, their potential roles in disease transmission, and the use of pesticides in their control. Such knowledge shall include identification of and familiarity with life cycles and habitat requirements, special environmental hazards associated with the use of pesticides in control programs, and knowledge of the importance of integrating chemical and non-chemical control methods. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

b. **Other Pests**. Applicants seeking certification in the subcategory of Other Pest Control as described in Section 2(A)(VIII)(b) must demonstrate a practical knowledge of the species involved, their potential roles in disease transmission, and the use of pesticides in their control. Such knowledge shall include identification of and familiarity with life cycles and habitat requirements, special environmental hazards associated with the use of pesticides in control programs, and knowledge of the importance of integrating chemical and non-chemical control methods. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

IX. **Regulatory Pest Control**

Applicants seeking certification in the category of Regulatory Pest Control as described in Section 2(A)(IX) must demonstrate practical knowledge of regulated pests and applicable laws relating to quarantine and other regulations of pests. Such knowledge shall also include environmental impact of pesticide use in eradication and suppression programs, and factors influencing introduction, spread, and population dynamics of relevant pests. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

X. **Demonstration and Research Pest Control**

Applicants seeking certification in the category of Demonstration and Research Pest Control as described in Section 2(A)(X) must demonstrate practical

knowledge in the broad spectrum of activities involved in advising other applicators and the public as to the safe and effective use of pesticides. Persons involved specifically in demonstration activities will be required to demonstrate knowledge of pesticide-organism interactions, the importance of integrating chemical and non-chemical control methods, and a grasp of the pests, life cycles and problems appropriate to the particular demonstration situation. Field researchers will be required to demonstrate general knowledge of pesticides and pesticide safety, as well as a familiarity with the specific standards of this Section which apply to their particular areas of experimentation. All individuals certified in this category must also be certified in one or more of the previous categories or subcategories which represent at least 80% of their practice. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

XI. **Aerial Pest Control**

Applicants seeking certification in the category of Aerial Pest Control as described in Section 2(A)(XI) must demonstrate at least a practical knowledge of problems which are of special significance in aerial application of pesticides, including chemical dispersal equipment, tank, pump and plumbing arrangements; nozzle selection and location; ultra-low volume systems; aircraft calibration; field flight patterns; droplet size considerations; flagging methods; and loading procedures. Applicants must also demonstrate competency in the specific category or subcategory in which applications will be made, as described in paragraphs I, II, VI and VIII herein. Also required shall be a knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans.

4. Competency Standards for Certification of Commercial Applicator/Master

A. **Regulations Exam**. An applicant seeking certification as a commercial applicator/master must successfully complete a closed book exam on the appropriate chapters of the Board's regulations. The passing grade shall be 80%. An applicant must successfully complete the regulations exam before being allowed to proceed to the master exam. The staff may waive the requirements for the closed book regulation exam if it determines that a pest management emergency exists necessitating the issuance of a nonresident license pursuant to Section 6 B. of this chapter, provided that the staff verbally reviews the pertinent regulations with the applicant prior to issuing a nonresident license.

B. **Master Exam**. An applicant seeking certification as a commercial applicator/master must also demonstrate practical knowledge in ecological and environmental concerns, pesticide container and rinsate disposal, spill and accident mitigation, pesticide storage and on site security, employee safety and training, potential chronic effects of exposure to pesticides, pesticide registration and special review, the potential for groundwater contamination, principles of pesticide drift and measures to reduce drift, protection of

public health, minimizing public exposure and use of non pesticide control methods. In addition, applicant must demonstrate the ability to interact with a concerned public.

5. Certification Procedures for Commercial Applicators

A. Initial Certification

I. **Application for Exams**. All persons desiring to take exams must request an application from the Board's office and submit all required information and fees. All fees are waived for governmental employees.

a. Information shall include name, Social security number, home address, company address, name and telephone number of supervisor and categories for which certification is desired.

b. A non-refundable fee of $10.00 for each core, category or subcategory exam shall accompany the application.

c. Study materials for other than the regulations exam are available through the University of Maine Cooperative Extension Pest Management Office for a fee.

d. A non-refundable fee of $50.00 for the regulations and master exams shall accompany the application for Master exams. Study material for the regulations exam will be sent to the applicant upon receipt of their application and the required fees.

II. **Appointment for Exams**

a. Upon receipt of an application the staff shall schedule an exam date and notify the applicant. If the scheduled date is not convenient for the applicant, it shall be the responsibility of the applicant to contact the Board's office to arrange a more convenient time to take the exams.

b. All exam fees shall be forfeited if an applicant fails to notify the Board that he/she cannot sit for the exams on the scheduled date at least 24 hours in advance of the scheduled exam. Applicants who cancel their exam appointment two times in a row shall also forfeit their exam fees. Re-application shall require an additional $15.00 fee.

c. Exams will be available year-round on an appointment basis at the Board's office in Augusta.

d. Exams may also be offered at other locations designated by the Board staff. Appointments for these exams should be arranged by application with the Board's office in Augusta.

III. **Exams**

a. Applicants in all areas except category I(b)IV, Post Harvest Treatment shall take a closed book core exam plus a closed book category technical exam on each applicable category or subcategory for which they anticipate making pesticide applications.

b. In addition to the exams described above in sections (a), applicants for commercial applicator/master certification in all areas except category I(b)IV, Post Harvest Treatment must complete a closed book written regulations exam as well as a master exam. Applicants for commercial applicator/master must successfully complete the core and at least one category exam or the combined exam before being eligible to take the master exams. Applicants must also successfully complete the regulations exam before being allowed to commence on the master exam.

c. Applicants in subcategory I(b)IV Post Harvest Treatment shall take one closed book exam which combines the core exam and the category exam.

IV. **Examination Procedures**. All applicants shall comply with these rules or forfeit their opportunity to complete the exams at a specified appointment.

a. Applicants should be present and ready to take the exams at the appointed time.

b. Applicants shall not talk during the examination period.

c. Applicants shall not be allowed to bring any books, papers, cellular telephones, calculators or electronically stored data into the examining room. Pencils and work sheets will be provided and all papers shall be collected at the end of the period.

d. Applicants shall not make notes of the exams and shall not leave the table during an exam unless authorized by the staff.

V. **Qualification Requirements**. An applicant must achieve a passing score of 80 percent on each exam.

a. An applicant who fails the core exam must re-apply and pay all required fees and may not retake that examination prior to ~~14~~ 6 days after the date of such failed examination. If an applicant fails again the applicant must reapply and pay all required fees and wait ~~30~~ 6 more days before retaking again.

b. An applicant who fails a category exam must re-apply and pay all required fees and may not retake that examination prior to ~~14~~ 6 days after the date of such failed examination. If an applicant fails again the applicant must reapply and pay all required fees and wait ~~30~~ 6 more days before retaking again.

c. An applicant who passes the core and one category exam shall be considered eligible for operator level licensing in that particular category so long as that person will be working under the supervision of a Master applicator. If at a later date the applicant wishes to add another category, only the appropriate category exam shall be required.

d. An applicant who fails a master exam must re-apply and pay all required fees and may not retake the examination prior to ~~14~~ 6 days after the date of such failed examination.

e. Any applicant must pass both the core and at least one category exam within 12 months before qualifying for certification.

f. Any applicant who violates any of the rules pertaining to examinations shall wait a minimum of 60 days before retaking.

VI. **Expiration**. Certification under this Section will expire on December 31st of the sixth year after the date of successful completion of the exams and on December 31st of every sixth year thereafter unless a special restricted certification period is assigned by the Board or Board staff.

VII. An applicant's original certification period shall not be extended due to the applicant qualifying for another category or upgrading to the master level.

B. **Recertification of Applicators**

I. Persons with current valid certification may renew that certification by either providing documentation from a substantially equivalent professional certification program approved by the board or by accumulating recertification credits during the certification period described in Section 5(A)VI according to the following schedule:

a. **Master level** - 18 credit hours, including at least 3 in a category or subcategory they are licensed for and 1 credit hour in environmental science, ecology or toxicology.

b. **Operator level** - 12 credit hours, including at least 3 in a category or subcategory they are licensed for and 1 credit hour in environmental science, ecology or toxicology.

II. Recertification credits will be available through Board-approved meetings including but not limited to industry and trade organization seminars, workshops where pesticide topics are presented and approved home study courses.

a. Board staff will review program agendas and monitor programs as time permits.

III. Credit will be allowed for topics including, but not limited to:

a. Applicable laws and regulations.

b. Environmental hazards.

c. Calibration and new application techniques.

d. Label review.

e. Applicator safety.

f. Storage and disposal.

g. Pest identification and control.

h. Integrated pest management.

IV. Persons organizing meetings for which they want credits awarded must contact the Board in writing at least 15 days in advance of the meeting with details of the agenda. Board staff will review program agendas and assign credit values.

a. One credit will be assigned for each 1 hour of presentation on appropriate topics.

b. An individual who conducts a meeting for which the Board does assign recertification credits will be eligible for two credits for each 1 hour of presentation on appropriate topics.

c. An individual who organizes a meeting shall be required to maintain a sign up sheet and supervise the signing of the sheet by all applicators attending the program. That individual shall submit the signup sheet to the Board at the same time the verification attendance forms are collected and submitted to the Board.

V. For in state programs, each participant will complete a form to verify attendance at each program for which credit is allowed at the site. For out of state programs, applicators must notify the Board about attendance and send a registration receipt or other proof of attendance and a copy of the agenda or other description of the presentations attended. The agenda must show the length of each presentation and describe what was covered.

VI. A person who fails to accumulate the necessary credits during their first six year certification period will have to retake and pass all exam(s) required for initial certification. If a person fails to accumulate the necessary credits again that person must retake and pass all exam(s) required for initial certification and within one year thereafter, obtain the balance of the recertification credits which that person failed to accumulate during the previous certification period. If that person does not obtain the balance of credits needed, the Board will not renew their license until the make- up credits are accrued.

VII. Attendance verification forms must verify attendance by the applicator of the entire approved program(s) for which recertification credit is sought, and must be completed, signed and submitted to the program organizer or Board representative by the applicator seeking recertification credit(s). No other person may complete or sign the form on the applicator's behalf. Any form that is completed or signed by a person other than the applicator will be deemed a fraudulent report and will not be approved by the Board for recertification credit(s). Any credit(s) approved by the Board pursuant to an attendance verification form which is subsequently determined by the Board to have been completed or signed by a person other than the applicator shall be void and may not be counted towards the applicator's recertification requirements; and any recertification issued on the basis of such credits shall be void.

6. Licensing

A. All Commercial Applicators required to be certified under this chapter and state pesticide law shall be licensed before using or supervising the use of pesticides as described in Section 1(A).

B. Nonresident licenses. When the staff determines that a pest management emergency exists which necessitates the use of aerial application and for which there are not sufficient qualified Maine licensees, it may issue a license without examination to nonresidents who are licensed or certified by another state or the Federal Government substantially in accordance with the provisions of this chapter. Nonresident licenses issued pursuant to this section are effective until December 31 of the year in which they are issued.

~~B.~~C. **Application**. Application for a commercial applicator license shall be on forms provided by the Board.

I. The completed application must include the name of the company or agency employing the applicant.

II. Unless the applicant is the owner of a company, the completed application must be signed by both the applicant and that person's supervisor to verify the applicant is an employee of the company/agency.

~~C.~~D. **Fee**. At the time of application, the applicant must tender the appropriate fee as follows:

I. For a commercial applicator license - $70.00 per person.

II. For replacement, upgrade to master or to add categories $5.00.

~~D.~~E. Commercial applicators who apply pesticides for hire (custom applicators) and operate a company that is incorporated or which employs more than one applicator (licensed or unlicensed) must comply with Chapter 35, Certification & Licensing Provisions/Spray Contracting Firms which requires an additional Spray Contracting Firm License.

~~E.~~F. **Insurance**. Commercial applicators who spray for hire (custom applicators) shall be required to have liability insurance in force at any time they make a pesticide application.

I. Applicators shall submit a completed and signed form provided by the Board at the time they apply for their license which attests that they will have the required amounts of insurance coverage in effect when they make pesticide treatments. The information submitted on the form must be true and correct.

II. Insurance coverage must meet or exceed the following minimum levels of liability:

a. Ground applicators:

Public liability	$100,000 each person $300,000 each occurrence
Property damage	$100,000 each occurrence

b. Aircraft applicators:

Public liability	$100,000 each person $300,000 each occurrence
Property damage	$100,000 each occurrence

~~F.~~G. **Reports**. Annual Summary Reports described in Chapter 50, Section 2(A) must be submitted for each calendar year by January 31 of the following year. In the event a required report is not received by the due date, the person's license is temporarily suspended until the proper report is received or until a decision is rendered at a formal hearing as described in 22 MRSA §1471-D (7).

~~G.~~H. **Expiration**

I. All licenses will expire at the end of the second calendar year after issuance or when an individual licensee terminates employment with the company/agency with which the individual's license is affiliated.

II. The licensee or a company/agency representative shall notify the Board in writing within 10 days after a licensee is terminated from employment.

III. Also, all licenses within a company/agency are suspended if the licensed Master is terminated from employment or dies.

~~H.~~I. **Decision**. Within 60 days of receipt of application by the Board, unless the applicant agrees to a longer period of time, the Director shall issue, renew or deny the license. The Director's decision shall be considered final agency action for purposes of 5 M.R.S.A. §11001 *et seq*.

~~**7. Grandfathering and Transitions**~~

~~A. The amendments to Section 1 shall not affect the licensing status of municipal applicators or residential lawn herbicide applicators. Those licensees with restricted operator licenses shall be allowed to operate without a master level license until January 1, 1997. At that time they must successfully complete the master regulation and oral exams and upgrade to the master level to be eligible for license renewal.~~

~~B. Applicators licensed prior to January 1, 1996 in category VII(a), General Pest Control shall be automatically licensed in category VII (g) Termite Pest control.~~

~~C. The three category or subcategory specific recertification credits and one credit in environmental science, ecology or toxicology required by Section 5(B)(I)(a)and(b) must be accumulated by any applicator recertifying after December 31, 1998.~~

~~D. The 1999 amendments to this chapter which extend license and certification periods shall be phased in over two years. Phase one shall include licensees renewing licenses after December 31, 2000 whose last name begins with the letters A through J. Phase two shall include licensees renewing licenses after December 31, 2001 whose last name begins with the letters K through Z. All new licenses issued after December 31, 2000 shall be issued according to these amendments.~~

STATUTORY AUTHORITY: 22 M.R.S.A., Section 1471-D

EFFECTIVE DATE:
January 1, 1983 (filed with Secretary of State August 13, 1982)

AMENDED:
December 29, 1982
January 1, 1984
January 1, 1984 - Section 7
May 20, 1984 - Section 6
May 13, 1985 - Section 5
Emergency amendment effective April 18, 1986 - Section 6
August 3, 1986 - Section 6
November 30, 1986 - Section 3
May 23, 1987 - Section 1
April 27, 1988
April 29, 1990
January 1, 1996 (adopted by Board October 7, 1994 - see Section 8 for transition dates)
October 2, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:

December 28, 1999 -- also converted to MS Word
March 5, 2003
July 3, 2005 – filing 2005-267
March 4, 2007 – filing 2007-69
July 2, 2009 – filing 2009-318 (EMERGENCY, later reverted to pre-emergency status)

CORRECTIONS:
February, 2014 – agency names, formatting

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 32: CERTIFICATION & LICENSING PROVISIONS/PRIVATE APPLICATORS

SUMMARY: These regulations describe the requirements for certification and licensing of private applicators.

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1. Competency Standards for Certification - Private Applicator

A. No person shall be certified as a private applicator unless he has fulfilled requirements demonstrating his knowledge of basic subjects including pesticide labeling, safety, environmental concerns, pest organisms, pesticides, equipment, application techniques, and applicable laws and regulations. Also required shall be knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides, and the potential adverse effect of pesticides on plants, animals or humans (core exam).

B. No person shall be certified as a private applicator unless he has demonstrated knowledge of the general principles of pest control for his major commodity, including specific pests of the crop, their life cycle, and proper timing of control measures to be efficacious (Commodity Exam).

2. Certification Procedures for Private Applicators

A. **Initial Certification**

1. Any person seeking to be certified as a private applicator must pass a written core exam and a written exam in the area of his primary commodity. Both exams shall be closed book.

2. Exams may be taken at cooperating County University of Maine Cooperative Extension offices. Exams may also be offered at other locations designated by the Board staff or available on an appointment basis at the office of the Board,

3. **Examination Procedures**. All applicants shall comply with these rules or forfeit their opportunity to complete the exams at a specified appointment.

a. Applicants should be present and ready to take the exams at the appointed time.

b. Applicants shall not talk during the examination period.

c. Applicants shall not be allowed to bring any books, papers, calculators or electronically stored data into the examining room. Pencils and work

sheets will be provided and all papers shall be collected at the end of the period.

d. Applicants shall not make notes of the exams and shall not leave the table during an exam unless authorized by the staff.

4. **Qualification Requirements**. An applicant must achieve a passing score of 80 percent on each exam.

a. An applicant who fails the core exam may not retake that examination prior to ~~14~~ 6 days after the date of such failed examination. If an applicant fails again the applicant must wait ~~30~~ 6 more days before retaking the exam again.

b. An applicant who fails the exam in the area of his primary commodity may not retake the that examination prior to ~~14~~ 6 days after the date of such failed examination. If an applicant fails again the applicant must wait ~~30~~ 6 more days before retaking the exam again.

c. Any applicant must pass both the core and at least one commodity exam within 12 months before qualifying for certification.

d. Any applicant who violates any of the rules pertaining to examinations shall wait a minimum of 60 days before retesting.

5. At its discretion, the Board may, in special circumstances, offer the option of an oral core and commodity exam to a person with recognized difficulty in reading.

a. The person requesting this option must identify another qualified individual from whom he can seek advice and guidance necessary for the safe and proper use of pesticides related to his certification.

b. The person identified as reader and advisor to applicant must be present at time of oral exam and acknowledge his willingness to assist the private applicator.

6. Certification under this section will expire on October 31st of the third year after the date of successful completion of the exams and on October 31st of every third year thereafter unless a special restricted certification period is assigned by the Board or Board staff.

B. **Recertification**

1. Any person with current valid certification may renew that certification by accumulating 6 recertification credits during the certification period described in Section 2(A)6.

2. Recertification credits will be available through Board-approved meetings including but not limited to industry and trade organization seminars, workshops where pesticide topics are presented and approved home study courses.

3. Credit will be allowed for topics including, but not limited to:

   a. Applicable laws and regulations.

   b. Environmental hazards.

   c. Calibration and new application techniques.

   d. Label review.

   e. Applicator safety.

   f. Storage and disposal.

   g. Pest identification and control.

   h. Integrated pest management.

4. Persons organizing meetings for which they want credits awarded must contact the Board in writing at least 15 days in advance of the meeting and submit details of the pesticide topics, including titles and length of time devoted to them. Board staff will review program agendas and assign credit values. Board staff will monitor programs as time permits.

   a. A minimum credit of one hour shall be assigned for each one hour of presentation on appropriate topics.

   b. An individual conducts a meeting for which the Board does assign recertification credits will be eligible for two credits for each 1 hour of presentation on appropriate topics.

5. For in state programs, each participant will complete a form to verify attendance at each program for which credit is allowed at the site. For out of state programs, applicators must notify the Board about attendance and send a registration receipt or other proof of attendance and a copy of the agenda or other description of the presentations attended. The agenda must show the length of each presentation and describe what was covered.

6. A person who fails to accumulate the necessary credits will have to re-apply to take the exams required for initial certification.

3. Licensing

A. **Application**. Application for a private applicator license, shall be on forms provided by the Board. Information shall include name; Social Security number; mailing address; farm name, location and telephone number; and major crop(s).

B. **Fee**. At the time of application, the applicant must tender the appropriate fee as follows:

1. For a private applicator license - $15.00 per person.

2. For replacement or alteration - $5.00.

C. **Expiration**. Private applicator licenses are issued on a three-year period and will expire on October 31st of the third year. Any person who has accumulated the required number of recertification credits must apply for license renewal within one year of the expiration date of the license or the recertification credits are forfeited and that person must retake and pass both the core and commodity exams to again be eligible for licensing.

D. **Decision**. Within 60 days of receipt of application by the Board, unless the applicant agrees to a longer period of time, the Director shall issue, renew or deny the license. The Director's decision shall be considered final agency action for purposes of 5 M.R.S.A. §11001 *et seq*.

STATUTORY AUTHORITY: 22 M.R.S.A. § 1471-D

EFFECTIVE DATE:
January 1, 1983

AMENDMENT EFFECTIVE:
December 6, 1987
August 17, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
August 25, 1997 – fees
January 4, 2005 – filing 2004-605, Section 3.C.

CORRECTIONS:
February, 2014 – agency names, formatting

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 33: CERTIFICATION & LICENSING PROVISIONS/PRIVATE APPLICATORS OF GENERAL USE PESTICIDES

SUMMARY: These regulations describe the requirements for certification and licensing of private applicators using general-use pesticides to produce plants or plant products intended for human consumption as food, where the person applying the pesticides or the employer of the person applying the pesticides derives $1,000 or more in annual gross income from the sale of those commodities.

SECTION 1. Competency Standards for Certification—Private Applicator of General Use Pesticides (Core exam)

A. No person shall be certified as a private applicator of general-use pesticides unless the person has fulfilled requirements demonstrating knowledge of pest problems and pest-control practices, including, as a minimum, the ability to recognize common pests and the damage they cause, to understand the pesticide label and to apply pesticides in accordance with label instructions and warnings.

B. Also required shall be knowledge of current methodology and technology for the control of pesticide drift to non-target areas, the proper meteorological conditions for the application of pesticides and the potential adverse effect of pesticides on plants, animals or humans.

SECTION 2. Certification Procedures for Private Applicators

A. **Initial Certification**

1. Any person seeking to be certified as a private applicator of general-use pesticides must pass a written core exam. The exam shall be closed book.

2. Exams may be taken at cooperating County University of Maine Cooperative Extension offices. Exams may also be offered at other locations designated by the Board staff or available on an appointment basis at the office of the Board.

3. **Examination Procedures**. All applicants shall comply with these rules or forfeit their opportunity to complete the exams at a specified appointment.

   a. Applicants should be present and ready to take the exams at the appointed time.

   b. Applicants shall not talk during the examination period.

c. Applicants shall not be allowed to bring any books, papers, calculators or electronically stored data into the examining room. Pencils and work sheets will be provided and all papers shall be collected at the end of the period.

d. Applicants shall not make notes of the exams and shall not leave the table during an exam unless authorized by the staff.

4. **Qualification Requirements**. An applicant must achieve a passing score of 80 percent on the core exam.

a. An applicant who fails the core exam may not retake that examination prior to ~~14~~ 6 days after the date of such failed examination. If an applicant fails again the applicant must wait ~~30~~ 6 more days before retaking the exam again.

b. Any applicant who violates any of the rules pertaining to examinations shall wait a minimum of 60 days before retesting.

5. Certification under this section will expire on October 31 of the third year after the date of successful completion of the exams and on October 31 of every third year thereafter unless a special restricted certification period is assigned by the Board or Board staff.

B. **Recertification**

1. Any person with a current valid certification may renew that certification by accumulating three recertification credits during the certification period described in Section 2(A)(5).

2. Recertification credits will be available through Board-approved meetings including, but not limited to, University or industry and trade organization seminars or workshops and approved home study courses where pest management topics are included.

3. Credit will be allowed for topics including, but not limited to:

a. Applicable laws and regulations;

b. Environmental hazards;

c. Calibration and new application techniques;

d. Label review;

e. Pesticide risk and applicator safety;

f. Pesticide storage and disposal;

g. Pest identification, biology and management;

h. Integrated pest management;

i. Pesticide fate and drift management;

j. Risk communication; and

k. Public relations.

4. Persons organizing meetings for which they want credits awarded must contact the Board in writing at least 15 days in advance of the meeting and submit details of the pesticide topics, including titles and length of time devoted to them. Board staff will review program agendas and assign credit values. Board staff will monitor programs as time permits.

a. A minimum of one credit shall be assigned for each one hour of presentation on appropriate topics.

b. An individual who conducts a meeting for which the Board does assign recertification credits will be eligible for two credits for each one hour of presentation on appropriate topics.

5. For in-state programs, each participant will complete an on-site process to verify attendance at each program for which credit is allowed. For electronic, correspondence or out-of-state programs, applicators must notify the Board about attendance and send a registration receipt or other proof of completion or attendance and a copy of the agenda or syllabus of the training provided. The agenda or syllabus must show the length of each presentation and describe what was covered.

6. A person who fails to accumulate the necessary credits will have to take the most current exam required for initial certification.

SECTION 3. Licensing

A. **Application**. Application for a private applicator of general-use pesticides license shall be on forms provided by the Board. Information shall include name, Social Security number, mailing address, farm name, location, telephone number and major crop(s).

B. **Fee**. At the time of application, the applicant must tender the appropriate fee as follows:

1. For a private applicator of general-use pesticides license—$15.00 per person.

2. For replacement or alteration—$5.00.

C. **Expiration**. Private applicator of general-use pesticides licenses are issued on a three-year basis and will expire on October 31 of the third year.

D. **Decision**. Within 60 days of receipt of application by the Board, unless the applicant agrees to a longer period of time, the Director shall issue, renew or deny the license. The Director's decision shall be considered final agency action for purposes of 5 M.R.S.A. §11001 *et seq*.

STATUTORY AUTHORITY: 22 M.R.S. §1471-D(2-D), 22 M.R.S. §1471-M(1)(C-1)

EFFECTIVE DATE:
December 26, 2011 – filing 2011-474

CORRECTIONS:
February, 2014 – agency names, formatting

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 41: SPECIAL RESTRICTIONS ON PESTICIDE USE

SUMMARY: This chapter describes special limitations placed upon the use of (1) aldicarb (Temik 15G) in proximity to potable water bodies; (2) trichlorfon (Dylox, Proxol); (3) hexazinone (Velpar, Pronone), (4) aquatic herbicides in the State of Maine and (5) plant-incorporated protectants.

Section 1. ALDICARB (TEMIK®)

The registration of aldicarb (Temik 15G) is subject to the following buffer zone requirements:

A. Aldicarb (Temik 15G) shall not be applied within 50 feet of any potable water source if that water source has been tested and found to have an aldicarb concentration in the range of one to ten parts per billion (ppb). The 50 foot buffer would be mandatory for one year with a required retesting of the water at the end of the period.

B. Aldicarb (Temik 15G) shall not be applied within 100 feet of any potable water source if that water source has been tested and found to have an aldicarb concentration in excess of 10 ppb. The 100 foot buffer would be mandatory for one year with a required retesting of the water at the end of this period.

Section 2. TRICHLORFON (DYLOX, PROXOL)

The registration of trichlorfon (Dylox, Proxol) is subject to the following requirements:

A. Trichlorfon shall only be used for control of subsurface insects on turf.

B. Prior to application the target pest must be identified and the severity of the infestation must be determined, including the extent of the damage.

C. Only infested areas shall be treated with trichlorfon. Broadcast treatments of the entire turf area are prohibited.

D. Following application, the trichlorfon must be watered into the soil with at least ½ inch of water and according to the label directions. The applicator must assure that the appropriate watering will take place prior to re-entry by any unprotected person.

Section 3. HEXAZINONE (VELPAR, PRONONE)

The registration of hexazinone is subject to the following limitations and conditions.

~~A. **Prohibition of Certain Air-Carrier Application Equipment**~~

~~It shall be unlawful to apply any liquid pesticide mixture containing the active ingredient hexazinone with any application equipment that utilizes a mechanically generated airstream to propel the spray droplets unless the airstream is directed downward.~~

B. **Licenses Required**

I. No person shall ~~purchase,~~ use or supervise the use of any pesticide containing the active ingredient hexazinone unless they have obtained a ~~private or commercial pesticide~~ applicator's license ~~from the Board~~ in accordance with 22 M.R.S. 1471-D.

~~II. No person shall:~~

~~a. Distribute any pesticide containing the active ingredient hexazinone without a restricted use pesticide dealer's license from the Board; or~~

~~b. Distribute any pesticide containing the active ingredient hexazinone to any person who is not licensed as a private or commercial pesticide applicator by the Board.~~

~~C. **Records and Reporting**~~

~~Dealers distributing pesticides containing the active ingredient hexazinone shall keep records of such sales and provide reports to the Board as described in Chapter 50, "Record Keeping and Reporting Requirements."~~

Section 4. AQUATIC HERBICIDES

The registration of pesticides for which there is an aquatic herbicide use on the product label shall be subject to the following limitations and conditions.

A. **Board Publication of List**

The Board of Pesticides Control will publish by May 23, 2003 and by March 15th of each year thereafter a list of herbicide products registered in Maine for which the manufacturer has verified that there is an aquatic use on the pesticide label. Based on available information, the Board may exempt from this list pesticides that it determines are not for use in the control of aquatic vegetation. Pesticides labeled solely for use in aquariums and antifouling paints, are specifically exempt from this list.

B. **Licenses Required**

I. Unless exempted under Chapter 41, Section 4 (B) (III), no person shall purchase, use or supervise the use of any aquatic herbicides identified on the Board's

annual listing unless they have obtained a private or commercial pesticide applicator's license from the Board.

II. No person shall:

a. Distribute any aquatic herbicides identified on the Board's annual listing without a restricted use pesticide dealer's license from the Board; or

b. Unless exempted under Chapter 41, Section 4 (B) (III), distribute any aquatic herbicides identified on the Board's annual listing to any person who is not licensed as a private or commercial applicator by the Board.

III. Registered herbicides containing only the active ingredients erioglaucine (Acid Blue 9 or FD&C Number 1, CAS Registry No. 1934-21-0) and/or tartrazine (Acid Yellow 23 or FD&C Yellow Number 5, CAS Registry No. 2650-18-2 (trisodium salt) or 3844-45-9 (triammonium salt)) are exempt from the applicator licensing requirements described in Chapter 41, Section 4 (B) (I) and Chapter 41, Section 4 (B) (II) (b).

C. **Disclosure**

The Board will make a disclosure form available to dealers distributing any aquatic herbicides identified on the Board's annual listing. The Board requests that dealers present to customers the disclosure form that advises purchasers that, (1) an aquatic discharge license must be obtained from the Maine Department of Environmental Protection before any application may be made to any surface waters of the State as defined in 38 M.R.S.A. Section 361-A(7) including any private ponds that may flow into such a body of water at any time of year, (2) that Best Management Practices developed jointly by the Board and the Maine Department of Environmental Protection on the use of aquatic herbicides are available.

D. **Records and Reporting**

Dealers distributing any aquatic herbicides identified on the Board's annual listing shall keep records of such sales and provide reports to the Board as described for restricted use pesticides in Chapter 50, "Record Keeping and Reporting Requirements."

E. **Use of Best Management Practices**

Aquatic herbicides applied to private ponds and not subject to an aquatic discharge permit may only be applied consistent with Best Management Practices developed jointly by the Board and the Maine Department of Environmental Protection.

Section 5. PLANT-INCORPORATED PROTECTANTS

The registration, distribution and use of plant-incorporated protectants are subject to the following limitations and conditions:

A. **Definitions**

"Plant-incorporated protectant" means a pesticidal substance that is intended to be produced and used in a living plant, or in the produce thereof, and the genetic material necessary for the production of such a pesticidal substance.

B. **License Required**

No person shall distribute any plant-incorporated protectant without either a general use pesticide dealer license or a (restricted or limited use) pesticide dealer license from the Board.

C. **Dealer Requirements**

Dealers distributing plant-incorporated protectants are subject to the following requirements:

I. General use and (restricted or limited use) pesticide dealers shall notify the Board of their intent to distribute plant-incorporated protectants on all initial license and license renewal application forms provided by the Board.

II. General use and (restricted or limited use) pesticide dealers shall maintain sales records showing the list of the names and addresses of all purchasers of plants, plant parts or seeds containing plant-incorporated protectants. These records must be made available to representatives of the Board for inspection at reasonable times, upon request, and must be maintained for two calendar years from the date of sale.

III. Any general use and (restricted or limited use) pesticide dealer who discontinues the sale of plant-incorporated protectants shall notify the Board in writing and shall provide the Board, upon request, with all records required by Section 5(C)II of this chapter.

D. **Grower Requirements**

I. All users of plant-incorporated protectants shall maintain the records listed below for a period of two years from the date of planting. Such records shall be kept current by recording all the required information on the same day the crop is planted. These records shall be maintained at the primary place of business and shall be available for inspection by representatives of the Board at reasonable times, upon request.

a. Site and planting information, including town and field location, a map showing crop location and refuge configuration in relation to adjacent crops within 500 feet that may be susceptible to cross-pollination;

b. Total acres planted with the plant-incorporated protectant and seeding rate;

c. Total acres planted as refuge and seeding rate;

d. Detailed application information on any pesticide applied to the refuge as described in Section 1(A) of Chapter 50, "Record Keeping and Reporting Requirements"; and

e. Planting information for each distinct site including:

i. date and time of planting; and

ii. brand name of the plant-incorporated protectant used.

II. There are no annual reporting requirements for growers.

E. **Product-Specific Requirements**

I. Requirements for plant-incorporated protectant corn containing Bacillus thuringiensis (Bt) protein and the genetic material necessary for its production.

a. Prior to planting plant-incorporated protectant corn containing any Bacillus thuringiensis (Bt) protein and the genetic material necessary for its production, the grower must have completed a Board-approved training course and possess a valid product-specific training certificate.

b. Product-specific training certificates shall be issued following each Board-approved session. The certificates will remain valid until December 31 of the third year after issuance.

c. Non-Bt-corn growers whose crops are or will be located within 500 feet of a prospective Bt-corn planting site can request that the Bt-corn grower protect the non-Bt-corn crop from pollen drift.

i. the request must be made prior to planting of the Bt-corn crop;

ii. the request must identify the non-Bt-corn crop to be protected; and

iii. the growers may agree on any method for protection but, if an agreement cannot be reached,

1. the Bt-corn grower must plant any refuge required by the Bt-corn grower agreement, grower guide or product label in a configuration that provides maximum protection from pollen drift onto the adjacent non-Bt-corn crop; or

2. if no refuge is required, the Bt-corn grower shall maintain at least a 300-foot Bt-corn-free buffer to non-Bt-corn crops.

d. Bt-corn growers are encouraged to follow all best management practices developed by the Board or the Department of Agriculture, Conservation and Forestry.

II. Dealers distributing Bt-sweet corn shall only sell the seed in quantities large enough to plant one acre or more.

F. **Confidentiality**

Any person providing information to the Board in connection with the record-keeping and reporting requirements of Section 5 of this chapter may designate that information as confidential in accordance with 7 M.R.S.A. §20.

STATUTORY AUTHORITY: 5 M.R.S.A. §§ 8051 *et seq*.
7 M.R.S.A. §§ 601-610
22 M.R.S.A. §§ 1471-A, 1471-B, 1471-C, 1471-D, 1471-M

EFFECTIVE DATE:
March 8, 1981 (Captan)

AMENDED:
May 7, 1981 (Trichlorfon)
January 2, 1984 (Aldicarb)
May 8, 1988 (Trichlorfon)
August 5, 1990 (Captan)
August 17, 1996 (Hexazinone)
October 2, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
May 7, 1997 - Section 3(B)(II)

CONVERTED TO MS WORD:
March 11, 2003

AMENDED:
May 12, 2003 - Section 4 added

NON-SUBSTANTIVE CORRECTIONS:
June 24, 2003 - summary only

AMENDED:
February 2, 2004 - Section 4, 1st paragraph and sub-section A, filing 2004-31
April 30, 2007 – filing 2007-154
February 3, 2008 – filing 2008-36
July 16, 2009 – filing 2009-253 (final adoption, major substantive)
May 3, 2012 – filing 2012-99 (final adoption, major substantive)

CORRECTIONS:
February, 2014 – agency names, formatting

PAUL R. LEPAGE
GOVERNOR

STATE OF MAINE
MAINE DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY
BOARD OF PESTICIDES CONTROL
28 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0028

WALTER E. WHITCOMB
COMMISSIONER

HENRY S. JENNINGS
DIRECTOR

BOARD OF PESTICIDES CONTROL

June 27, 2014

Cafeteria, Madison Area Memorial High School, 486 Main Street, Madison, Maine

MINUTES

10:00 AM

Present: Bohlen, Eckert, Flewelling, Granger, Jemison, Morrill, Stevenson

1. Introductions of Board and Staff

- The Board, Staff, and Assistant Attorney General Randlett, introduced themselves
- Staff Present: Bills, Connors, Hicks, Jennings, Patterson, Tomlinson

2. Minutes of the March 28 and May 16, 2014, Board Meetings

Presentation By: Henry Jennings
Director

Action Needed: Amend and/or Approve

- **Flewelling/Granger: Moved and seconded to approve the March minutes**
- **In favor: Unanimous**

- In the May minutes, Jemison noted that on page 8, agenda item 9, first bullet, "bill" was misspelled, "absence" was misspelled and there was an extra period in front of the word "Lakes".

- **Eckert/Granger: Moved and seconded to approve the May minutes as amended**
- **In favor: Unanimous**

3. Public Forum (limited to one hour)

At this time, the Board invites anyone interested to address its members with questions or concerns about any pesticide-related issues.

Presentation By: Henry Jennings
Director

Action Needed: None required

- Dave Colson, Maine Organic Farmers and Gardeners Association (MOFGA), said that the requirement for the Ag Basic license is not well known and that there are several groups across the

state willing to assist. A discussion ensued about how to make people aware of the new license requirement.

4. Interpretation of the Term "food production" in the Context of the Agricultural Basic Pesticide Applicator License

Questions have arisen about the term "food production" in the statute that requires certification for a "private applicator of general use pesticides for food production" (Title 22, Sec. 1471-D [2-D]). The staff is asking the Board to interpret the meaning of the term in this context.

Presentation By: Gary Fish
Manager of Pesticide Programs

Action Needed: Provide guidance to the staff on how to interpret the statute

- Jennings explained that there have been several questions from growers on whether they need a license. He referred to Fish's memo. Examples include a greenhouse grower who disinfects pots prior to planting; a greenhouse grower using disinfectants on capillary mats and benches when no plants are present; various post-harvest treatments; and disinfecting of bins, storage areas, etc. The Board needs to be true to the language of the statute, while interpreting what it thinks the intent was. Applying common sense and practicality would be helpful to the staff. There are food safety and environmental concerns, and food safety was probably foremost in the legislator's minds.
- Granger said that it started as a concern that folks are putting pesticides on food that don't have any training. If people are going to be eating food that has been treated, the growers ought to know what they're doing. It should apply to any core practice that is apt to leave a residue on the food. It ought to be related to making sure that people using pesticides on food know the rules about pesticides. If sanitizing equipment presents no likelihood of getting residues on food, then it should not be included; post-harvest treatments go directly on food, they should be included. Look at in terms of residues on food. Stevenson agreed.
- Hicks noted that sanitizing equipment is crucial to control bacteria, etc., so from a food safety issue it is important. Bohlen argued that the risk caused by poorly done sanitation is a food issue, not a pesticide issue; the Board's authority relates to pesticide use, not food-borne pathogens.
- Eckert suggested including anything from planting the seed or whatever, to the post-harvest treatment, when product is sold or transferred.
- Jemison suggested that any product that has an EPA number should be included; it's easier to define. Bleach has an EPA number; it is the start of the process.
- Flewelling noted that people doing sanitation must have a license of some kind.
- Jennings stated that there are people in food production using products without an EPA number.
- Bohlen said that EPA number is one trigger, but the Board needs to put boundaries around what constitutes food production. Post-harvest treatment is straight-forward, others are trickier. What about producing seeds for home gardens? This is not the sale of a food product, but is there a risk in that person not having training?
- Granger mentioned neonicotinoids.
- Morrill said that should be included because the end goal is for the plant to be eaten.
- Hicks suggested borrowing a standard from MOFGA: growers can use a registered disinfectant or sanitizer in production as long as it doesn't come in contact with food.
- Bohlen asked about soil; sanitation early on, soil pathway.
- Morrill said it should start with soil. Flewelling agreed, saying it shouldn't start with the container. Morrill suggested using "growing medium" instead of "soil."
- Granger expressed concern that this would not be a clean definition and asked whether it could be based on products having an "agricultural" label. Hicks noted that if a label has Worker Protection

Standard information on it, it could be considered agricultural. Morrill said that you could have identical products without that information.

- **Consensus was reached for staff to draft a policy where food production is defined as beginning with soil treatments and ending with the transfer of the food product.**

5. Overview of Board of Pesticides Control Posting/Notification Requirements

At the March 28, 2014, meeting, the subject of Board of Pesticides Control sign requirements came up as the Board reviewed a complaint filed by Donna Herczeg. There was Board sentiment to review the BPC sign requirements at a future meeting and determine whether they are serving the intended purpose. The staff has summarized those requirements and will share the results with the Board.

Presentation By: Henry Jennings
Director

Action Needed: Determine whether the signs are serving the intended purpose

- Jennings explained that this item came from the March meeting, when Donna Herczeg spoke. One of her concerns was about signs used in lawn care. Some Board members expressed an interest in having a fuller understanding of all sign requirements. The staff attempted to summarize them in the memo. At one time there was an attempt to consolidate all notification requirements in Chapter 28, where the self-initiated request, non-agricultural registry, and residential sign requirements are contained. However, new rules for schools and indoor applications contain separate notification requirements. At the last meeting there was a discussion about adding biting fly (7E) and general vegetation management (6B) if done in a fashion that isn't related to a ROW. Chapter 51 is the oldest chapter with notification requirements; those were around budworm spraying which goes back to 1983. The Legislature made a finding that one way to reduce conflict and concern was to increase communication, so it required public notice for forest insect applications. A couple of concerns that were voiced about residential signs are that the signs have become so busy it is difficult to find pesticide information on them. When Chapter 28 was enacted, the Board wasn't opposed to advertising, but maybe the advertising piece has gone beyond what was anticipated. The question the Board asked in March was: Are the regulations serving the original purpose?
- Eckert noted that, at the time, they wanted companies to think that signage could be a good thing; this company is doing a good thing, being a good public citizen by letting people know; trying to put a little sweetener on it. She is always amazed at how small the sign is allowed to be. If you see something like this on a lawn, you don't see the sign, you notice the holder. You know they sprayed, but don't know what. Are the signs doing what we want them to do? Should they be bigger? The simpler they are, the better, so people can easily identify their purpose.
- Jemison said that he remembers the rules as having a "Board-approved" symbol and minimum information. The Board could keep it simple, such as company name and phone number. The most important thing is that people can see the "Caution, pesticide application" component. That was the purpose. Some of the pictures of signs that Donna Herzog brought were difficult to recognize as an application sign.
- Morrill noted that there were two issues with those signs: (1) One of them was facing the wrong way, and (2) what can be on the sign? It seems like all the required information was there. Maybe there should be a defined border around the required information. Every company uses a different size sign; they should be able to use whatever they want. He prefers not to want to regulate what additional information can be on the sign. Add a border that defines required information and the sign should to point toward ingress.
- Hicks pointed out that the staff gets a lot of calls from the public from these signs; the logo does more to identify a company than a phone number. It's advertising, but it's also useful.

- Jennings said that it does tell you who the company is, but does it tell you that an application was done? One of the requirements is that signs be light-colored with dark, bold lettering. One sign that Donna Herczeg brought in was bright colors. This kind of color scheme can really draw attention to bright colors and detract from the pesticide information in black-and-white text.
- Stevenson suggested that the staff go to the particular companies and tell them they are not following the rule. He agreed that there should be borders around the required information; if they put extra stuff around that, it's fine. There is a perception out there that the original intent was a strategy to frighten people away from making applications. It's a source of pollution, although good for marketing. When you see them on the pallets, you realize how many are put out there.
- Tim Hobbs noted that, if you look back at the minutes, Herczeg's issue was companies using the signs for marketing. If someone is concerned about pesticides, they will know that's what it means. Make sure there's a balance; one person complaining about marketing needs to be kept in perspective. If the rule about contrasting colors is followed, the signs do work.
- Eckert asked whether the Board should be more open to different signage or posting that accomplishes the same purpose.
- Flewelling said he is happy with how the rule is currently written. He is okay with advertising on it and doesn't like to tell people how to do business.
- Jemison suggested making the required information on white, with black letters, with a black border around it, 4x5 inches. Outside of that, they can do anything they want.
- Morrill said the way the rule is written is fine. It gives the option of using multiple-color signs; some companies use different colors for different types of applications.
- Jemison said that if there are too many colors the information is lost in the busy-ness. He is okay with colors as described in rule, but make sure that area (with the required information) is clearly visible.
- Morrill agreed that signs should follow the current rule. Signs called into question probably did not. This fact should be pointed out to the companies.
- Jennings noted that the way it's written now, the information could be spread all over the sign; Jemison advocated that it should be all together in a boxed area.

    - **Consensus was reached that the rule should be left as is and enforced as currently written.**

6. <u>Mosquito-Borne Disease Update</u>

During 2012 and 2013, the Board completed two sets of rulemaking in order to allow governmental entities in Maine to conduct adult mosquito-control programs to prevent mosquito-borne diseases. In addition, there have been two bills in the Maine Legislature affecting public-health-related mosquito control. The Maine Department of Agriculture, Conservation and Forestry also submitted a plan to the Legislature for preventing mosquito-borne diseases. Finally, the Maine Department of Environmental Protection is finalizing a Pesticide General Permit that would allow for wide-area, aerial-spray programs for control of forest and public health pests, and is working with BPC staff on amending the permit for the use of Bt as a larvicide for mosquito control. The staff will update the Board on the status of these activities and mosquito-borne disease trends.

Presentation By: Henry Jennings
Director

Action Needed: None—informational only

- Jennings noted that the only document included in the Board packet was the bill enacted by the Legislature. The Department of Agriculture, Conservation and Forestry (DACF) put in a bill in the first session and it was met with concern in the agricultural community and groups concerned about

pesticide use. A lot of people are opposed to the use of pesticides until something is frightening enough. The bill basically says that we're really scared of pesticides and we're really scared of mosquito-borne diseases, so only use pesticides if we really have to. The Department of Health and Human Services makes the determination of when the critical phase is met. DACF has responsibility for mosquito-control programs, but this responsibility is dependent on funds. The rulemaking that the Board did was around whether landowner consent should be required for public-health mosquito control. The Legislature did approve the amendments, so the Board will need to do a final adoption at the August meeting. Massachusetts makes it very clear that once a public health emergency is declared, landowner prerogative is out the window. The Board did put in rule that government agencies will attempt to exclude four areas: certain agricultural land, public water supplies, aquaculture and fish hatcheries, and endangered species.

- In order for government entities to exclude agricultural areas, the DACF must receive a digital map. Last year, Katy Green from MOFGA provided maps of MOFGA farms in York and Cumberland counties. They are looking for easier ways for this to be accomplished.
- Testing of mosquitoes begins July 1. The Maine Vector-borne Disease Working Group, through the Maine CDC has been producing an Arboviral Plan for about 10 years. It's good on monitoring and communication, but weak on response. There is a group now, with people from CDC and DACF and others, working on how the response plan would work. 2012 was a big year across the country and Maine for West Nile Virus (WNV), and Maine had its first confirmed case of WNV in a Gorham resident. There is some evidence that hot dry years are WNV years. Last year the concern was EEE; there were 26 positive pools for EEE, both the highest number of positive pools and the earliest ever detections. Maine has tested horses, emus, pheasants; moose and deer blood tested positive for EEE. It's been found in all 16 counties. This year they are testing human blood.
- One important factor is how long is mosquito season? The viruses cycle between mosquitoes and birds; when virus levels reach a certain level, humans are then at risk. This seems to occur in mid-August to September when virus levels get high enough. Most years Maine won't need to do any spraying because by the time virus levels get high enough, it is too cold to spray in the evening which is the preferred timing for efficacy purposes. The Maine CDC communicates with towns, encourages them to move times of outdoor activities so they're not playing outside at dusk.
- Dr. Sears left CDC.

7. <u>Other Old or New Business</u>

   a. Letter from Emera Maine about substation spraying

   b. Variance Permit for Dubois Contracting

   c. Variance Permit for the Maine Department of Transportation

   d. Variance Permit for Bartlett Tree Company

   e. Variance Permit for RCL Services

   f. Ogunquit Ordinance

   g. Other

- Jennings noted that the variance permits were just "fyi." The staff issued them because they are repeats or they fall under a policy allowing the staff to issue them. Flewelling asked if any railroads are really close to water. Jennings replied that in some places they're basically going through the lake; some places the railroad track is the lake frontage. He noted that the Board had agreed to look into this issue during the coming winter.
- The Ogunquit ordinance was "void and of no effect" because the town did not notify the Board. They forgot a lot of exemptions, such as paints and stains. Flewelling asked if it was enforceable as

written. Jennings replied that back in the 1980s the Maine law court made a determination that towns have the right to be more restrictive than the state in terms of pesticide use. That is why the Legislature put in statute that the Board should be notified, and the Board maintains a centralized listing. They notify us in advance in case there is a conflict that we could make them aware of, but we have no right to stop them.

- Randlett noted that ordinances can be more restrictive, but there are two statutes that apply. The one requiring notification to the Board, and an agriculture statute which prohibits municipalities from making ordinances that prohibit the use of BMPs for agriculture.

8. Schedule of Future Meetings

August 8 (public hearing for rulemaking), September 12, October 24 and December 5, 2014 are tentative Board meeting dates. The Board will decide whether to change and/or add dates.

Action Needed: Adjustments and/or Additional Dates?

- **No adjustments made nor additional dates added**

9. Adjourn

- **Eckert/Stevenson: Moved and seconded to adjourn at 11:56 AM**
- **In favor: Unanimous**

BASIS STATEMENT FOR ADOPTION OF
CMR 01-026, CHAPTER 20—SPECIAL PROVISIONS

Basis Statement
Surveillance data from the last decade show that mosquito-borne viruses are on the increase in Maine. The first confirmed human case of West Nile Virus in Maine was documented in 2012. Maine's Arboviral Illness Surveillance, Prevention and Response Plan is based on a national model and is similar to most other states. That plan calls for the Maine Center for Disease Control and Prevention to recommend adult mosquito control programs in targeted areas of the state if the threat of mosquito-borne disease reaches the "high" or "critical" phase. Conducting these programs would not be feasible under current state law. Chapter 20 requires authorization from each individual property owner which would be impractical for wide-area programs conducted in residential areas. The proposed amendment to Chapter 20 relaxes the need for individual property owner authorization when the Maine CDC recommends spraying due to vector-borne disease threats.

No changes were made to the amendments based on comments received.

The majority of comments received during the comment period indicate that many people have concerns about wide-area spraying of pesticides for control of mosquitoes. The Board also has concerns, but concluded that its role has never been to determine whether pests should be controlled with pesticides. Rather, the Board's role has always been to ensure that applicators are appropriately trained and to prescribe best practices for the application of pesticides. The Board would like to emphasize that it is not recommending spraying, but is amending its rules to make urgent public health related spraying feasible if Maine's public health officials determine that control of adult mosquitoes is in the best interest of the state.

Impact on Small Business
In accordance with 5 MRSA §8052, sub-§5-A, a statement of the impact on small business has been prepared. Information is available upon request from the Maine Board of Pesticides Control office, State House Station #28, Augusta, Maine 04333-0028, telephone 207-287-2731.

Provisional Adoption
At its May 24, 2013 meeting, the Board provisionally adopted the major substantive amendments to Chapter 20.

Legislative Approval
On June 26, 2013 and January 14, 2014 the Joint Standing Committee on Agriculture, Conservation and Forestry (ACF) held public hearings on LD 1568, the resolve authorizing final adoption of the amendments. Work sessions were held on June 26, 2013, January 14, 2014 and January 23, 2014. Subsequently the ACF reported the resolve out as ought-to-pass as amended. The Legislature enacted the resolve and it became law without the Governor's signature on February 26, 2014 (Resolve 2013, Chapter 87).

BASIS STATEMENT FOR ADOPTION OF
CMR 01-026 CHAPTER 22—STANDARDS FOR OUTDOOR APPLICATION OF PESTICIDES BY POWERED EQUIPMENT IN ORDER TO MINIMIZE OFF-TARGET DEPOSITION

Basis Statement

Surveillance data from the last decade show that mosquito-borne viruses are on the increase in Maine. The first confirmed human case of West Nile Virus in Maine was documented in 2012. Maine's Arboviral Illness Surveillance, Prevention and Response Plan is based on a national model and is similar to most other states. That plan calls for the Maine Center for Disease Control and Prevention to recommend adult mosquito control programs in targeted areas of the state if the threat of mosquito-borne disease reaches the "high" or "critical" phase. Conducting these programs would not be feasible under current state law. Chapter 22 imposes operational standards that would be impractical for wide-area programs conducted in residential areas.

The amendments to Chapter 22 originally exempted wide-area vector control programs from the entire chapter. Some comments received during the comment period suggested that certain portions of Chapter 22 were appropriate and feasible for public health related mosquito control programs. The Board agreed that there was some value to retaining some of the requirements in Chapter 22 and revised the proposed amendments consistent with the comments. Notably the Equipment standards, Weather Condition standards, and Positive Identification of Target Site were retained. The sections to be exempted include Identifying and Recording Sensitive Areas, Presence of Humans and Animals, and certain specifics of Site Plans, which would not be practical in an emergency situation.

The majority of comments received during the comment period indicate that many people have concerns about wide-area spraying of pesticides for control of mosquitoes. The Board also has concerns, but concluded that its role has never been to determine whether pests should be controlled with pesticides. Rather, the Board's role has always been to ensure that applicators are appropriately trained and to prescribe best practices for the application of pesticides. The Board would like to emphasize that it is not recommending spraying, but is amending its rules to make urgent public health related spraying feasible if Maine's public health officials determine that control of adult mosquitoes is in the best interest of the state.

Impact on Small Business

In accordance with 5 MRSA §8052, sub-§5-A, a statement of the impact on small business has been prepared. Information is available upon request from the Maine Board of Pesticides Control office, State House Station #28, Augusta, Maine 04333-0028, telephone 207-287-2731.

Provisional Adoption

At its May 24, 2013 meeting, the Board provisionally adopted the major substantive amendments to Chapter 22.

Legislative Approval

On June 26, 2013 and January 14, 2014 the Joint Standing Committee on Agriculture, Conservation and Forestry (ACF) held public hearings on LD 1567, the resolve authorizing final adoption of the amendments. Work sessions were held on June 26, 2013, January 14, 2014 and January 23, 2014. Subsequently the ACF reported the resolve out as ought-to-pass as amended. The Legislature enacted the resolve and it became law without the Governor's signature on February 26, 2014 (Resolve 2013, Chapter 88).

BASIS STATEMENT FOR ADOPTION OF
CMR 026-01, CHAPTER 51—NOTICE OF AERIAL PESTICIDE APPLICATIONS

Basis Statement
Surveillance data from the last decade show that mosquito-borne viruses are on the increase in Maine. The first confirmed human case of West Nile Virus in Maine was documented in 2012. Maine's Arboviral Illness Surveillance, Prevention and Response Plan is based on a national model and is similar to most other states. That plan calls for the Maine Center for Disease Control and Prevention to recommend adult mosquito control programs in targeted areas of the state if the threat of mosquito-borne disease reaches the "high" or "critical" phase. Conducting these programs would not be feasible under current state law.

Chapter 51 details requirements for notice of aerial applications. Originally, the intent of the Board was to exempt government-sponsored, wide-area vector control programs from the entire chapter because notice requirements are included in Chapter 20 in lieu of individual notification. Comments received during comment period suggested that certain elements of Chapter 51 were still feasible. The Board agreed with those comments and revised its proposed amendments consistent with the comments. Notably, the Board decided there was value in retaining the requirement for notice to the Board and Maine Poison Control Center as described in the chapter.

The majority of comments received during the comment period indicate that many people have concerns about wide-area spraying of pesticides for control of mosquitoes. The Board also has concerns, but concluded that its role has never been to determine whether pests should be controlled with pesticides. Rather, the Board's role has always been to ensure that applicators are appropriately trained and to prescribe best practices for the application of pesticides. The Board would like to emphasize that it is not recommending spraying, but is amending its rules to make urgent public health related spraying feasible if Maine's public health officials determine that control of adult mosquitoes is in the best interest of the state.

Impact on Small Business
In accordance with 5 MRSA §8052, sub-§5-A, a statement of the impact on small business has been prepared. Information is available upon request from the Maine Board of Pesticides Control office, State House Station #28, Augusta, Maine 04333-0028, telephone 207-287-2731.

Provisional Adoption
At its May 24, 2014 meeting, the Board provisionally adopted the major substantive amendments to Chapter 51.

Legislative Approval
On June 26, 2013 and January 14, 2014 the Joint Standing Committee on Agriculture, Conservation and Forestry (ACF) held public hearings on LD 1569, the resolve authorizing final adoption of the amendments. Work sessions were held on June 26, 2013, January 14, 2014 and January 23, 2014. Subsequently the ACF reported the resolve out as ought-to-pass as amended. The Legislature enacted the resolve and it became law without the Governor's signature on February 26, 2014 (Resolve 2013, Chapter 86).

01 DEPARTMENT OF AGRICULTURE, FOOD AND RURAL RESOURCES

026 BOARD OF PESTICIDES CONTROL

Chapter 20: SPECIAL PROVISIONS

SUMMARY: These provisions regulate the use, storage and disposal of pesticides with specific emphasis on registered pesticides, right of way and aquatic applications and employer/employee requirements.

Section 1. Registered Pesticides

A. The use of any pesticide not registered by the Maine Board of Pesticides Control in accordance with Title 7 M.R.S.A. 601 is prohibited except as otherwise provided in this chapter or by FIFRA, Section 2(ee).

B. The use of registered pesticides for other than registered uses, or at greater than registered dosages, or at more frequent than registered intervals is prohibited, provided that application or use of unregistered pesticides and unregistered applications or uses of registered pesticides may be made for experimental purposes if in accordance with requirements of the Maine Board of Pesticides Control, and the U.S. Environmental Protection Agency.

C. Retailers and end users of pesticides no longer registered in Maine may continue to sell and use those items provided they were properly registered when obtained and such distribution and use is not prohibited by FIFRA or other Federal law.

D. In conducting review of registration or re-registration pursuant to 7 M.R.S.A. §607-A, the Board may consider the potential for environmental damage by the pesticide through direct application on or off-target or by reason of drift. If the Board finds that the use of the pesticide is anticipated to result in significant adverse impacts on the environment, whether on or off-target, which cannot be avoided or adequately mitigated, registration or re-registration will not be granted unless the Board finds that anticipated benefits of registration clearly outweigh the risks. In any case where the Board may request data in connection with registration or re-registration of any pesticide, such data may include that concerning pesticide residues, propensity for drift and testing therefor. Such data, if requested, shall provide information regarding residues and residue effects on plant tissues, soil and water and other potential deposition sites, and shall take into consideration differences in plants, soils, climatic conditions at the time of application and application techniques.

Section 2. Right-of-Way

Deciduous growth over six feet in height and evergreen growth over three feet in height shall not be sprayed with a herbicide within the right-of-way of any public way except that deciduous

growth which has been cut to the ground and which has grown more than six feet during the growing season following the cutting, may be sprayed that following season. In addition, chemical pruning of single limbs of trees over the prescribed heights may be performed.

Section 3. Pesticide Storage and Disposal

A. Unused pesticides, whether in sealed or open containers, must be kept in a secure enclosure and otherwise maintained so as to prevent unauthorized use, mishandling or loss; and so as to prevent contamination of the environment and risk to public health.

B. Obsolete, expired, illegal, physically or chemically altered or unusable pesticides, except household pesticide products, shall be either:

1. stored in a secure, safe place under conditions that will prevent deterioration of containers or any contamination of the environment or risk to public health, or

2. returned to the manufacturer or formulator for recycling, destruction, or disposal as appropriate, or

3. disposed of in a licensed hazardous waste facility or other approved disposal site that meets or exceeds all current requirements of the Maine Department of Environmental Protection and the U.S. Environmental Protection Agency for facilities receiving such waste.

Section 4. Aquatic Applications

No person, firm, corporation or other legal entity shall, for the purpose of controlling aquatic pests, apply any pesticide to or in any waters of the state as defined in 38 M.R.S.A. §361-A(7) without approval of the Maine Department of Environmental Protection.

Section 5. Employer/Employee Requirements

A. Any person applying pesticide shall instruct their employees and those working under their direction about the hazards involved in the handling of pesticides to be employed as set forth on the pesticide label and shall instruct such persons as to the proper steps to be taken to avoid such hazards.

B. Any person applying pesticides shall provide and maintain, for the protection of their employees and persons working under their direction, the necessary safety equipment as set forth on the label of the pesticide to be used.

~~**Section 6. Prohibition of Unauthorized Application of Pesticides**~~

~~A. Except as provided by Chapter 20.6(D) and 6(E) below, no person may contract with, or otherwise engage, a pesticide applicator to make any pesticide application to property unless that person is the owner, manager, or legal occupant of the property to which the~~

~~pesticide is to be applied, or that person has the consent of the owner, manager or legal occupant to enter into an agreement for pesticide applications to be made to that property. The term "legal occupant" includes tenants of rented property.~~

~~B. Except as provided by Chapter 20.6(D) and 6(E) below, no person may apply a pesticide to a property of another unless prior consent for the pesticide application has been obtained from the owner, manager or legal occupant of that property. The term "legal occupant" includes tenants of rented property.~~

~~C. Except as provided by Chapter 20.6(D) and 6(E) below, no commercial applicator may perform ongoing, periodic non-agricultural pesticide applications to a property unless:~~

~~1. there is a signed, written agreement with the property owner, manager or legal occupant that explicitly states that such pesticide applications shall continue until a termination date specified in the agreement, unless sooner terminated by the applicator or property owner, manager or legal occupant, or~~

~~2. the commercial applicator utilizes another system of verifiable authorization approved by the Board that provides substantially equivalent assurance that the customer is aware of the services to be provided and the terms of the agreement.~~

~~D. The requirements of Chapter 20.6(A), (B) or (C) shall not apply when the pesticide application is made by or on behalf of the holder of an easement or right of way, for the purposes of maintaining such easement or right of way.~~

~~E. When the Maine Center for Disease Control (CDC) recommends mosquito control for arboviral diseases, the requirements of Chapter 20.6(A), (B) or (C) shall not apply to government sponsored mosquito control programs, provided that the government entity:~~

~~1. makes a reasonable effort to provide advance notice to residents about mosquito control programs using multiple forms of publicity which may include, but is not limited to, signs, newspaper, television or radio notices, direct mailings, electronic communication or other effective methods; and~~

~~2. implements an "opt out" option whereby residents may request that their property be excluded from any ground based control program and the government entity makes a reasonable effort to honor such requests; and~~

~~3. if aerial applications are made, makes efforts to avoid applications to certified organic crops and livestock.~~

Section 6. Authorization for Pesticide Applications

A. Authorization to apply pesticides to private property is not required when a pesticide application is made by or on behalf of the holder of an easement or right of way, for the purposes of establishing or maintaining such easement or right of way.

B. When the Maine Center for Disease Control and Prevention (CDC) has identified that an organism is a vector of human disease and the vector and disease are present in an area, a government entity shall obtain authorization for ground-based applications by:

1. Sending a written notice to the person(s) owning property or using residential rental, commercial or institutional buildings within the intended target site at least three days but not more than 60 days before the commencement of the intended spray applications. For absentee property owners who are difficult to locate, mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice; and

2. Implementing an "opt out" option whereby residents and property owners may request that their property be excluded from the application by submitting written notice to the government entity at least 24 hours before spraying is scheduled to commence. Authorization is considered given for any property for which written notice was submitted and no "opt out" request was received by the sponsoring government entity.

C. When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government entities are not required to receive prior authorization to apply pesticides to private property, provided that the government entity sponsoring the vector control program:

1. Provides advance notice to residents about vector control programs using multiple forms of publicity which may include, but is not limited to, signs, newspaper, television or radio notices, direct mailings, electronic communication or other effective methods; and

2. Implements an "opt out" option whereby residents and property owners may request that their property be excluded from any ground based control program and the government entity makes a reasonable effort to honor such requests; and

3. If aerial applications are made, takes affirmative steps, to the extent feasible, to avoid applications to exclusion areas as identified by Board policy.

D. General Provisions. For any pesticide application not described in Chapter 20.6(A),(B) or (C), the following provision apply:

1. No person may contract with, or otherwise engage, a pesticide applicator to make any pesticide application to property unless that person is the owner, manager, or legal occupant of the property to which the pesticide is to be applied, or that person has the authorization of the owner, manager or legal occupant to enter into an agreement for pesticide applications to be made to that property. The term "legal occupant" includes tenants of rented property.

2. No person may apply a pesticide to a property of another unless prior authorization for the pesticide application has been obtained from the owner, manager or legal occupant of that property. The term "legal occupant" includes tenants of rented property.

3. No commercial applicator may perform ongoing, periodic non-agricultural pesticide applications to a property unless:

i. there is a signed, written agreement with the property owner, manager or legal occupant that explicitly states that such pesticide applications shall continue until a termination date specified in the agreement, unless sooner terminated by the applicator or property owner, manager or legal occupant; or

ii. the commercial applicator utilizes another system of verifiable authorization approved by the Board that provides substantially equivalent assurance that the customer is aware of the services to be provided and the terms of the agreement.

~~**Section 7. Transition**~~

~~This regulation will become effective on January 1, 2008.~~

STATUTORY AUTHORITY: Title 22 M.R.S.A., Chapter 258-A

EFFECTIVE DATE:
July 6, l979

AMENDMENT EFFECTIVE:
April 1, 1985
January 1, 1988
May 21, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
May 7, 1997 - Section 5

CONVERTED TO MS WORD:
March 11, 2003

CORRECTED HEADER CHAPTER NUMBER:
January 10, 2005

AMENDED:
January 1, 2008 – new Sections 6 and 7, filing 2007-65
September 13, 2012 – Section 6(E) and references added, filing 2012-270 (Emergency – expires in 90 days unless proposed and adopted in the meantime as non-emergency)
December 12, 2012 – emergency filing expires, chapter reverts to January 1, 2008 version

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 22: STANDARDS FOR OUTDOOR APPLICATION OF PESTICIDES BY POWERED EQUIPMENT IN ORDER TO MINIMIZE OFF-TARGET DEPOSITION

SUMMARY: These regulations establish procedures and standards for the outdoor application of pesticides by powered equipment in order to minimize spray drift and other unconsented exposure to pesticides. The primary purpose of these regulations is to implement the legislative mandate of the Board, as expressed by 7 M.R.S.A. §606(2)(G), to design rules which "minimize pesticide drift to the maximum extent practicable under currently available technology."

SECTION 1. EXEMPTIONS

The regulations established by this chapter shall not apply to pesticide applications in any of the following categories:

A. Applications of pesticides confined entirely to the interior of a building;

B. Applications of pesticides by non-powered equipment;

C. Applications of pesticides exclusively in granular or pelletized form;

D. Applications of pesticides injected underground or otherwise injected directly into the target medium. Such applications must involve no spraying of pesticides whatsoever.

SECTION 2. STANDARDS OF CONDUCT FOR PESTICIDE APPLICATIONS

All pesticide applications subject to these regulations shall be undertaken in compliance with the following standards of conduct:

A. Equipment

I. Pesticide spray equipment shall be used in accordance with its manufacturer's recommendations and instructions, and shall be in sound mechanical condition, free of leaks and other defects or malfunctions which might cause pesticides to be deposited off-target.

II. Pesticide spray equipment shall be properly calibrated consistent with Board or University published guidance. Sufficient records to demonstrate proper calibration must be maintained and made available to representatives of the Board upon request.

III. Pesticide application equipment shall have properly functioning shut-off valves or other mechanisms which enable the operator to prevent direct discharge and minimize drift to non-target areas. Spray equipment designed to draw water must also have a properly functioning antisiphoning device.

B. Weather Conditions

I. Spray applications shall not be undertaken when weather conditions favor pesticide drift onto Sensitive Areas or otherwise prevent proper deposition of pesticides on target.

II. Pesticide application must cease immediately when visual observation reveals or should reveal that spray is not being deposited on target.

III. Without limitation of the other requirements herein, under no circumstances shall pesticide application occur when wind speed in the area is in excess of 15 miles per hour.

C. Identifying and Recording Sensitive Areas

Prior to spraying a pesticide, the applicator must become familiar with the area to be sprayed and must identify and record the existence, type and location of any Sensitive Area located within 500 feet of the target area. Applicators shall prepare a site map or other record, depicting the target area and adjacent Sensitive Areas. The map or other record shall be updated annually. The site map or other record shall be retained by the applicator for a period of two years following the date of applications and shall be made available to representatives of the Board upon request. This requirement shall not apply to commercial application categories 3B (turf), 3A (ornamental tree and plant) or 7A (structural general pest control applications).

D. Presence of Humans, Animals

Pesticide applications shall be undertaken in a manner which minimizes exposure to humans, livestock and domestic animals.

The applicator shall cease spray activities at once upon finding evidence showing the likely presence of unprotected persons in the target area or in such proximity as to result in unconsented exposure to pesticides.

E. Other Requirements

These regulations are intended to be minimum standards. Other factors may require the applicator to take special precautions, beyond those set forth in these regulations, in order to avoid adverse impacts on off-target areas and to protect public health and the environment.

SECTION 3. STANDARDS FOR AERIAL APPLICATION OF PESTICIDES

A. Positive Identification of the Target Site

The person contracting for an aerial pesticide application shall ensure that the application site (i.e., target area) is positively identified prior to application, using a unique and verifiable method, including;

I. An onboard, geo-referenced electronic mapping and navigation system (e.g., GPS); or

II. Effective site markings visible to the applicator; or

III. Other method(s) approved by the Board.

B. Site Plans Required

Prior to spraying by aerial application within 1,000 feet of a Sensitive Area Likely to Be Occupied, the person contracting for the application shall provide to the applicator a site plan that includes:

I. a site map drawn to scale that:

(i) delineates the boundaries of the target area and the property lines;

(ii) depicts significant landmarks and flight hazards;

(iii) depicts the type and location of any Sensitive Area Likely to Be Occupied within 1,000 feet of the target area; and

(iv) depicts other Sensitive Areas within 500 feet of the target area.

II. If applicable, a school bus schedule shall accompany the site map.

III. The site plan and site map with identified sensitive areas required under Section 3(B) shall be retained by the applicator for a period of two years following the date of applications and shall be made available to representatives of the Board upon request.

IV. Compliance with this section satisfies the requirements of Section 2(C).

C. Site-Specific Application Checklist

Prior to conducting an aerial pesticide application within 1,000 feet of a Sensitive Area Likely to Be Occupied, the applicator shall complete a Board-approved pre-application checklist for each distinct field or target site. The checklist shall be maintained by the applicator for a period of two years and shall be available for inspection by representatives of the Board at reasonable times, upon request. The checklist shall include, at a minimum, the following elements:

I. The date, time, description of the target site and name of the applicator;

II. Confirmation that the notification requirements contained in CMR 01-026, Chapters 28 and 51, have been carried out;

III. Confirmation that the target site has been positively identified;

IV. The location of where weather conditions are measured and a description of the equipment used to measure the wind speed and direction;

V. Confirmation that conditions are acceptable to treat the proposed target site, considering the location of any Sensitive Area Likely to Be Occupied and current weather conditions;

VI. Wind speed and direction;

VII. The measures used to protect all Sensitive Areas;

VIII. Confirmation that there are no humans visible in or near the target area.

D. Buffer Zones for any Sensitive Area Likely to Be Occupied

Aerial applicators shall employ site-specific buffer zones adjacent to any Sensitive Area Likely to Be Occupied sufficient to prevent unlawful pesticide drift, unless consent has been granted by the landowner, lessee and occupant (when applicable), consistent with the provisions of Section 4(C) of this rule.

E. Wind Speeds for Aerial Applications

Unless otherwise specified by the product label, an applicator may not conduct an aerial application of pesticides within 1,000 feet of a Sensitive Area Likely to Be Occupied unless the wind speed is between 2 and 10 miles per hour.

SECTION 4. GENERAL STANDARDS FOR OFF-TARGET PESTICIDE DISCHARGE AND RESIDUE

A. Prohibition of Unconsented, Off-Target Direct Discharge of Pesticides.

Pesticide applications shall be undertaken in a manner which does not result in off-target direct discharge of pesticides, unless prior authorization and consent is obtained from the owner or lessee of the land onto which such discharge may occur in a manner consistent with the pesticide label.

B. Standards for Unconsented, Off-Target Drift of Pesticides

I. General Standard. Pesticide applications shall be undertaken in a manner which minimizes pesticide drift to the maximum extent practicable, having due regard for prevailing weather conditions, toxicity and propensity to drift of the

pesticide, presence of Sensitive Areas in the vicinity, type of application equipment and other pertinent factors.

II. Prima Facie Evidence. Pesticide residues in or on any off-target Sensitive Area Likely to Be Occupied resulting from off-target drift of pesticides from a nearby application that are 1% or greater of the residue in the target area are considered prima facie evidence that the application was not conducted in a manner to minimize drift to the maximum extent practicable. The Board shall review the site-specific application checklist completed by the applicator and other relevant information to determine if a violation has occurred. For purposes of this standard, the residue in the target area, and the residue in the Sensitive Area Likely to Be Occupied, may be adequately determined by evaluation of one or more soil, foliage or other samples, or by extrapolation or other appropriate techniques.

III. Standard of Harm. An applicator may not apply a pesticide in a manner that results in:

(i) Off-target pesticide residue detected in or on any nearby crop which violates EPA tolerances for that crop, as established under 40 CFR, Part 180.

(ii) Off-target pesticide residue detected in or on any nearby organic farm or garden which causes the agricultural products thereof to be excluded from organic sale in accordance with 7 CFR, Part 205, Section 205.671.

(iii) Off-target pesticide residue detected on any nearby persons or vehicles using public roads.

(iv) Documented human illness. For this standard to be met, the Board must receive verification from two physicians that an individual has experienced a negative health effect from exposure to an applied pesticide and that the effect is consistent with epidemiological documentation of human sensitivity to the applied pesticide.

(v) Off-target damage or injury to any organism.

IV. Enforcement Considerations. The Board shall consider the particular circumstances of violations arising from Subsections 4(B)(I) and (III) in determining an appropriate response, including, but not limited to:

(i) The standard of care exercised by the applicator;

(ii) The degree of harm or potential harm that resulted from or could have resulted from off-target drift from the application;

(iii) The risk (toxicity and exposure) of adverse effects from the pesticide applied.

C. Consent

I. Consent, How Given. Authorization and consent by the owner or lessee and occupant (when applicable) of land receiving a pesticide discharge or drift in a manner consistent with the pesticide label may be given in any manner, provided that the consent is reasonably informed and is given prior to the onset of the spray activity in question. The burden of proof shall be upon the applicator to demonstrate that requisite authorization and consent has been given. For this reason, applicators are encouraged to obtain such consent in writing and to maintain records thereof.

II. The residue and harm standards in Sections 4(B)(II) and (III) for off-target drift do not apply where the owner, lessee and occupant (when applicable) of the off-target area receiving the pesticide drift have given authorization and consent as prescribed in Section 4(C).

III. Except with the prior written approval of the Board, no authorization or consent may be given with regard to off-target direct discharge or off-target drift of pesticides upon any bodies of water or critical areas as defined in CMR 01-026, Chapter 10, "Definitions; Sensitive Area."

SECTION 5. VARIANCES FROM STANDARDS

A. Variance Permit Application

An applicator may vary from any of the standards imposed under this chapter by obtaining a permit to do so from the Board. Permit applications shall be made on such forms as the Board provides and shall include at least the following information:

I. The name, address, and telephone number of the applicant;

II. The area(s) where pesticides will be applied;

III. The type(s) of pesticides to be applied;

IV. The purpose for which the pesticide application(s) will be made;

V. The approximate date(s) of anticipated spray activities;

VI. The type(s) of spray equipment to be employed;

VII. The particular standards from which the applicant seeks a variance;

VIII. The particular reasons why the applicant seeks a variance from such standards, including a detailed description of the techniques to be employed to assure a reasonably equivalent degree of protection and of the monitoring efforts to be made to assure such protection;

IX. The names and addresses of all owners or lessees of land within 500 feet of the proposed spray activity, and evidence that such persons have been notified of the application. The Board may waive this requirement where compliance would be unduly burdensome and the applicant attempts to notify affected persons in the community by another means which the Board finds reasonable.

B. Board Review; Legal Effect of Permit, Delegation of Authority to Staff

I. Within 60 days after a complete application is submitted, the Board shall issue a permit if it finds that the applicant will achieve a substantially equivalent degree of protection as adherence to the requirements of this chapter would provide and will conduct spray activities in a manner which protects human health and the environment. Such permit shall authorize a variance only from those particular standards for which variance is expressly requested in the application and is expressly granted in the permit. The Board may place conditions on any such permit, and the applicant shall comply with such conditions. Except as conditioned in the permit, the applicant shall undertake spray activities in accordance with all of the procedures described in the application and all other applicable legal standards. Permits issued by the Board under this section shall not be transferable or assignable except with further written approval of the Board and shall be valid only for the period specified in the permit.

II. The Board may delegate authority to review applications and issue permits to the staff as it feels appropriate. All conditions and limitations as described in Section 5(B) I shall remain in effect for permits issued by the staff. If the staff does not grant the variance permit, the applicator may petition the Board for exemption following the requirements set forth in 22 MRSA §1471-T, "Exemptions."

SECTION 6. EMERGENCIES

A. In the event that severe pest or weather conditions threaten to cause a ~~public health emergency as determined by the Commissioner of the Maine Department of Health and Human Services, or a threat of~~ significant natural resource and/or economic loss, as determined by ~~either~~ the Commissioner of the Maine Department of Agriculture, Conservation and Forestry ~~or the Commissioner of the Maine Department of Agriculture, Food and Rural Resources~~, the ~~specified~~ requirements contained in Section 3 of this Chapter shall be waived, subject to the following conditions:

I. The severe pest and/or weather conditions must necessitate immediate wide-scale aerial application of pesticides.

II. The immediate need for aerial pesticide application does not provide sufficient time to complete the requirements of Section 3 of this Chapter,

III. Prior to any aerial application, the Commissioner shall issue a press release notifying residents of affected regions about the emergency, the likelihood of aerial application in the affected regions and the approximate dates that the emergency may continue.

IV. The Commissioner, in consultation with the Board's staff, shall specify the requirements in Section 3 that will be waived.

V. Land managers and aerial applicators shall make good faith efforts to comply with the intent of Section 3 and minimize off-target drift to Sensitive Areas.

B. When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government sponsored vector control programs are exempt from Sections 2C, 2D, 3B, 3C, 3D, 3E and 4 of this chapter, provided that reasonable efforts are made to avoid spraying non-target areas.

June 12, 2009 amendments become effective on January 1, 2010

STATUTORY AUTHORITY: 7 M.R.S.A. §606(2)(G):
22 M.R.S.A. §1471-M(2)(D)

EFFECTIVE DATE:
January 1, 1988

AMENDED:
October 2, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
September 22, 1998 - also converted to MS Word
January 4, 2005 – filing 2004-603 affecting Section 3.B.II.(iii)
January 1, 2010 by request of agency in filing 2009-252

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 51: NOTICE OF AERIAL PESTICIDE APPLICATIONS

SUMMARY: These regulations describe the notification requirements for persons contracting aerial pesticide applications to control forest, ornamental plant, right-of-way, biting fly and public health pests.

Section I. Content of All Newspaper Articles/Advertisements, Written Notices to Property Owners and Posters

A. All newspaper articles/advertisements and written notices to property owners required by this chapter shall contain the following:

1. Description of the target area sufficient to inform people who may be in the vicinity.

2. Name of the person who contracts for the application or her/his representative or the applicator and the address and telephone number to contact for more specific information about the intended application.

3. Intended purpose of the pesticide application.

4. Pesticide(s) to be used.

5. Date or reasonable range of dates on which application(s) are proposed to take place.

6. Telephone number of the Maine Board of Pesticides Control.

7. Telephone number of the Maine Poison Control Center.

8. Public precautions which appear on the pesticide label.

B. All newspaper articles/advertisements must be printed in a minimum of 10 point types and at least 2 inches wide.

C. All posters required by this chapter shall contain the following:

1. Name of the person who contracts for the application or her/his representative or the applicator and the address and telephone number to contact for more specific information about the intended application.

2. Intended purpose of the pesticide application.

3. Pesticide(s) to be used.

4. Telephone number of the Maine Board of Pesticides Control

5. Telephone number of the Maine Poison Control Center.

6. Public precautions which appear on the pesticide label.

Section II. Forest Insect Applications

A. **Responsible Parties**

1. In the event of a forest insect spray program administered pursuant to Title 12, Chapter 801, the Maine Department of Conservation, Bureau of Forestry, is responsible for notices.

2. In the case of any other forest insect aerial spray activity, responsibility for notices lies with the landowner, her/his representative or the lessee if the land is leased.

B. **Newspaper Articles/Advertisements and Written Notices to Property Owners**

1. An article about/advertisement of a major forest insect aerial spray application shall be published in a newspaper of general circulation in the affected area at least 14 days but not more than 30 days prior to commencement of planned spray activity.

2. An article about/advertisement of a minor forest insect aerial spray application shall be published in a newspaper of general circulation in the affected area at least 4 days but not more than 10 days prior to commencement of planned spray activity.

3. An addition of spray areas not specified in the original newspaper article/advertisement and any change from the insecticides specified in the original article/advertisement shall be published in the same newspaper at least 24 hours before the change is effected.

4. A written notice of all forest insect aerial pesticide applications shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Posting of Areas Subject to Major and Minor Forest Insect Aerial Spray Applications**

1. A poster shall be posed conspicuously just prior to the planned spray activity and shall not be removed by the landowner or landowner's agent for at least 2 days (48 hours) after spray activity ceases. Areas that shall be posed include each major point of ingress and egress of the public into the area to be sprayed. Major points of ingress and egress include federal, state, municipal and private roads open to the public and known to be used by the public that lead into the area to be sprayed; utility crossings of these roads; known boat launching sites on rivers leading through spray areas and within the boundaries of the land owned by the person authorizing the spray activity; and marked points of access to foot trails known to be used by the public.

2. Posters shall be constructed of brightly colored, weather resistant stock and shall be at least 11 x 14 inches in size. They shall contain the information required in Section I(C). The information shall be printed in both English and French.

D. **Written Notice to the Board and the Maine Poison Control Center**

1. A written notice shall be given to the Board and to the Maine Poison Control Center according to the following schedule:

   a. Written notice of major forest insect aerial spray applications shall be given to the Board and the Maine Poison Control Center at least 15 days but not more than 30 days prior to the commencement of planned spray activity.

   b. Written notice of minor forest insect spray application shall be given to the Board and the Maine Poison Control Center at least 5 days prior to the commencement of planned spray activity.

   c. Any addition of spray blocks not specified in the original notice to the Board and any change in pesticide assignments to particular blocks shall be given to the Board as soon as practicable, and in any case every reasonable effort shall be made to give notice of change to the Board prior to initiation of pesticide application. Notice under this subsection may be accomplished by telephone communication with the Board's office.

2. **Notice to the Board**. These notices shall be prepared on forms provided by the Board and shall consist of:

   a. A description of the proposed spray activity including detailed spray application maps showing sensitive areas and major public routes of ingress and egress. Use *of The Maine Atlas and Gazetteer*, by DeLorme Mapping Company or some other similar atlas is the suggested format for the base map.

   b. The date or dates on which spraying is proposed to take place.

c. The name, address, telephone number and license number of the spray contracting firm which will carry out the spray activity.

d. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

e. A listing of precautions taken to insure notice to the public, including copies of the newspaper notice and the poster to be used.

f. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Board promptly upon request.

3. **Notice to the Maine Poison Control Center**. These notices shall be prepared on forms provided by the Board and shall consist of:

a. A description of the general area the proposed application activity will take place.

b. The date or dates on which spraying is proposed to take place.

c. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

d. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Maine Poison Control Center promptly upon request.

Section III. Ornamental Plant Applications

A. Responsible Parties

The licensed applicator must provide the person contracting for services with the proper materials to provide notification according to the provisions described in this chapter. The licensed applicator must not commence spray activities until the person contracting for the services provides written proof that the notification procedures contained Section III(B) and (C) have been completed. The person who provides the notification and certifies that the requirements have been fulfilled is responsible for that notification.

B. Newspaper Articles/Advertisements and Written Notices to Property Owners

1. An article about/advertisement of ornamental plant aerial pesticide applications shall be published in a paper of general circulation in the affected area at least 3 days but not more than 60 days prior to the commencement of the intended spray

activity. The article/ advertisement shall contain the information required in section I(A) and (B) and shall not be limited to a legal notice.

2. A written notice of ornamental plant aerial pesticide applications shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Written Notice to the Board and the Maine Poison Control Center**

Written notices to the Board and the Maine Poison Control Center must be given according to Section VI of this rule (Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications).

Section IV. Rights-Of-Way, Forest Vegetation Management and Other Forest Pest Applications

A. **Responsible Parties**

The licensed applicator must provide the person contracting for services with the proper materials to provide notification according to the provisions described in this chapter. The licensed applicator must not commence spray activities until the person contracting for the services provides written proof that the notification procedures contained Section IV(B) and (C) have been completed. The person who provides the notification and certifies that the requirements have been fulfilled is responsible for that notification.

B. **Newspaper Articles/Advertisements or Written Notices to Property Owners**

1. An article about/advertisement of rights-of-way, forest vegetation management or other forest pest aerial pesticide applications shall be published in a paper of general circulation in the affected area at least 3 days but not more than 60 days prior to the commencement of the intended spray activity. The article/advertisement shall contain the information required in Section I(A) and (B) and shall not be limited to a legal notice or;

2. In areas where there is no regular newspaper circulation, the person contracting for services may substitute individual notice to all landowners within 500 feet of the target site. This individual notice shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Posting Requirements for Rights-of-Way, Forest Vegetation Management and Other Forest Pest Aerial Applications**

1. A poster shall be posed conspicuously just prior to the planned spray activity and shall not be removed by the landowner or landowner's agent for at least 2 days (48 hours) after spray activity ceases. The poster shall contain the information required in Section I(C). Areas that shall be posed include each major point of ingress and egress of the public into the area to be sprayed. Major points of ingress and egress include federal, state, municipal and private roads open to the public and known to be used by the public that lead into the area to be sprayed; utility crossings of these roads and any place a maintained public trail enters the application site.

2. Poster shall be constructed of brightly colored, weather resistant stock and shall be at least 11 x 14 inches in size. The information shall be printed in both English and French.

D. **Written Notice to the Board and the Maine Poison Control Center**

Written notices to the Board and the Maine Poison Control Center must be given according to Section VI of this rule (Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications).

Section V. Biting Fly and Public Health Pest Applications

A. **Responsible Parties**

The licensed applicator must provide the person contracting for services with the proper materials to provide notification according to the provisions described in this chapter. The licensed applicator must not commence spray activities until the person contracting for the services provides written proof that the notification procedures contained Section V(B) and (C) have been completed. The person who provides the notification and certifies that the requirements have been fulfilled is responsible for that notification.

B. **Newspaper Articles/Advertisements and Written Notice to Property Owners**

1. An article about/advertisement of biting fly and public health pest aerial pesticide applications shall be published in a paper of general circulation in the affected area at least 3 days but not more than 60 days prior to the commencement of the intended spray activity. The article/advertisement shall contain the information required in Section I(A) and (B) and shall not be limited to a legal notice.

2. A written notice shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are

difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Written Notice to the Board and the Maine Poison Control Center**

Written notices to the Board and the Maine Poison Control Center must be given according to Section VI of this rule (Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications).

Section VI. Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications

A. A written notice shall be given to the Board and the Maine Poison Control Center at least 7 days but not more than 30 days prior to the commencement of planned spray activity.

B. These notices shall be prepared on forms provided by the Board and shall consist of:

1. **Written notice to the Board**

a. A description of the proposed spray activity including detailed spray application maps showing sensitive areas and major public routes of ingress and egress. Use *of The Maine Atlas and Gazetteer*, by DeLorme Mapping Company or some other similar atlas is the suggested format for the base map.

b. The date or dates on which spraying is proposed to take place.

c. A description of the delivery mechanism which shall include the name, address, telephone number and license number of the spray contracting firm which will carry out the spray activity.

d. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

e. A listing of precautions taken to insure notice to the public, including copies of the newspaper notice or the notice given to person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site.

f. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Board promptly upon request.

2. **Written notice to the Maine Poison Control Center**

a. A description of the general area the proposed application activity will take place.

b. The date or dates on which spraying is proposed to take place.

c. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

d. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Maine Poison Control Center promptly upon request.

C. Any addition of spray blocks not specified in the original notice to the Board and any change in pesticide assignments to particular blocks shall be given to the Board as soon as practicable, and in any case every reasonable effort shall be made to give notice of change to the Board prior to initiation of pesticide application. Notice under this subsection may be accomplished by telephone communication with the Board's staff.

Section VII. ~~**Variances From Notice Requirements**~~**Emergencies**

A. ~~*[Repealed by sunset provision, April 19, 1996.]*~~**Disease Vectors**

When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government sponsored vector control programs are exempt from this chapter provided that the responsible governmental entity submits the written notice to Board and the written notice to the Maine Poison Control Center as described in this chapter.

B. **Other Emergencies**

The Board's staff may grant an emergency variance from the notice requirements set forth in Sections III, IV, V and VI of this chapter if the notice requirements prevent efficacious application of pesticide(s) and the staff determines that an emergency situation exists.

1. An emergency situation:

a. Involves the introduction or dissemination of a pest new to or not theretofore known to be widely prevalent or distributed within or throughout the United States and its territories; or

b. Will present significant risks to human health; or

c. Will present significant risks to threatened or endangered species, beneficial organisms, unique ecosystems or the environment; or

d. Will cause significant economic loss due to:

i. an outbreak or an expected outbreak of a pest; or

ii. a change in plant growth or development caused by unusual environmental conditions where such change can be rectified by the use of a pesticide(s).

2. Any emergency variance granted by the staff under this section shall include provisions demonstrating the applicant will furnish substantially equivalent notification as provided by this chapter and shall include:

a. Documented notification of person(s) owning property or using commercial or institutional buildings within 500 feet of the intended target site prior to the pesticide application and where appropriate;

b. Radio or television announcements or,

c. Prominently positioned poster.

3. No variance may be granted if the emergency situation is the result of an unjustifiable delay created by the person seeking the variance or the person requesting the pesticide application.

4. If the staff does not grant the variance, the applicator or the person requesting the pesticide application may petition the Board for exemption following the requirements set forth in 22 M.R.S.A. §1471-T, "Exemption".

STATUTORY AUTHORITY: 22 M.R.S.A. §1471-G, M, R and T

EFFECTIVE DATE:
August 12, 1985

AMENDED:
May 19, 1991
April 8, 1992
April 19, 1994
October 2, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
April 14, 1998 - inserted “residential rental,” in II(B)(4), III(B)(2), IV(B)(2), V(B)(2), VI(B)(1)(e); conversion to MS Word 2.0.
March 5, 2003 - VI(A), filing 2003-62
July 11, 2012 - spelling correction in Section 2(B)(3)

BASIS STATEMENT FOR ADOPTION OF
CMR 01-026, CHAPTER 20—SPECIAL PROVISIONS

Basis Statement
Surveillance data from the last decade show that mosquito-borne viruses are on the increase in Maine. The first confirmed human case of West Nile Virus in Maine was documented in 2012. Maine's Arboviral Illness Surveillance, Prevention and Response Plan is based on a national model and is similar to most other states. That plan calls for the Maine Center for Disease Control and Prevention to recommend adult mosquito control programs in targeted areas of the state if the threat of mosquito-borne disease reaches the "high" or "critical" phase. Conducting these programs would not be feasible under current state law. Chapter 20 requires authorization from each individual property owner which would be impractical for wide-area programs conducted in residential areas. The proposed amendment to Chapter 20 relaxes the need for individual property owner authorization when the Maine CDC recommends spraying due to vector-borne disease threats.

No changes were made to the amendments based on comments received.

The majority of comments received during the comment period indicate that many people have concerns about wide-area spraying of pesticides for control of mosquitoes. The Board also has concerns, but concluded that its role has never been to determine whether pests should be controlled with pesticides. Rather, the Board's role has always been to ensure that applicators are appropriately trained and to prescribe best practices for the application of pesticides. The Board would like to emphasize that it is not recommending spraying, but is amending its rules to make urgent public health related spraying feasible if Maine's public health officials determine that control of adult mosquitoes is in the best interest of the state.

Impact on Small Business
In accordance with 5 MRSA §8052, sub-§5-A, a statement of the impact on small business has been prepared. Information is available upon request from the Maine Board of Pesticides Control office, State House Station #28, Augusta, Maine 04333-0028, telephone 207-287-2731.

Provisional Adoption
At its May 24, 2013 meeting, the Board provisionally adopted the major substantive amendments to Chapter 20.

Legislative Approval
On June 26, 2013 and January 14, 2014 the Joint Standing Committee on Agriculture, Conservation and Forestry (ACF) held public hearings on LD 1568, the resolve authorizing final adoption of the amendments. Work sessions were held on June 26, 2013, January 14, 2014 and January 23, 2014. Subsequently the ACF reported the resolve out as ought-to-pass as amended. The Legislature enacted the resolve and it became law without the Governor's signature on February 26, 2014 (Resolve 2013, Chapter 87).

Rulemaking Statement of Impact on Small Business
5 MRSA §8052, sub-§5-A

Agency

Department of Agriculture, Conservation and Forestry—Maine Board of Pesticides Control

Chapter Number and Title of Rule

CMR 01-026, Chapter 20—Special Provision

Identification of the Types and an Estimate of the Number of the Small Businesses Subject to the Proposed Rule

Small business that contract for mosquito control work may benefit from the proposed rule amendments. There may be as many as 200 such businesses.

Projected Reporting, Record Keeping, and Other Administrative Costs Required for Compliance with the Proposed Rule, including the Type of Professional Skills Necessary for Preparation of the Report or Record

There are no reporting or other administrative costs associated with the proposed amendments that would impact small businesses.

Brief Statement of the Probable Impact on Affected Small Businesses

The proposed amendments would reduce the administrative burdens for small businesses.

Description of Any Less Intrusive or Less Costly, Reasonable Alternative Methods of Achieving the Purposes of the Proposed Rule

Since there are no anticipated increased burdens on small businesses, there are no less intrusive or less costly alternatives.

01 DEPARTMENT OF AGRICULTURE, FOOD AND RURAL RESOURCES

026 BOARD OF PESTICIDES CONTROL

Chapter 20: SPECIAL PROVISIONS

SUMMARY: These provisions regulate the use, storage and disposal of pesticides with specific emphasis on registered pesticides, right of way and aquatic applications and employer/employee requirements.

Section 1. Registered Pesticides

A. The use of any pesticide not registered by the Maine Board of Pesticides Control in accordance with Title 7 M.R.S.A. 601 is prohibited except as otherwise provided in this chapter or by FIFRA, Section 2(ee).

B. The use of registered pesticides for other than registered uses, or at greater than registered dosages, or at more frequent than registered intervals is prohibited, provided that application or use of unregistered pesticides and unregistered applications or uses of registered pesticides may be made for experimental purposes if in accordance with requirements of the Maine Board of Pesticides Control, and the U.S. Environmental Protection Agency.

C. Retailers and end users of pesticides no longer registered in Maine may continue to sell and use those items provided they were properly registered when obtained and such distribution and use is not prohibited by FIFRA or other Federal law.

D. In conducting review of registration or re-registration pursuant to 7 M.R.S.A. §607-A, the Board may consider the potential for environmental damage by the pesticide through direct application on or off-target or by reason of drift. If the Board finds that the use of the pesticide is anticipated to result in significant adverse impacts on the environment, whether on or off-target, which cannot be avoided or adequately mitigated, registration or re-registration will not be granted unless the Board finds that anticipated benefits of registration clearly outweigh the risks. In any case where the Board may request data in connection with registration or re-registration of any pesticide, such data may include that concerning pesticide residues, propensity for drift and testing therefor. Such data, if requested, shall provide information regarding residues and residue effects on plant tissues, soil and water and other potential deposition sites, and shall take into consideration differences in plants, soils, climatic conditions at the time of application and application techniques.

Section 2. Right-of-Way

Deciduous growth over six feet in height and evergreen growth over three feet in height shall not be sprayed with a herbicide within the right-of-way of any public way except that deciduous

growth which has been cut to the ground and which has grown more than six feet during the growing season following the cutting, may be sprayed that following season. In addition, chemical pruning of single limbs of trees over the prescribed heights may be performed.

Section 3. Pesticide Storage and Disposal

A. Unused pesticides, whether in sealed or open containers, must be kept in a secure enclosure and otherwise maintained so as to prevent unauthorized use, mishandling or loss; and so as to prevent contamination of the environment and risk to public health.

B. Obsolete, expired, illegal, physically or chemically altered or unusable pesticides, except household pesticide products, shall be either:

1. stored in a secure, safe place under conditions that will prevent deterioration of containers or any contamination of the environment or risk to public health, or

2. returned to the manufacturer or formulator for recycling, destruction, or disposal as appropriate, or

3. disposed of in a licensed hazardous waste facility or other approved disposal site that meets or exceeds all current requirements of the Maine Department of Environmental Protection and the U.S. Environmental Protection Agency for facilities receiving such waste.

Section 4. Aquatic Applications

No person, firm, corporation or other legal entity shall, for the purpose of controlling aquatic pests, apply any pesticide to or in any waters of the state as defined in 38 M.R.S.A. §361-A(7) without approval of the Maine Department of Environmental Protection.

Section 5. Employer/Employee Requirements

A. Any person applying pesticide shall instruct their employees and those working under their direction about the hazards involved in the handling of pesticides to be employed as set forth on the pesticide label and shall instruct such persons as to the proper steps to be taken to avoid such hazards.

B. Any person applying pesticides shall provide and maintain, for the protection of their employees and persons working under their direction, the necessary safety equipment as set forth on the label of the pesticide to be used.

~~**Section 6. Prohibition of Unauthorized Application of Pesticides**~~

~~A. Except as provided by Chapter 20.6(D) and 6(E) below, no person may contract with, or otherwise engage, a pesticide applicator to make any pesticide application to property unless that person is the owner, manager, or legal occupant of the property to which the~~

~~pesticide is to be applied, or that person has the consent of the owner, manager or legal occupant to enter into an agreement for pesticide applications to be made to that property. The term "legal occupant" includes tenants of rented property.~~

~~B. Except as provided by Chapter 20.6(D) and 6(E) below, no person may apply a pesticide to a property of another unless prior consent for the pesticide application has been obtained from the owner, manager or legal occupant of that property. The term "legal occupant" includes tenants of rented property.~~

~~C. Except as provided by Chapter 20.6(D) and 6(E) below, no commercial applicator may perform ongoing, periodic non-agricultural pesticide applications to a property unless:~~

~~1. there is a signed, written agreement with the property owner, manager or legal occupant that explicitly states that such pesticide applications shall continue until a termination date specified in the agreement, unless sooner terminated by the applicator or property owner, manager or legal occupant, or~~

~~2. the commercial applicator utilizes another system of verifiable authorization approved by the Board that provides substantially equivalent assurance that the customer is aware of the services to be provided and the terms of the agreement.~~

~~D. The requirements of Chapter 20.6(A), (B) or (C) shall not apply when the pesticide application is made by or on behalf of the holder of an easement or right of way, for the purposes of maintaining such easement or right of way.~~

~~E. When the Maine Center for Disease Control (CDC) recommends mosquito control for arboviral diseases, the requirements of Chapter 20.6(A), (B) or (C) shall not apply to government sponsored mosquito control programs, provided that the government entity:~~

~~1. makes a reasonable effort to provide advance notice to residents about mosquito control programs using multiple forms of publicity which may include, but is not limited to, signs, newspaper, television or radio notices, direct mailings, electronic communication or other effective methods; and~~

~~2. implements an "opt out" option whereby residents may request that their property be excluded from any ground based control program and the government entity makes a reasonable effort to honor such requests; and~~

~~3. if aerial applications are made, makes efforts to avoid applications to certified organic crops and livestock.~~

Section 6. Authorization for Pesticide Applications

A. Authorization to apply pesticides to private property is not required when a pesticide application is made by or on behalf of the holder of an easement or right of way, for the purposes of establishing or maintaining such easement or right of way.

B. When the Maine Center for Disease Control and Prevention (CDC) has identified that an organism is a vector of human disease and the vector and disease are present in an area, a government entity shall obtain authorization for ground-based applications by:

1. Sending a written notice to the person(s) owning property or using residential rental, commercial or institutional buildings within the intended target site at least three days but not more than 60 days before the commencement of the intended spray applications. For absentee property owners who are difficult to locate, mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice; and

2. Implementing an "opt out" option whereby residents and property owners may request that their property be excluded from the application by submitting written notice to the government entity at least 24 hours before spraying is scheduled to commence. Authorization is considered given for any property for which written notice was submitted and no "opt out" request was received by the sponsoring government entity.

C. When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government entities are not required to receive prior authorization to apply pesticides to private property, provided that the government entity sponsoring the vector control program:

1. Provides advance notice to residents about vector control programs using multiple forms of publicity which may include, but is not limited to, signs, newspaper, television or radio notices, direct mailings, electronic communication or other effective methods; and

2. Implements an "opt out" option whereby residents and property owners may request that their property be excluded from any ground based control program and the government entity makes a reasonable effort to honor such requests; and

3. If aerial applications are made, takes affirmative steps, to the extent feasible, to avoid applications to exclusion areas as identified by Board policy.

D. General Provisions. For any pesticide application not described in Chapter 20.6(A),(B) or (C), the following provision apply:

1. No person may contract with, or otherwise engage, a pesticide applicator to make any pesticide application to property unless that person is the owner, manager, or legal occupant of the property to which the pesticide is to be applied, or that person has the authorization of the owner, manager or legal occupant to enter into an agreement for pesticide applications to be made to that property. The term "legal occupant" includes tenants of rented property.

2. No person may apply a pesticide to a property of another unless prior authorization for the pesticide application has been obtained from the owner, manager or legal occupant of that property. The term "legal occupant" includes tenants of rented property.

3. No commercial applicator may perform ongoing, periodic non-agricultural pesticide applications to a property unless:

i. there is a signed, written agreement with the property owner, manager or legal occupant that explicitly states that such pesticide applications shall continue until a termination date specified in the agreement, unless sooner terminated by the applicator or property owner, manager or legal occupant; or

ii. the commercial applicator utilizes another system of verifiable authorization approved by the Board that provides substantially equivalent assurance that the customer is aware of the services to be provided and the terms of the agreement.

~~**Section 7. Transition**~~

~~This regulation will become effective on January 1, 2008.~~

STATUTORY AUTHORITY: Title 22 M.R.S.A., Chapter 258-A

EFFECTIVE DATE:
July 6, l979

AMENDMENT EFFECTIVE:
April 1, 1985
January 1, 1988
May 21, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
May 7, 1997 - Section 5

CONVERTED TO MS WORD:
March 11, 2003

CORRECTED HEADER CHAPTER NUMBER:
January 10, 2005

AMENDED:
January 1, 2008 – new Sections 6 and 7, filing 2007-65
September 13, 2012 – Section 6(E) and references added, filing 2012-270 (Emergency – expires in 90 days unless proposed and adopted in the meantime as non-emergency)
December 12, 2012 – emergency filing expires, chapter reverts to January 1, 2008 version

BASIS STATEMENT FOR ADOPTION OF
CMR 01-026 CHAPTER 22—STANDARDS FOR OUTDOOR APPLICATION OF PESTICIDES BY POWERED EQUIPMENT IN ORDER TO MINIMIZE OFF-TARGET DEPOSITION

Basis Statement

Surveillance data from the last decade show that mosquito-borne viruses are on the increase in Maine. The first confirmed human case of West Nile Virus in Maine was documented in 2012. Maine's Arboviral Illness Surveillance, Prevention and Response Plan is based on a national model and is similar to most other states. That plan calls for the Maine Center for Disease Control and Prevention to recommend adult mosquito control programs in targeted areas of the state if the threat of mosquito-borne disease reaches the "high" or "critical" phase. Conducting these programs would not be feasible under current state law. Chapter 22 imposes operational standards that would be impractical for wide-area programs conducted in residential areas.

The amendments to Chapter 22 originally exempted wide-area vector control programs from the entire chapter. Some comments received during the comment period suggested that certain portions of Chapter 22 were appropriate and feasible for public health related mosquito control programs. The Board agreed that there was some value to retaining some of the requirements in Chapter 22 and revised the proposed amendments consistent with the comments. Notably the Equipment standards, Weather Condition standards, and Positive Identification of Target Site were retained. The sections to be exempted include Identifying and Recording Sensitive Areas, Presence of Humans and Animals, and certain specifics of Site Plans, which would not be practical in an emergency situation.

The majority of comments received during the comment period indicate that many people have concerns about wide-area spraying of pesticides for control of mosquitoes. The Board also has concerns, but concluded that its role has never been to determine whether pests should be controlled with pesticides. Rather, the Board's role has always been to ensure that applicators are appropriately trained and to prescribe best practices for the application of pesticides. The Board would like to emphasize that it is not recommending spraying, but is amending its rules to make urgent public health related spraying feasible if Maine's public health officials determine that control of adult mosquitoes is in the best interest of the state.

Impact on Small Business

In accordance with 5 MRSA §8052, sub-§5-A, a statement of the impact on small business has been prepared. Information is available upon request from the Maine Board of Pesticides Control office, State House Station #28, Augusta, Maine 04333-0028, telephone 207-287-2731.

Provisional Adoption

At its May 24, 2013 meeting, the Board provisionally adopted the major substantive amendments to Chapter 22.

Legislative Approval

On June 26, 2013 and January 14, 2014 the Joint Standing Committee on Agriculture, Conservation and Forestry (ACF) held public hearings on LD 1567, the resolve authorizing final adoption of the amendments. Work sessions were held on June 26, 2013, January 14, 2014 and January 23, 2014. Subsequently the ACF reported the resolve out as ought-to-pass as amended. The Legislature enacted the resolve and it became law without the Governor's signature on February 26, 2014 (Resolve 2013, Chapter 88).

Rulemaking Statement of Impact on Small Business
5 MRSA §8052, sub-§5-A

Agency

Department of Agriculture, Conservation and Forestry—Maine Board of Pesticides Control

Chapter Number and Title of Rule

CMR 01-026, Chapter 22—Standards for Outdoor Application of Pesticides by Powered Equipment in Order to Minimize Off-Target Deposition

Identification of the Types and an Estimate of the Number of the Small Businesses Subject to the Proposed Rule

Small businesses that contract for mosquito control work may benefit from the proposed amendments. There may be as many as 200 such businesses.

Projected Reporting, Record Keeping, and Other Administrative Costs Required for Compliance with the Proposed Rule, including the Type of Professional Skills Necessary for Preparation of the Report or Record

There are no reporting or other administrative costs associated with the proposed amendments that would impact small businesses.

Brief Statement of the Probable Impact on Affected Small Businesses

The proposed amendments would reduce the administrative burden on small businesses.

Description of Any Less Intrusive or Less Costly, Reasonable Alternative Methods of Achieving the Purposes of the Proposed Rule

Since there are no anticipated impacts on small businesses, there are no less intrusive or less costly alternatives.

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 22: STANDARDS FOR OUTDOOR APPLICATION OF PESTICIDES BY POWERED EQUIPMENT IN ORDER TO MINIMIZE OFF-TARGET DEPOSITION

SUMMARY: These regulations establish procedures and standards for the outdoor application of pesticides by powered equipment in order to minimize spray drift and other unconsented exposure to pesticides. The primary purpose of these regulations is to implement the legislative mandate of the Board, as expressed by 7 M.R.S.A. §606(2)(G), to design rules which "minimize pesticide drift to the maximum extent practicable under currently available technology."

SECTION 1. EXEMPTIONS

The regulations established by this chapter shall not apply to pesticide applications in any of the following categories:

A. Applications of pesticides confined entirely to the interior of a building;

B. Applications of pesticides by non-powered equipment;

C. Applications of pesticides exclusively in granular or pelletized form;

D. Applications of pesticides injected underground or otherwise injected directly into the target medium. Such applications must involve no spraying of pesticides whatsoever.

SECTION 2. STANDARDS OF CONDUCT FOR PESTICIDE APPLICATIONS

All pesticide applications subject to these regulations shall be undertaken in compliance with the following standards of conduct:

A. Equipment

I. Pesticide spray equipment shall be used in accordance with its manufacturer's recommendations and instructions, and shall be in sound mechanical condition, free of leaks and other defects or malfunctions which might cause pesticides to be deposited off-target.

II. Pesticide spray equipment shall be properly calibrated consistent with Board or University published guidance. Sufficient records to demonstrate proper calibration must be maintained and made available to representatives of the Board upon request.

III. Pesticide application equipment shall have properly functioning shut-off valves or other mechanisms which enable the operator to prevent direct discharge and minimize drift to non-target areas. Spray equipment designed to draw water must also have a properly functioning antisiphoning device.

B. Weather Conditions

I. Spray applications shall not be undertaken when weather conditions favor pesticide drift onto Sensitive Areas or otherwise prevent proper deposition of pesticides on target.

II. Pesticide application must cease immediately when visual observation reveals or should reveal that spray is not being deposited on target.

III. Without limitation of the other requirements herein, under no circumstances shall pesticide application occur when wind speed in the area is in excess of 15 miles per hour.

C. Identifying and Recording Sensitive Areas

Prior to spraying a pesticide, the applicator must become familiar with the area to be sprayed and must identify and record the existence, type and location of any Sensitive Area located within 500 feet of the target area. Applicators shall prepare a site map or other record, depicting the target area and adjacent Sensitive Areas. The map or other record shall be updated annually. The site map or other record shall be retained by the applicator for a period of two years following the date of applications and shall be made available to representatives of the Board upon request. This requirement shall not apply to commercial application categories 3B (turf), 3A (ornamental tree and plant) or 7A (structural general pest control applications).

D. Presence of Humans, Animals

Pesticide applications shall be undertaken in a manner which minimizes exposure to humans, livestock and domestic animals.

The applicator shall cease spray activities at once upon finding evidence showing the likely presence of unprotected persons in the target area or in such proximity as to result in unconsented exposure to pesticides.

E. Other Requirements

These regulations are intended to be minimum standards. Other factors may require the applicator to take special precautions, beyond those set forth in these regulations, in order to avoid adverse impacts on off-target areas and to protect public health and the environment.

SECTION 3. STANDARDS FOR AERIAL APPLICATION OF PESTICIDES

A. Positive Identification of the Target Site

The person contracting for an aerial pesticide application shall ensure that the application site (i.e., target area) is positively identified prior to application, using a unique and verifiable method, including;

I. An onboard, geo-referenced electronic mapping and navigation system (e.g., GPS); or

II. Effective site markings visible to the applicator; or

III. Other method(s) approved by the Board.

B. Site Plans Required

Prior to spraying by aerial application within 1,000 feet of a Sensitive Area Likely to Be Occupied, the person contracting for the application shall provide to the applicator a site plan that includes:

I. a site map drawn to scale that:

(i) delineates the boundaries of the target area and the property lines;

(ii) depicts significant landmarks and flight hazards;

(iii) depicts the type and location of any Sensitive Area Likely to Be Occupied within 1,000 feet of the target area; and

(iv) depicts other Sensitive Areas within 500 feet of the target area.

II. If applicable, a school bus schedule shall accompany the site map.

III. The site plan and site map with identified sensitive areas required under Section 3(B) shall be retained by the applicator for a period of two years following the date of applications and shall be made available to representatives of the Board upon request.

IV. Compliance with this section satisfies the requirements of Section 2(C).

C. Site-Specific Application Checklist

Prior to conducting an aerial pesticide application within 1,000 feet of a Sensitive Area Likely to Be Occupied, the applicator shall complete a Board-approved pre-application checklist for each distinct field or target site. The checklist shall be maintained by the applicator for a period of two years and shall be available for inspection by representatives of the Board at reasonable times, upon request. The checklist shall include, at a minimum, the following elements:

I. The date, time, description of the target site and name of the applicator;

II. Confirmation that the notification requirements contained in CMR 01-026, Chapters 28 and 51, have been carried out;

III. Confirmation that the target site has been positively identified;

IV. The location of where weather conditions are measured and a description of the equipment used to measure the wind speed and direction;

V. Confirmation that conditions are acceptable to treat the proposed target site, considering the location of any Sensitive Area Likely to Be Occupied and current weather conditions;

VI. Wind speed and direction;

VII. The measures used to protect all Sensitive Areas;

VIII. Confirmation that there are no humans visible in or near the target area.

D. Buffer Zones for any Sensitive Area Likely to Be Occupied

Aerial applicators shall employ site-specific buffer zones adjacent to any Sensitive Area Likely to Be Occupied sufficient to prevent unlawful pesticide drift, unless consent has been granted by the landowner, lessee and occupant (when applicable), consistent with the provisions of Section 4(C) of this rule.

E. Wind Speeds for Aerial Applications

Unless otherwise specified by the product label, an applicator may not conduct an aerial application of pesticides within 1,000 feet of a Sensitive Area Likely to Be Occupied unless the wind speed is between 2 and 10 miles per hour.

SECTION 4. GENERAL STANDARDS FOR OFF-TARGET PESTICIDE DISCHARGE AND RESIDUE

A. Prohibition of Unconsented, Off-Target Direct Discharge of Pesticides.

Pesticide applications shall be undertaken in a manner which does not result in off-target direct discharge of pesticides, unless prior authorization and consent is obtained from the owner or lessee of the land onto which such discharge may occur in a manner consistent with the pesticide label.

B. Standards for Unconsented, Off-Target Drift of Pesticides

I. General Standard. Pesticide applications shall be undertaken in a manner which minimizes pesticide drift to the maximum extent practicable, having due regard for prevailing weather conditions, toxicity and propensity to drift of the

pesticide, presence of Sensitive Areas in the vicinity, type of application equipment and other pertinent factors.

II. Prima Facie Evidence. Pesticide residues in or on any off-target Sensitive Area Likely to Be Occupied resulting from off-target drift of pesticides from a nearby application that are 1% or greater of the residue in the target area are considered prima facie evidence that the application was not conducted in a manner to minimize drift to the maximum extent practicable. The Board shall review the site-specific application checklist completed by the applicator and other relevant information to determine if a violation has occurred. For purposes of this standard, the residue in the target area, and the residue in the Sensitive Area Likely to Be Occupied, may be adequately determined by evaluation of one or more soil, foliage or other samples, or by extrapolation or other appropriate techniques.

III. Standard of Harm. An applicator may not apply a pesticide in a manner that results in:

(i) Off-target pesticide residue detected in or on any nearby crop which violates EPA tolerances for that crop, as established under 40 CFR, Part 180.

(ii) Off-target pesticide residue detected in or on any nearby organic farm or garden which causes the agricultural products thereof to be excluded from organic sale in accordance with 7 CFR, Part 205, Section 205.671.

(iii) Off-target pesticide residue detected on any nearby persons or vehicles using public roads.

(iv) Documented human illness. For this standard to be met, the Board must receive verification from two physicians that an individual has experienced a negative health effect from exposure to an applied pesticide and that the effect is consistent with epidemiological documentation of human sensitivity to the applied pesticide.

(v) Off-target damage or injury to any organism.

IV. Enforcement Considerations. The Board shall consider the particular circumstances of violations arising from Subsections 4(B)(I) and (III) in determining an appropriate response, including, but not limited to:

(i) The standard of care exercised by the applicator;

(ii) The degree of harm or potential harm that resulted from or could have resulted from off-target drift from the application;

(iii) The risk (toxicity and exposure) of adverse effects from the pesticide applied.

C. Consent

I. Consent, How Given. Authorization and consent by the owner or lessee and occupant (when applicable) of land receiving a pesticide discharge or drift in a manner consistent with the pesticide label may be given in any manner, provided that the consent is reasonably informed and is given prior to the onset of the spray activity in question. The burden of proof shall be upon the applicator to demonstrate that requisite authorization and consent has been given. For this reason, applicators are encouraged to obtain such consent in writing and to maintain records thereof.

II. The residue and harm standards in Sections 4(B)(II) and (III) for off-target drift do not apply where the owner, lessee and occupant (when applicable) of the off-target area receiving the pesticide drift have given authorization and consent as prescribed in Section 4(C).

III. Except with the prior written approval of the Board, no authorization or consent may be given with regard to off-target direct discharge or off-target drift of pesticides upon any bodies of water or critical areas as defined in CMR 01-026, Chapter 10, "Definitions; Sensitive Area."

SECTION 5. VARIANCES FROM STANDARDS

A. Variance Permit Application

An applicator may vary from any of the standards imposed under this chapter by obtaining a permit to do so from the Board. Permit applications shall be made on such forms as the Board provides and shall include at least the following information:

I. The name, address, and telephone number of the applicant;

II. The area(s) where pesticides will be applied;

III. The type(s) of pesticides to be applied;

IV. The purpose for which the pesticide application(s) will be made;

V. The approximate date(s) of anticipated spray activities;

VI. The type(s) of spray equipment to be employed;

VII. The particular standards from which the applicant seeks a variance;

VIII. The particular reasons why the applicant seeks a variance from such standards, including a detailed description of the techniques to be employed to assure a reasonably equivalent degree of protection and of the monitoring efforts to be made to assure such protection;

IX. The names and addresses of all owners or lessees of land within 500 feet of the proposed spray activity, and evidence that such persons have been notified of the application. The Board may waive this requirement where compliance would be unduly burdensome and the applicant attempts to notify affected persons in the community by another means which the Board finds reasonable.

B. Board Review; Legal Effect of Permit, Delegation of Authority to Staff

I. Within 60 days after a complete application is submitted, the Board shall issue a permit if it finds that the applicant will achieve a substantially equivalent degree of protection as adherence to the requirements of this chapter would provide and will conduct spray activities in a manner which protects human health and the environment. Such permit shall authorize a variance only from those particular standards for which variance is expressly requested in the application and is expressly granted in the permit. The Board may place conditions on any such permit, and the applicant shall comply with such conditions. Except as conditioned in the permit, the applicant shall undertake spray activities in accordance with all of the procedures described in the application and all other applicable legal standards. Permits issued by the Board under this section shall not be transferable or assignable except with further written approval of the Board and shall be valid only for the period specified in the permit.

II. The Board may delegate authority to review applications and issue permits to the staff as it feels appropriate. All conditions and limitations as described in Section 5(B) I shall remain in effect for permits issued by the staff. If the staff does not grant the variance permit, the applicator may petition the Board for exemption following the requirements set forth in 22 MRSA §1471-T, "Exemptions."

SECTION 6. EMERGENCIES

A. In the event that severe pest or weather conditions threaten to cause a ~~public health emergency as determined by the Commissioner of the Maine Department of Health and Human Services, or a threat of~~ significant natural resource and/or economic loss, as determined by ~~either~~ the Commissioner of the Maine Department of Agriculture, Conservation and Forestry ~~or the Commissioner of the Maine Department of Agriculture, Food and Rural Resources~~, the ~~specified~~ requirements contained in Section 3 of this Chapter shall be waived, subject to the following conditions:

I. The severe pest and/or weather conditions must necessitate immediate wide-scale aerial application of pesticides.

II. The immediate need for aerial pesticide application does not provide sufficient time to complete the requirements of Section 3 of this Chapter,

III. Prior to any aerial application, the Commissioner shall issue a press release notifying residents of affected regions about the emergency, the likelihood of aerial application in the affected regions and the approximate dates that the emergency may continue.

IV. The Commissioner, in consultation with the Board's staff, shall specify the requirements in Section 3 that will be waived.

V. Land managers and aerial applicators shall make good faith efforts to comply with the intent of Section 3 and minimize off-target drift to Sensitive Areas.

B. When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government sponsored vector control programs are exempt from Sections 2C, 2D, 3B, 3C, 3D, 3E and 4 of this chapter, provided that reasonable efforts are made to avoid spraying non-target areas.

June 12, 2009 amendments become effective on January 1, 2010

STATUTORY AUTHORITY: 7 M.R.S.A. §606(2)(G):
22 M.R.S.A. §1471-M(2)(D)

EFFECTIVE DATE:
January 1, 1988

AMENDED:
October 2, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
September 22, 1998 - also converted to MS Word
January 4, 2005 – filing 2004-603 affecting Section 3.B.II.(iii)
January 1, 2010 by request of agency in filing 2009-252

BASIS STATEMENT FOR ADOPTION OF
CMR 026-01, CHAPTER 51—NOTICE OF AERIAL PESTICIDE APPLICATIONS

Basis Statement
Surveillance data from the last decade show that mosquito-borne viruses are on the increase in Maine. The first confirmed human case of West Nile Virus in Maine was documented in 2012. Maine's Arboviral Illness Surveillance, Prevention and Response Plan is based on a national model and is similar to most other states. That plan calls for the Maine Center for Disease Control and Prevention to recommend adult mosquito control programs in targeted areas of the state if the threat of mosquito-borne disease reaches the "high" or "critical" phase. Conducting these programs would not be feasible under current state law.

Chapter 51 details requirements for notice of aerial applications. Originally, the intent of the Board was to exempt government-sponsored, wide-area vector control programs from the entire chapter because notice requirements are included in Chapter 20 in lieu of individual notification. Comments received during comment period suggested that certain elements of Chapter 51 were still feasible. The Board agreed with those comments and revised its proposed amendments consistent with the comments. Notably, the Board decided there was value in retaining the requirement for notice to the Board and Maine Poison Control Center as described in the chapter.

The majority of comments received during the comment period indicate that many people have concerns about wide-area spraying of pesticides for control of mosquitoes. The Board also has concerns, but concluded that its role has never been to determine whether pests should be controlled with pesticides. Rather, the Board's role has always been to ensure that applicators are appropriately trained and to prescribe best practices for the application of pesticides. The Board would like to emphasize that it is not recommending spraying, but is amending its rules to make urgent public health related spraying feasible if Maine's public health officials determine that control of adult mosquitoes is in the best interest of the state.

Impact on Small Business
In accordance with 5 MRSA §8052, sub-§5-A, a statement of the impact on small business has been prepared. Information is available upon request from the Maine Board of Pesticides Control office, State House Station #28, Augusta, Maine 04333-0028, telephone 207-287-2731.

Provisional Adoption
At its May 24, 2014 meeting, the Board provisionally adopted the major substantive amendments to Chapter 51.

Legislative Approval
On June 26, 2013 and January 14, 2014 the Joint Standing Committee on Agriculture, Conservation and Forestry (ACF) held public hearings on LD 1569, the resolve authorizing final adoption of the amendments. Work sessions were held on June 26, 2013, January 14, 2014 and January 23, 2014. Subsequently the ACF reported the resolve out as ought-to-pass as amended. The Legislature enacted the resolve and it became law without the Governor's signature on February 26, 2014 (Resolve 2013, Chapter 86).

Rulemaking Statement of Impact on Small Business
5 MRSA §8052, sub-§5-A

Agency

Department of Agriculture, Conservation and Forestry—Maine Board of Pesticides Control

Chapter Number and Title of Rule

CMR 01-026, Chapter 51—Notice of Aerial Pesticide Applications

Identification of the Types and an Estimate of the Number of the Small Businesses Subject to the Proposed Rule

There are currently two companies that contract to make aerial pesticide applications in Maine that might benefit from the proposed amendments.

Projected Reporting, Record Keeping, and Other Administrative Costs Required for Compliance with the Proposed Rule, including the Type of Professional Skills Necessary for Preparation of the Report or Record

There are no reporting or other administrative costs associated with the proposed amendments that would impact small businesses.

Brief Statement of the Probable Impact on Affected Small Businesses

The proposed amendments would reduce the administrative burdens on small businesses.

Description of Any Less Intrusive or Less Costly, Reasonable Alternative Methods of Achieving the Purposes of the Proposed Rule

Since there are no anticipated impacts on small businesses, there are no less intrusive or less costly alternatives.

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 51: NOTICE OF AERIAL PESTICIDE APPLICATIONS

SUMMARY: These regulations describe the notification requirements for persons contracting aerial pesticide applications to control forest, ornamental plant, right-of-way, biting fly and public health pests.

Section I. Content of All Newspaper Articles/Advertisements, Written Notices to Property Owners and Posters

A. All newspaper articles/advertisements and written notices to property owners required by this chapter shall contain the following:

1. Description of the target area sufficient to inform people who may be in the vicinity.

2. Name of the person who contracts for the application or her/his representative or the applicator and the address and telephone number to contact for more specific information about the intended application.

3. Intended purpose of the pesticide application.

4. Pesticide(s) to be used.

5. Date or reasonable range of dates on which application(s) are proposed to take place.

6. Telephone number of the Maine Board of Pesticides Control.

7. Telephone number of the Maine Poison Control Center.

8. Public precautions which appear on the pesticide label.

B. All newspaper articles/advertisements must be printed in a minimum of 10 point types and at least 2 inches wide.

C. All posters required by this chapter shall contain the following:

1. Name of the person who contracts for the application or her/his representative or the applicator and the address and telephone number to contact for more specific information about the intended application.

2. Intended purpose of the pesticide application.

3. Pesticide(s) to be used.

4. Telephone number of the Maine Board of Pesticides Control

5. Telephone number of the Maine Poison Control Center.

6. Public precautions which appear on the pesticide label.

Section II. Forest Insect Applications

A. **Responsible Parties**

1. In the event of a forest insect spray program administered pursuant to Title 12, Chapter 801, the Maine Department of Conservation, Bureau of Forestry, is responsible for notices.

2. In the case of any other forest insect aerial spray activity, responsibility for notices lies with the landowner, her/his representative or the lessee if the land is leased.

B. **Newspaper Articles/Advertisements and Written Notices to Property Owners**

1. An article about/advertisement of a major forest insect aerial spray application shall be published in a newspaper of general circulation in the affected area at least 14 days but not more than 30 days prior to commencement of planned spray activity.

2. An article about/advertisement of a minor forest insect aerial spray application shall be published in a newspaper of general circulation in the affected area at least 4 days but not more than 10 days prior to commencement of planned spray activity.

3. An addition of spray areas not specified in the original newspaper article/advertisement and any change from the insecticides specified in the original article/advertisement shall be published in the same newspaper at least 24 hours before the change is effected.

4. A written notice of all forest insect aerial pesticide applications shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Posting of Areas Subject to Major and Minor Forest Insect Aerial Spray Applications**

1. A poster shall be posed conspicuously just prior to the planned spray activity and shall not be removed by the landowner or landowner's agent for at least 2 days (48 hours) after spray activity ceases. Areas that shall be posed include each major point of ingress and egress of the public into the area to be sprayed. Major points of ingress and egress include federal, state, municipal and private roads open to the public and known to be used by the public that lead into the area to be sprayed; utility crossings of these roads; known boat launching sites on rivers leading through spray areas and within the boundaries of the land owned by the person authorizing the spray activity; and marked points of access to foot trails known to be used by the public.

2. Posters shall be constructed of brightly colored, weather resistant stock and shall be at least 11 x 14 inches in size. They shall contain the information required in Section I(C). The information shall be printed in both English and French.

D. **Written Notice to the Board and the Maine Poison Control Center**

1. A written notice shall be given to the Board and to the Maine Poison Control Center according to the following schedule:

   a. Written notice of major forest insect aerial spray applications shall be given to the Board and the Maine Poison Control Center at least 15 days but not more than 30 days prior to the commencement of planned spray activity.

   b. Written notice of minor forest insect spray application shall be given to the Board and the Maine Poison Control Center at least 5 days prior to the commencement of planned spray activity.

   c. Any addition of spray blocks not specified in the original notice to the Board and any change in pesticide assignments to particular blocks shall be given to the Board as soon as practicable, and in any case every reasonable effort shall be made to give notice of change to the Board prior to initiation of pesticide application. Notice under this subsection may be accomplished by telephone communication with the Board's office.

2. **Notice to the Board**. These notices shall be prepared on forms provided by the Board and shall consist of:

   a. A description of the proposed spray activity including detailed spray application maps showing sensitive areas and major public routes of ingress and egress. Use *of The Maine Atlas and Gazetteer*, by DeLorme Mapping Company or some other similar atlas is the suggested format for the base map.

   b. The date or dates on which spraying is proposed to take place.

c. The name, address, telephone number and license number of the spray contracting firm which will carry out the spray activity.

d. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

e. A listing of precautions taken to insure notice to the public, including copies of the newspaper notice and the poster to be used.

f. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Board promptly upon request.

3. **Notice to the Maine Poison Control Center**. These notices shall be prepared on forms provided by the Board and shall consist of:

a. A description of the general area the proposed application activity will take place.

b. The date or dates on which spraying is proposed to take place.

c. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

d. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Maine Poison Control Center promptly upon request.

Section III. Ornamental Plant Applications

A. Responsible Parties

The licensed applicator must provide the person contracting for services with the proper materials to provide notification according to the provisions described in this chapter. The licensed applicator must not commence spray activities until the person contracting for the services provides written proof that the notification procedures contained Section III(B) and (C) have been completed. The person who provides the notification and certifies that the requirements have been fulfilled is responsible for that notification.

B. Newspaper Articles/Advertisements and Written Notices to Property Owners

1. An article about/advertisement of ornamental plant aerial pesticide applications shall be published in a paper of general circulation in the affected area at least 3 days but not more than 60 days prior to the commencement of the intended spray

activity. The article/ advertisement shall contain the information required in section I(A) and (B) and shall not be limited to a legal notice.

2. A written notice of ornamental plant aerial pesticide applications shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Written Notice to the Board and the Maine Poison Control Center**

Written notices to the Board and the Maine Poison Control Center must be given according to Section VI of this rule (Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications).

Section IV. Rights-Of-Way, Forest Vegetation Management and Other Forest Pest Applications

A. **Responsible Parties**

The licensed applicator must provide the person contracting for services with the proper materials to provide notification according to the provisions described in this chapter. The licensed applicator must not commence spray activities until the person contracting for the services provides written proof that the notification procedures contained Section IV(B) and (C) have been completed. The person who provides the notification and certifies that the requirements have been fulfilled is responsible for that notification.

B. **Newspaper Articles/Advertisements or Written Notices to Property Owners**

1. An article about/advertisement of rights-of-way, forest vegetation management or other forest pest aerial pesticide applications shall be published in a paper of general circulation in the affected area at least 3 days but not more than 60 days prior to the commencement of the intended spray activity. The article/advertisement shall contain the information required in Section I(A) and (B) and shall not be limited to a legal notice or;

2. In areas where there is no regular newspaper circulation, the person contracting for services may substitute individual notice to all landowners within 500 feet of the target site. This individual notice shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Posting Requirements for Rights-of-Way, Forest Vegetation Management and Other Forest Pest Aerial Applications**

1. A poster shall be posed conspicuously just prior to the planned spray activity and shall not be removed by the landowner or landowner's agent for at least 2 days (48 hours) after spray activity ceases. The poster shall contain the information required in Section I(C). Areas that shall be posed include each major point of ingress and egress of the public into the area to be sprayed. Major points of ingress and egress include federal, state, municipal and private roads open to the public and known to be used by the public that lead into the area to be sprayed; utility crossings of these roads and any place a maintained public trail enters the application site.

2. Poster shall be constructed of brightly colored, weather resistant stock and shall be at least 11 x 14 inches in size. The information shall be printed in both English and French.

D. **Written Notice to the Board and the Maine Poison Control Center**

Written notices to the Board and the Maine Poison Control Center must be given according to Section VI of this rule (Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications).

Section V. Biting Fly and Public Health Pest Applications

A. **Responsible Parties**

The licensed applicator must provide the person contracting for services with the proper materials to provide notification according to the provisions described in this chapter. The licensed applicator must not commence spray activities until the person contracting for the services provides written proof that the notification procedures contained Section V(B) and (C) have been completed. The person who provides the notification and certifies that the requirements have been fulfilled is responsible for that notification.

B. **Newspaper Articles/Advertisements and Written Notice to Property Owners**

1. An article about/advertisement of biting fly and public health pest aerial pesticide applications shall be published in a paper of general circulation in the affected area at least 3 days but not more than 60 days prior to the commencement of the intended spray activity. The article/advertisement shall contain the information required in Section I(A) and (B) and shall not be limited to a legal notice.

2. A written notice shall be provided to the person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site at least 3 days but not more than 60 days before the commencement of the intended spray applications. The notice shall contain the information required in Section I(A). For absentee property owners who are

difficult to locate, certified or equivalent mailing of the notice to the address listed in the Town tax record shall be considered sufficient notice.

C. **Written Notice to the Board and the Maine Poison Control Center**

Written notices to the Board and the Maine Poison Control Center must be given according to Section VI of this rule (Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications).

Section VI. Notices to the Board and the Maine Poison Control Center for Other Than Aerial Forest Insect Applications

A. A written notice shall be given to the Board and the Maine Poison Control Center at least 7 days but not more than 30 days prior to the commencement of planned spray activity.

B. These notices shall be prepared on forms provided by the Board and shall consist of:

1. **Written notice to the Board**

a. A description of the proposed spray activity including detailed spray application maps showing sensitive areas and major public routes of ingress and egress. Use *of The Maine Atlas and Gazetteer*, by DeLorme Mapping Company or some other similar atlas is the suggested format for the base map.

b. The date or dates on which spraying is proposed to take place.

c. A description of the delivery mechanism which shall include the name, address, telephone number and license number of the spray contracting firm which will carry out the spray activity.

d. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

e. A listing of precautions taken to insure notice to the public, including copies of the newspaper notice or the notice given to person(s) owning property or using residential rental, commercial or institutional buildings within 500 feet of the intended target site.

f. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Board promptly upon request.

2. **Written notice to the Maine Poison Control Center**

a. A description of the general area the proposed application activity will take place.

b. The date or dates on which spraying is proposed to take place.

c. Pesticide(s) to be used, dilution agent(s), ratio(s) and notation of any experimental applications.

d. The name, address and telephone number of a contact person who will be reasonably accessible by telephone and who will make reasonably current and detailed information about the project available to the Maine Poison Control Center promptly upon request.

C. Any addition of spray blocks not specified in the original notice to the Board and any change in pesticide assignments to particular blocks shall be given to the Board as soon as practicable, and in any case every reasonable effort shall be made to give notice of change to the Board prior to initiation of pesticide application. Notice under this subsection may be accomplished by telephone communication with the Board's staff.

Section VII. ~~**Variances From Notice Requirements**~~**Emergencies**

A. ~~*[Repealed by sunset provision, April 19, 1996.]*~~**Disease Vectors**

When the Maine Center for Disease Control and Prevention (CDC) recommends control of disease vectors, government sponsored vector control programs are exempt from this chapter provided that the responsible governmental entity submits the written notice to Board and the written notice to the Maine Poison Control Center as described in this chapter.

B. **Other Emergencies**

The Board's staff may grant an emergency variance from the notice requirements set forth in Sections III, IV, V and VI of this chapter if the notice requirements prevent efficacious application of pesticide(s) and the staff determines that an emergency situation exists.

1. An emergency situation:

a. Involves the introduction or dissemination of a pest new to or not theretofore known to be widely prevalent or distributed within or throughout the United States and its territories; or

b. Will present significant risks to human health; or

c. Will present significant risks to threatened or endangered species, beneficial organisms, unique ecosystems or the environment; or

d. Will cause significant economic loss due to:

i. an outbreak or an expected outbreak of a pest; or

ii. a change in plant growth or development caused by unusual environmental conditions where such change can be rectified by the use of a pesticide(s).

2. Any emergency variance granted by the staff under this section shall include provisions demonstrating the applicant will furnish substantially equivalent notification as provided by this chapter and shall include:

a. Documented notification of person(s) owning property or using commercial or institutional buildings within 500 feet of the intended target site prior to the pesticide application and where appropriate;

b. Radio or television announcements or,

c. Prominently positioned poster.

3. No variance may be granted if the emergency situation is the result of an unjustifiable delay created by the person seeking the variance or the person requesting the pesticide application.

4. If the staff does not grant the variance, the applicator or the person requesting the pesticide application may petition the Board for exemption following the requirements set forth in 22 M.R.S.A. §1471-T, "Exemption".

STATUTORY AUTHORITY: 22 M.R.S.A. §1471-G, M, R and T

EFFECTIVE DATE:
August 12, 1985

AMENDED:
May 19, 1991
April 8, 1992
April 19, 1994
October 2, 1996

EFFECTIVE DATE (ELECTRONIC CONVERSION):
March 1, 1997

AMENDED:
April 14, 1998 - inserted “residential rental,” in II(B)(4), III(B)(2), IV(B)(2), V(B)(2), VI(B)(1)(e); conversion to MS Word 2.0.
March 5, 2003 - VI(A), filing 2003-62
July 11, 2012 - spelling correction in Section 2(B)(3)

Rulemaking Statement of Impact on Small Business
5 MRSA §8052, sub-§5-A

Agency

Department of Agriculture, Conservation and Forestry—Maine Board of Pesticides Control

Chapter Number and Title of Rule

CMR 01-026, Chapter 20—Special Provision

Identification of the Types and an Estimate of the Number of the Small Businesses Subject to the Proposed Rule

Small business that contract for mosquito control work may benefit from the proposed rule amendments. There may be as many as 200 such businesses.

Projected Reporting, Record Keeping, and Other Administrative Costs Required for Compliance with the Proposed Rule, including the Type of Professional Skills Necessary for Preparation of the Report or Record

There are no reporting or other administrative costs associated with the proposed amendments that would impact small businesses.

Brief Statement of the Probable Impact on Affected Small Businesses

The proposed amendments would reduce the administrative burdens for small businesses.

Description of Any Less Intrusive or Less Costly, Reasonable Alternative Methods of Achieving the Purposes of the Proposed Rule

Since there are no anticipated increased burdens on small businesses, there are no less intrusive or less costly alternatives.

Rulemaking Statement of Impact on Small Business
5 MRSA §8052, sub-§5-A

Agency

Department of Agriculture, Conservation and Forestry—Maine Board of Pesticides Control

Chapter Number and Title of Rule

CMR 01-026, Chapter 22—Standards for Outdoor Application of Pesticides by Powered Equipment in Order to Minimize Off-Target Deposition

Identification of the Types and an Estimate of the Number of the Small Businesses Subject to the Proposed Rule

Small businesses that contract for mosquito control work may benefit from the proposed amendments. There may be as many as 200 such businesses.

Projected Reporting, Record Keeping, and Other Administrative Costs Required for Compliance with the Proposed Rule, including the Type of Professional Skills Necessary for Preparation of the Report or Record

There are no reporting or other administrative costs associated with the proposed amendments that would impact small businesses.

Brief Statement of the Probable Impact on Affected Small Businesses

The proposed amendments would reduce the administrative burden on small businesses.

Description of Any Less Intrusive or Less Costly, Reasonable Alternative Methods of Achieving the Purposes of the Proposed Rule

Since there are no anticipated impacts on small businesses, there are no less intrusive or less costly alternatives.

Rulemaking Statement of Impact on Small Business
5 MRSA §8052, sub-§5-A

Agency

Department of Agriculture, Conservation and Forestry—Maine Board of Pesticides Control

Chapter Number and Title of Rule

CMR 01-026, Chapter 51—Notice of Aerial Pesticide Applications

Identification of the Types and an Estimate of the Number of the Small Businesses Subject to the Proposed Rule

There are currently two companies that contract to make aerial pesticide applications in Maine that might benefit from the proposed amendments.

Projected Reporting, Record Keeping, and Other Administrative Costs Required for Compliance with the Proposed Rule, including the Type of Professional Skills Necessary for Preparation of the Report or Record

There are no reporting or other administrative costs associated with the proposed amendments that would impact small businesses.

Brief Statement of the Probable Impact on Affected Small Businesses

The proposed amendments would reduce the administrative burdens on small businesses.

Description of Any Less Intrusive or Less Costly, Reasonable Alternative Methods of Achieving the Purposes of the Proposed Rule

Since there are no anticipated impacts on small businesses, there are no less intrusive or less costly alternatives.

TABLE 1 - TESTIMONY GIVEN AT MARCH 1, 2013 PUBLIC HEARING		
Person/Affiliation	**Summary of Testimony**	**Board Response**
Katy Green (MOFGA) (also submitted written testimony)	Questions the efficacy of spraying mosquitoes to prevent disease. Would like the Board to do more outreach on how people can protect themselves. Any person should be able to opt out for any reason. Government-sponsored spray programs should not be exempted from entire chapter e.g., in Chapter 22: monitoring of wind speeds, positive identification of sites. Hope protection of organic farms will be included in rule; prefer anyone be able to opt out, but if not, then at least organic farms. MOFGA has been working on mapping organic farms; it's unclear how the mapping will be managed and who will maintain the maps . Would like Board policy to be available for review and comment soon. Concerned that Maine does not have enough data about mosquitoes and virus presence and we are putting the spraying ahead of monitoring.	The Board is sensitive to concerns about pesticide use and is not recommending pesticide applications, but it is proposing changes to its rules to make public health related treatments feasible if state public health officials determine it's in the best interest of the state. The Board continues to support education to help people protect themselves from mosquitoes and supports the use of an IPM approach to managing mosquitoes and protecting public health. The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications. The Board reviewed Chapters 22 and 51 and agreed that parts of them should not be exempted. It adjusted the proposed amendments accordingly. The Board will work with MOFGA and other groups to develop plans for mapping exclusion zones. The Board agrees that mosquito surveillance is critical to making informed decisions and is working with the Maine CDC to expand mosquito surveillance.
Jody Spear (also submitted written testimony)	Spray programs are ineffective . Pesticides are dangerous for the environment, especially for pollinators. Organic farmers should be able to opt out of aerial spraying. Maine should not "come into line" with other states, but should lead the way by having a policy that is less damaging	The Board is sensitive to concerns about pesticide use and is not recommending pesticide applications, but it is proposing changes to its rules to make public health related treatments feasible if state public health officials determine it's in the best interest of the state. Data from Massachusetts suggest that bees are not harmed by carefully conducted public health mosquito-control pesticide applications because of product choice

TABLE 1 - TESTIMONY GIVEN AT MARCH 1, 2013 PUBLIC HEARING		
Person/Affiliation	**Summary of Testimony**	**Board Response**
	to the environment. Granger asked if there is any way to conduct a spray program and protect the pollinators and Spear replied that there is not.	application rates and application timing. The Board supports exclusion zones for organic farms but recognizes that some parcels may be too small to be practically excluded from aerial applications. The Board supports the use of an IPM approach to managing mosquitoes and protecting public health.
Dave Bell (Maine Wild Blueberry Commission) (also submitted written testimony)	Concerned about potential residue on fruit, making it unacceptable to overseas customers. Would like organic farms to be named as sensitive sites to be avoided. Looked at cranberry study done in Massachusetts, but because the samples were taken 3–5 days after spraying, can't be sure there would be no detect the day after spraying. Would like research on the materials most likely to be used. Concerned that the way the rule is currently written it would require only a "reasonable effort" for ground-based spraying. Needs a stronger requirement to avoid application to commercial fruits, especially near suburban interfaces. For aerial spraying the "extent feasible" is not adequate to provide protection. Section should be strengthened. Wild blueberries are only sensitive near harvest. Would like to see research on the timing. If the materials biodegrade in 24 hours then they could postpone harvest for one or two days, but if it takes longer, couldn't postpone for five days, would lose harvest. Shouldn't be exempt from standards in Chapter 22: equipment, weather, identification and recording of sensitive sites; some sections would have to be modified, but most	There are U.S. tolerances for residues of the active ingredients which could be used in a public health mosquito application. Mosquito public health adulticide applications are at much lower rates of active ingredient per acre than are residential or agricultural uses. Blueberry farms are large enough to be easily excluded; and would not generally be part of the target areas for mosquito control which are centered around the interface of vector habitat and population areas. Data from Massachusetts on cranberries suggests that within a few days there will be no residues from the insecticides most likely to be used in a public health mosquito control program. The Board supports the idea of additional research to address crop residue concerns. The BPC toxicologist indicated that some research has already been done on residues and she will study the data and report back. The Board agrees that agricultural sites need not be sprayed and supports mapping those sites as exclusion zones. It also recognizes that very small sites may not be feasible to exclude from an aerial spray program. The Board is sensitive to concerns about the standard

TABLE 1 - TESTIMONY GIVEN AT MARCH 1, 2013 PUBLIC HEARING		
Person/Affiliation	**Summary of Testimony**	**Board Response**
	should not be exempted.	of care required of the government entity, but could not identify alternative language that would not create an unreasonable impediment to public health control programs. The Board agrees that parts of Chapter 22 should not be exempt and has revised the amendments to address this concern.
May Linda Rapelye (also submitted written testimony)	Would like organic to be able to opt out. Wonders what happens to the pesticide when it kills mosquitoes in the air; do the mosquitoes, along with the pesticide, drop into the water? Thinks treating larvae with Bti is more effective and would like to see it made possible.	The Board is sensitive to concerns about pesticide use and is not recommending pesticide applications, but it is proposing changes to its rules to make public health related treatments feasible if state public health officials determine it's in the best interest of the state. EPA has approved labels for the products with wide-area public health programs for mosquito control. This means they have been through the environmental risk assessment process and EPA has determined that - at labeled rates - the products pose an acceptable risk to aquatic life. The Board supports the use of an IPM approach to managing mosquitoes and protecting public health which would include the use of *Bti* and other methods. The staff has engaged in a dialog with the Maine DEP about revising the General Permit for Larval Mosquito Control to make larval control more practical.

TABLE 2 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
INDIVIDUAL RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Bell, David – Executive Director, Maine Blueberry Commission	Concerned about pesticide residues on blueberries that may not be acceptable to international customers or above international tolerance levels. Concerned about organic growers losing the opportunity to sell their crop as certified organic if a prohibited substance is applied above a field. Wants a stronger opt-out option for ground-based applications in section 6.C.2.of Chapter 20. Wants to make sure that blueberry fields with maturing fruit are considered a sensitive site under section 6.C.3., and to strengthen the language, "takes affirmative steps" to ensure sensitive sites will be protected from residues. Suggests field trials to ensure that control materials used will result in minimal product quality risk. Suggests only exempting public health applications from specific requirements in Chapter 22 and to do a review to see if there may be a need for additional standards for this type of application project. Suggested specific changes to Chapter 22, Section 2.C & D.; Section 3.B,C,D&E and Section 4.B.	There are U.S. tolerances for residues of the active ingredients which could be used in a public health mosquito application. Mosquito public health adulticide applications are at much lower rates of active ingredient per acre than are residential or agricultural uses. Blueberry farms are large enough to be easily excluded; and would not generally be part of the target areas for mosquito control which are centered around the interface of vector habitat and population areas. Data from Massachusetts on cranberries suggests that within a few days there will be no residues from the insecticides most likely to be used in a public health mosquito control program.. The Board agrees that agricultural sites need not be sprayed and supports mapping those sites as exclusion zones. It also recognizes that very small sites may not be feasible to exclude from an aerial spray program. The Board is sensitive to concerns about the standard of care required of the government entity, but could not identify alternative language that would not create an unreasonable impediment to public health control programs. The Board supports the idea of additional research to address crop residue concerns. The BPC toxicologist indicated that some research has already been done on residues and she will study the data and report back The Board agrees that parts of Chapter 22 should not be exempt and has revised the amendments to address this concern.

TABLE 2 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
INDIVIDUAL RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Simone, Michael, Owner, Mosquito Terminators	Believes the exceptions from Chapters 20, 22 and 51 should be extended to any legitimate licensed mosquito control company operating in areas that have been identified by the Maine CDC.	The Board determined that the scope of the current rulemaking effort is public health mosquito control programs undertaken by governmental entities. Governmental entities will likely contract with commercial pesticide applicators for this type of control work, and therefore these amendments will apply to commercial applicators as well.
McCarron, Patricia, Director, Maine Lobstermen's Association	Strongly opposed to the amendments to all chapters. Concerned that insecticides sprayed for mosquitoes will harm lobster since both are arthropods and that they will have lethal and sub-lethal effects. Questions the efficacy of mosquito adulticiding and encourage public educational programs to emphasize elimination of breeding sites and resting habitat, encouraging natural predators and personal protection from bites. If education fails, suggest larvicide programs using *Bacillus thuringiensis israelensis* Opposes elimination of a property owner's right to be excluded from aerial spray programs.	EPA has approved labels for the products with wide-area public health programs for mosquito control. This means they have been through the environmental risk assessment process and EPA has determined that - at labeled rates – the products pose an acceptable risk to aquatic life. There are U.S. tolerances for residues of the active ingredients which could be used in a public health mosquito application. Mosquito public health adulticide applications are at much lower rates of active ingredient per acre than are residential or agricultural uses. The Board is sensitive to concerns about pesticide use and is not recommending pesticide applications, but it is proposing changes to its rules to make public health related treatments feasible if state public health officials determine it's in the best interest of the state. The Board continues to support education to help people protect themselves from mosquitoes and supports the use of an IPM approach to managing mosquitoes and protecting public health. The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications.

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INDIVIDUAL RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Spear, Jody, Harborside, Maine	Requests that the opt-out choice be retained in Chapter 20 and does not think the words "reasonable effort" in Section C.2 and "to the extent feasible" in Section C.3 are appropriate. Concerned that the "sensitive sites" referred to in Chapter 20 Section C.3 will go unprotected if Chapter 22 is amended as proposed. Would like more specifics in Chapter 20 B.1 and C.1 including a similar (3 day) advance notice for ground spraying. Doesn't think Chapter 20 properly replaces the 500 foot notification requirements in Chapter 51. Doesn't think the words "reasonable effort" in Chapter 22 Section 6.B are appropriate.	The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications. Sensitive sites referred to in Chapter 20 will be excluded from the target area and buffer zones will be implemented. The Board agrees that notifying the public is of paramount importance. It also recognizes an outbreak of EEE may require a very rapid response. Historically, the media has found wide-area spray programs to be extremely newsworthy. Additionally, government entities understand the value of keeping the public informed. The Board is sensitive to concerns about the standard of care required of the government entity, but could not identify alternative language that would not create an unreasonable impediment to public health control programs.
McCammon, Laurie, Scarborough, Maine	Strongly opposed to aerial spraying. Wants to make sure all have the ability to opt out of spraying. Has child with multiple life-threatening allergies.	The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications.
Green, Katy, Organic Transitions Coordinator, Maine Organic Farmers and Gardeners Association	Prefers that the Board educate the public about personal protection from arboviral disease instead of changing the rules to allow for spraying. Would like the rule to allow any citizen, for any reason, to have their property included in the exclusion zones that would be defined in either Board rule or policy for both aerial and ground applications.	The Board is sensitive to concerns about pesticide use and is not recommending pesticide applications, but itis proposing changes. to its rules to make public health related treatments feasible if state public health officials determine it's in the best interest of the state. The Board continues to support education to help people protect themselves from mosquitoes and supports the use

TABLE 2 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
INDIVIDUAL RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
	Sees no reason to exempt government sponsored spray programs from Chapter 22 or Section VI of Chapter 51. Wants to make sure the Board provides resources to ensure that no organic farm mapped by MOFGA is accidentally treated. Would like the Board to draft a policy regarding the system that will be used to identify exclusion zones and the process to be followed to make sure applicators get the maps that identify those exclusion zones. The Board should also direct resources to mosquito surveillance so that any spray program will be based on robust data.	of an IPM approach to managing mosquitoes and protecting public health. The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications. The Board reviewed Chapters 22 and 51 and agreed that parts of them should not be exempted. It adjusted the proposed amendments accordingly. The Board will work with MOFGA and other groups to develop plans for mapping exclusion zones. The Board agrees that mosquito surveillance is critical to making informed decisions and is working with the Maine CDC to expand mosquito surveillance.

TABLE 3 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
GROUP RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Beekeepers		
Thurlow-Kimball, Karen, Browns Bee Farm	Identified themselves as Beekeepers Opposed to the changes in all three rules and concerned about off-target deposition and effects on their hives. Believe everyone has the right to know about applications. Believe everyone should have the right to opt-out of applications. Some call for at least a 5 miles no-spray radius around hives.	Data from Massachusetts suggest that bees are not harmed by carefully conducted public health mosquito-control pesticide applications because of product choice application rates and application timing. The proposed amendments do not eliminate advance notification, they only modify the requirements for property owner authorization in the event of mosquito-borne disease public health threat. The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications.
Gideon, Victor, Raymond, Maine		
Weymouth, Jason, Brunswick, Maine		
Geer, Ron, Essential Valuation LLC		
Poppema, Louise, Cumberland, Maine		
Crowell, Sandra, Raymond, Maine		
Sullivan, Louise, Cape Elizabeth, Maine		
McCloskey, Susan		
Leavitt, Pete, Beekeeper		
Gilbert, William, Eliot, Maine		
Burks, Bernadette, Kennebunk, Maine		
Allen, Tracey, Scarborough, Maine		
Shoe, Randy, Berwick, Maine		

TABLE 3 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
GROUP RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Riney, Monika, Wildermirth Farm, Winthrop, Maine		
Peiffer, Lawrence, MSBA Vice President, Master Beekeeper		
Organic Farmers		
Bouchard, Jennifer	Identified themselves as organic farmers. Oppose the changes in Chapter 20 that allow application without landowner/occupant consent. All should be able to opt out of spray programs.	Requiring individual property owner authorization is not feasible and would prevent most wide-area public-health spray programs. The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications.
Wotton, Angela, Hammond, Maine		
Berry, Eli		
Faull, Sara, Mandala Farm, Gouldsboro, Maine		
Theriault, Sonya, Summit Springs Farm, Poland, Maine		
Forsythe, Alexander, Richmond, Maine		
Marquis, Wayne, Van Buren, Maine		
Pike, Jordan, Two Toad Farm, Lebanon, Maine		
Bolduc, Karen, South Auburn Organic Farm, Auburn, Maine		

TABLE 3 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
GROUP RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Lassen, Hugh, Intervale Blueberry Farm, Cherryfield, Maine Oliver, Sarah, Even Keel Farm, Pemaquid, Maine		
Unspecified		
Scully, David, President, Prouts Neck Audubon Society Kress, Stephen, Director, Seabird Restoration Program, National Audubon Society	Requests no-spray zone over Stratton and Bluff Islands because 32 priority bird species use the area during migration and more than 240 species including endangered Roseate Terns use the island.	Endangered and threatened species habitat are commonly excluded from public health related mosquito control programs.
Eddy, Terry, Scarborough, Maine Pepin, Kimberly	Against the changes in Chapter 20 that allow application without landowner/occupant consent. All should be able to opt out of spray programs.	Requiring individual property owner authorization is not feasible fand would prevent most wide-area public-health spray programs. The Board supports opt-out provision for ground spraying and an exclusion provision for aerial spraying, but recognizes that some parcels may be too small to be practically excluded from aerial applications.
Wilder, Sara, Norridgewock, Maine Tomash, Adam, West Gardiner, Maine Maier, James, M.D., Scarborough, Maine MacMahon, James, M.D., Scarborough, Maine	Oppose the changes to the rules. Against mosquito spraying. Prefer public education about personal protection. Efficacy of aerial applications negligible. Do not take away the requirement for consent before spraying.	The Board is sensitive to concerns about pesticide use and is not recommending pesticide applications, but it is proposing changes to its rules to make public health related treatments feasible if state public health officials determine it's in the best interest of the state. The Board continues to support education to help people protect themselves from mosquitoes and supports the use of an IPM approach to managing mosquitoes and

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GROUP RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Foley-Ferguson, Suzanne, Scarborough, Maine		protecting public health. Requiring individual property owner authorization is not feasible and would prevent most wide-area public-health spray programs.
Davis, Derek, Scarborough, Maine		
Bottesch, Marla, Norridgewock, Maine		
Balgooyen, Helen, Norridgewock, Maine		
Zando, Marla, Scarborough, Maine		
Woodin, Eddie, S. Portland, Maine		
Tanner, Nanette, Scarborough, Maine		
Sweet-Demetriou, Marcella, Winham, Maine		
Sweet, Arlene		
Sweet, William		
Robbins, Sandy		
Nomani, Louise, Norridgewock, Maine		
Michka, Kay, Lexington, Maine		
D'Andrea, Karen, Scarborough, Maine		

TABLE 3 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
GROUP RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Cutter, Jane, Scarborough, Maine		
Malis, Suzanne		
Stoesser, Cora, Bowdoin, Maine		
scooterweeks@yahoo.com		
Lamb, Scott, Appleton, Maine		
Hathaway, Nancy, Blue Hill, Maine and Surry Conservation Commission		
Christie, Jeanne		
Bedard, Deb		
Avila, Lelania, NE Harbor, Maine		
Ward, Dayle, Appleton, Maine		
McBride, Chris, Stephanie and Cooper		
Ludders, Jessica, Charleston, Maine		
Gleeson, Karen, Northport, Maine		
Christen, Renata, Waldo County		

TABLE 3 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
GROUP RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Bailey, Roberta, Fedco Seeds, Vassalboro, Maine		
Twidwell, Karen, Greene, Maine		
Rapelye, Mary Linda, Lyric Meadow Farm, Boothbay, Maine		
Elliott, Alice, Richmond, Maine		
Domenichelli, Angela, Belfast, Maine		
Burke, Amy, York, Maine		
Ciarrocca, Joe		
Pierce, Julia and Benjamin, Vassalboro, Maine		
Patrick, Eileen		
Brown, Deborah, Jefferson, Maine		
Comstock, Lauren		
Lodata, Bob, Charleston, Maine		
Livingston, Laura		
Drake, Cynthia, Dover-Foxcroft, Maine		
Moger, Bonnie, Westbrook, Maine		

TABLE 3 - WRITTEN COMMENTS RECEIVED BY MARCH 15, 2013		
GROUP RESPONSES		
Person/Affiliation	**Summary of Comments**	**Board Response**
Higgins, Lois, Kittery, Maine		
Thompson, Laurie, Dayton, Maine		

PAUL R. LEPAGE
GOVERNOR

STATE OF MAINE
DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY
BOARD OF PESTICIDES CONTROL
28 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0028

WALTER E. WHITCOMB
COMMISSIONER

HENRY S. JENNINGS
DIRECTOR

MAINE BOARD OF PESTICIDES CONTROL POLICY RELATING TO THE INTERPRETATION OF "FOOD PRODUCTION" AS IT RELATES TO THE AGRICULTURAL BASIC PESTICIDE LICENSE

DRAFT

BACKGROUND

The term "food production" is an important term used in the statute (*excerpt below*) that requires a "private applicator of general use pesticides" to obtain a license (referred to as an "Agricultural Basic" pesticide applicator license) 22 MRS § 1471-D (2-D):

> *2-D. (TEXT EFFECTIVE 4/1/15) Certification required; private applicator of general use pesticides for food production. A private applicator of general use pesticides may not use or supervise the use of general use pesticides for food production without prior certification from the board, except that a competent person who is not certified may use such a pesticide under the direct supervision of a certified applicator. Additional certification under this section is not required for a person certified as a commercial applicator or a private applicator under subsection 1 or 2, respectively.*

Some growers have asked for clarification as to whether certain practices constitute "food production" in this context, including:

- growing vegetable seedlings for sale to home gardeners
- sanitizing containers, benches or other surfaces to prepare for growing the crop
- post-harvest treatments applied directly to the food or applied to food boxes, containers or storage bins

The staff asked the Board to provide a clear interpretation of the meaning of "food production" in order to be able to consistently inform growers about which practices require an Agricultural Basic license. The Board had a lengthy discussion at its June 27, 2014, meeting and agreed on the policy below.

POLICY

For the purpose of determining the requirement for a private applicator of general use pesticide license (Agricultural Basic) per 22 MRS 1471-D (2-D), "food production" will include treatments beginning with the growing media and ending when the plant or plant product is transferred out of the grower's control.

This includes, but is not limited to:

- soil or other growing medium applications
- seed treatments
- foliar or root treatments
- soil, root or stem injections
- smoke, mist, fumigant or total release fogger applications to greenhouses or hoop houses, when food plants are present
- post-harvest treatments, such as dips, fumigation, produce rinsing with a disinfectant, etc.

Applications done in a manner that do not present a significant risk of resulting in pesticide residues on food do not require a license.

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WALTER E. WHITCOMB
COMMISSIONER

HENRY S. JENNINGS
DIRECTOR

To: Board Members

From: Raymond Connors, Manager of Compliance

Subject: Interpretation of Chapter 24, Section 7(D)

Date: August 8, 2014

The compliance staff occasionally encounters pesticides stored outdoors in self-service areas at retail establishments where pesticides are sold that may not fit the letter of the law with respect to CMR 012-026, Chapter 24, Pesticide Storage Facility Standards/Pesticide Distributors, Section 7(D) (*see excerpt below*). The staff is seeking guidance on how certain circumstances should be addressed. Some storage conditions include:

1. Pesticides stored on "farmers' porches" at farm and garden supply retailers
2. Partial fences with a gate surrounding certain retail establishments that store pesticides outdoors
3. Entry to facility that is gated, but where there is no fence

Excerpt from CMR 012-026, Chapter 24, Section 7(D)

Section 7. Special Requirements for Pesticide Distributor Self-Service Sales Areas

A. All pesticides, unless they are exempted products under 22 M.R.S.A. §1471-W(5), shall be displayed in a separate area that is identified by a Board approved sign informing the public where to obtain additional information. The signs must be positioned between four and seven feet above the floor and prominently posted in all areas where non-exempt pesticides are displayed.

B. All pesticide containers in the self-service sales area shall be in good condition and have full labeling intact. It is prohibited to have torn, punctured, rusted or leaking pesticide containers in the self-service sales area.

C. All pesticide products not exempted under 22 M.R.S.A. §1471-W(5) shall not be displayed within 10 feet of food or animal feed products unless they are stored in adjoining aisles separated by a solid barrier. Pesticides shall not be on display above food or animal feed products.

D. Any outdoor pesticide display area must be securely fenced and must have a roof to protect the material from the elements.

E. Each retail or wholesale establishment must be equipped with spill cleanup materials sufficient to absorb 2 times the volume of the largest container stored. These cleanup materials must be readily available and easily accessible.

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WALTER E. WHITCOMB
COMMISSIONER

HENRY S. JENNINGS
DIRECTOR

To: Board Members

From: Gary Fish, Manager of Pesticide Programs

Subject: Interpretation of Chapter 31, Section 1(E)(IV)

Date: August 8, 2014

Recently, Mary Tomlinson attended a meeting with other governmental officials and York Water District (YWD) personnel contemplating a possible aquatic application of copper sulfate to control algae on Chase's Pond, which is the York water supply. A question arose about whether the licensing exemption contained in Chapter 31, Section 1(E)(IV) (see *excerpt below*) would allow the YWD employees, who are certified as drinking water operators, to apply copper sulfate to Chase's Pond. In addition, the exemption language could be interpreted to imply that certified drinking water operators could make any type of pesticide application without a Board license. The staff is seeking Board guidance on this question.

Excerpt from CMR 01-026, Chapter 31, Section 1(E)

1. Individual Certification and Company/Agency Licensing Requirements

E. **Exemptions**

I. Employing entities only performing post harvest treatments to agricultural commodities are exempt from master licensing requirements.

II. Persons applying pesticides to household pets and other non agricultural domestic animals are exempt from commercial applicator licensing.

III. Swimming pool and spa operators that are certified by the National Swimming Pool Foundation, National Spa and Pool Institute or other organization approved by the Board are exempt from commercial applicator licensing. However, these persons must still comply with all provisions of C.M.R. 10-144, Chapter 202 – Rules Relating to Public Swimming Pools and Spas Administered by the Maine Bureau of Health.

IV. Certified or licensed Wastewater or Drinking Water Operators

PAUL R. LEPAGE
GOVERNOR

STATE OF MAINE
DEPARTMENT OF AGRICULTURE, FOOD AND RURAL RESOURCES
BOARD OF PESTICIDES CONTROL
28 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0028

WALTER E. WHITCOMB
COMMISSIONER

HENRY JENNINGS
DIRECTOR

July 1, 2014

Andy Knight
Urban Tree Service
PO Box 1631
Rochester, NH 03866-1631

RE: Variance Permit for CMR 01-026, Chapter 29

Dear Mr. Knight

On November 18, 2011, the Board authorized the staff to issue permits for broadcast pesticide applications within 25 feet of water for control of plants that pose a dermal toxicity hazard provided the applicator agrees to use low-pressure equipment and direct the spray away from the water.

By way of this letter, your request for a variance from the 25-foot setback requirement contained in Chapter 29, Section 6 is hereby granted for the treatment of a poison ivy at 150 US Route 1, York, Maine for 2014. Please bear in mind that your permit is based upon your company adhering to the precautions listed in Section X of your variance application.

We will alert the Board at its August 8, 2014 meeting that the variance permit has been issued. If you have any questions concerning this matter, please feel free to contact me at 287-2731.

Sincerely,

Henry Jennings

Henry Jennings
Director
Maine Board of Pesticides Control

PAUL R. LEPAGE
GOVERNOR

STATE OF MAINE
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WALTER E. WHITCOMB
COMMISSIONER

HENRY JENNINGS
DIRECTOR

July 1, 2014

Patrick Devou
The Lawn Dawg, Inc.
163 Washington Avenue
Portland, ME 04101

RE: Variance Permit for CMR 01-026, Chapter 29

Dear Mr. Devou:

On December 13, 2013, the Board authorized the staff to issue multi-year permits for broadcast pesticide applications within 25 feet of water for control of invasive plants provided the applicator has demonstrated knowledge of best management practices for control of the plant, has a multi-year plan for controlling the invasive plants, and has a re-vegetation plan for the site.

By way of this letter, your request for a variance from the 25-foot setback requirement contained in Chapter 29, Section 6 is hereby granted for the treatment of various invasive plants at 1 C Street in South Portland. This variance is valid until December 31, 2016. Please bear in mind that your permit is based upon your company adhering to the precautions listed in Section X of your variance application; also, the Board does require that you notify them if there is a change in products to be used.

We will alert the Board at its August 8, 2014 meeting that the variance permit has been issued. If you have any questions concerning this matter, please feel free to contact me at 287-2731.

Sincerely,

Henry Jennings

Henry Jennings
Director
Maine Board of Pesticides Control

Maine Board of Pesticides Control

Miscellaneous Pesticides Articles
July 2014

(identified by Google alerts or submitted by individuals)

Upcoming JPR Music Special
Josh Rouse Live Session Friday June 20th at Noon

JPR Classics Special Series
New C&N Series - Center Stage From Wolf Trap

Upcoming JPR Music Special
Lily & Madeleine Live Session Friday, June 27th at Noon

Several Hundred Honey Bees And Bumblebees Died **4:09 PM** THU JUNE 19, 2014

Another Large Bee Die-off Attributed to Pesticides

By RACHAEL MCDONALD

Originally published on Thu June 19, 2014 1:26 pm

Several hundred honey bees and bumblebees died at a Eugene apartment complex Tuesday after trees on the property were sprayed with pesticides. The state is investigating.

Listen 0:58

The State Department of Agriculture (http://www.oregon.gov/ODA/PEST/Pages/index.aspx) found out about the bee deaths from a TV report and sent an investigator out Wednesday. Bruce Pokarney is with ODA:

One of hundreds of bees that died at an apartment complex in Eugene Tuesday. The ODA found out about the die-off from a report on KVAL
Credit KVAL

Pokarney: "What we've discovered is that a commercial pesticide operator had applied a pesticide, active ingredient Imidacloprid on 17 trees at the complex early Tuesday morning. Most of those trees if not all of them were Linden trees. Those are the same trees that were involved in bee death incidents last year in Oregon."

Last summer 50 thousand bumblebees were found dead in a parking lot in Wilsonville after pesticides were applied to Linden Trees. After that incident, state regulators required label statements on products containing chemicals that harm bees. The labels advise against spraying trees in full bloom and attracting pollinators, as in this case.

Pokarney says ODA will potentially pursue enforcement action against the company, Glass Tree Care. The company says it's cooperating with the investigation.

Portland Press Herald, June 24, 2014

Buzz about bees: New study claims widely used class of pesticides is killing them

Neonicotinoids work by affecting the central nervous system of insects, causing paralysis and death, according to the EPA.

BY **NORTH CAIRN** STAFF WRITER
ncairn@pressherald.com | 207-791-6325

Many home-garden plants, promoted as "bee-friendly," are pretreated with a class of pesticides shown to harm and kill bees and other pollinating insects, according to several consumer groups that will release pesticide test results Wednesday at a press conference in Portland.

The Organic Consumers Association, Friends of the Earth, in conjunction with more than 20 beekeeping and organic gardening associations, including Maine Organic Farmers and Gardeners Association, will present the results of the study – said to be based on the largest data samples to date – at The Honey Exchange on Stevens Avenue. In addition, the organization will present homeowners and backyard gardeners with tips on how to reduce exposure to the pesticides – known as neonicotinoids – and to protect bees.

In this file photo, the queen bee is surrounded by the worker bees in one of The Honey Exchange's Portland hives. *Carl D. Walsh/Staff Photographer*

Neonicotinoids work by affecting the central nervous system of insects, causing paralysis and death, according to the U.S. Environmental Protection Agency.

They are systemic pesticides, meaning that they affect not just the surface of leaves of treated plants but also are absorbed through the entire system, penetrating even into the soil, said Erin Forbes, a master beekeeper from Portland. They are also persistent, lasting up to 15 years in soil, she said.

These pesticides have come under scrutiny in recent years due to the decline of honeybees, particularly from colony collapse disorder. Entomologists and biologists have been working to unravel the multiple factors involved in the disorder, which have decimated bee populations worldwide.

"Neonicotinoids "are absolutely a contributing factor to the increased decline of honeybee colonies in recent years," said Forbes. Most plants that are started in soil and transported from one state to another have neonicotinoids in the soil, she said.

Dozens of environmental and agricultural organization nationally and internationally are calling for action to address problems of neonicotinoids.

Last Friday, the White House issued a statement calling the decline of honeybees, native bees and other pollinators – including birds, bats and butterflies – a serious problem that "poses a significant challenge that needs to be addressed to ensure the sustainability of our food production systems, avoid additional economic impacts on the agricultural sector and protect the health of the environment."

President Obama called for several measures, including the establishment of a task force charged with developing a national strategy to improve pollinator health.

The White House stopped short of singling out neonicotinoid pesticides but included "pesticide exposure" as one of several factors in bee decline.

Pollinators contribute more than $24 billion to the U.S. economy annually – with honeybees accounting for more than $15 billion, according to the White House statement.

"Honeybees enable the production of at least 90 percent of commercially grown crops in North America," the statement said. Globally, animal pollinators enable the production of 87 of the leading 115 food crops, the White House estimated.

Portland Press Herald, June 24, 2014
http://www.pressherald.com/2014/06/24/buzz-about-bees-new-study-claims-widely-used-class-of-pesticides-is-killing-them/

Aliens in the Maine woods

Wednesday, June 18, 2014 at 10:52AM
Joe Rankin

Terrestrial invasive plants can wreak havoc with forests

By Joe Rankin

Forests for Maine's Future writer

Licensed forester Jeff Williams does the usual things foresters do: writes management plans, runs boundary lines, oversees harvests, lays out logging roads, marks trees. But more and more these days he's having to deal with invasive forest plants.


Pulling garlic mustard on Cutts Island (Photo: Maine Natural Areas Program)Williams, who owns Maine Forest Management in Hollis, said 30 to 40 percent of his time is spent helping his clients cope with the likes of glossy buckthorn and Japanese barberry, and that percentage goes up every year.

In fact, it's very seldom that he gets a job these days that doesn't involve invasive plant issues. Sometimes he even does herbicide applications (he has a master applicator's license) if a client can't find a contractor to do the work at an affordable price.

"As bad as it is now it's inevitable that it'll get worse," Williams said. "As it is now there are pockets where it's a real problem. In 50 years it'll be a huge problem for southern Maine and forests in Maine period."

Woodland invasive plants are also known as terrestrial or upland invasives. They haven't gotten the publicity that exotic insect pests or aquatic invasive plants have. Non-woodsy types who have heard of the emerald ash borer or recognize Eurasian milfoil on sight might give you a blank look at a mention of glossy buckthorn, black swallowwort or Asiatic bittersweet.

That's not unexpected, said Tom Doak, the executive director of the **Small Woodland Owners Association of Maine.**


Asiatic bittersweet (Photo: Tom Rawinski, USFS)Exotic insect pests prompt more attention because they kill trees outright and the damage is highly visible; the uncontrolled spread of invasive aquatic plant species threatens to imperil the state's thousands of lakes and ponds, said Doak.

In contrast, woodland invasives are more insidious: they're green in a landscape of green and growing things. "They don't generally kill the trees, but they occupy the land and prevent forest trees from growing," said Doak.

An invasive plant is generally defined as one that spreads quickly and crowds out other plants and trees. Most are exotics, immigrants from Asia, Africa or Europe. Many are sunlight lovers. They invade marshes (common reed), wetlands (purple loosestrife), grassy areas and roadsides (Japanese knotweed), and field-woodland edges (honeysuckle and autumn olive.)

Generally speaking, it's harder for an invasive plant to make it in a healthy forest with a full canopy. But some have no problem. There are vines, trees and shrubs already invading forests in Maine and others that will likely be here soon.


Common buckthorn (Photo: Maine Natural Areas Program)So, what species would a list of Maine's "most unwanted" woodland invasives include? The experts we talked to reeled these off:

Glossy buckthorn (*Frangula alnus*) and **common buckthorn** (*Rhamnus cathartica*) are fast-growing shrubs that form dense thickets in wetlands and woodlands. Their habit of leafing out before other plants and retaining their leaves late into the fall gives them an advantage and helps them shade out native species.

Japanese barberry (*Berberis japonicus*) is, as its name suggests, a spiny shrub originally from Asia. It grows three to six feet high. It forms dense thickets that can be impossible to bull your way through. The red berries are highly attractive to birds, which help spread it.

Asiatic bittersweet (C*elastrus orbiculata*) is the Boston strangler of invasives. This relative of American bittersweet grows fast and twines around trees as it reaches for sunlight, eventually smothering the host plant. It not only reproduces using attractive red berries, but also root suckers.

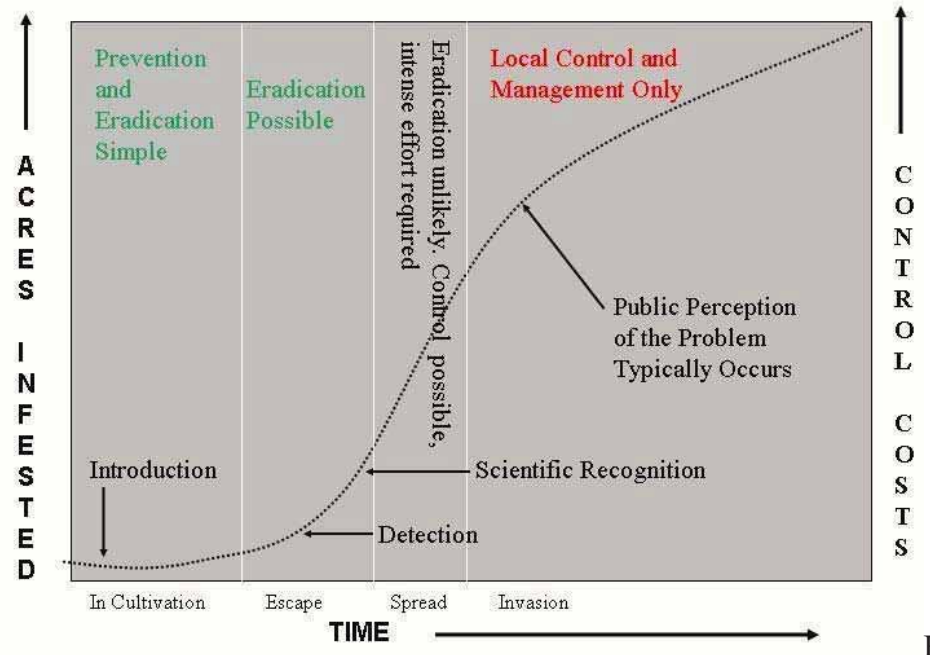

A forest of barberry at Laudholm Reserve in Wells (Photo: Maine Natural Areas Program)**Norway maple** (*Acer platanoides*) is an escapee from the nursery trade. This sugar maple look-alike, still planted as a shade and street tree, grows fast, even in shade, and forms dense colonies that can elbow aside native trees and shrubs.

Garlic mustard (*Alliaria petiiolata*) is a biennial herb that tolerates a wide spectrum of soils and growing conditions, and is especially aggressive in rich, moist upland forest soils, where it forms dense colonies of three-foot tall plants, shouldering aside all manner of native wildflowers and herbs.

Black swallowwort (*Cynanchum louiseae*) is a viney native of southwestern Europe that likes moist soils. It engulfs native plants and creates thickets.

Morrow honeysuckle (*Lonicera morrowii*) is a native of Asia that grows as high as 16 feet, forming dense thickets and shading out native plants. While it likes sunlit forest edges it will also invade mature forests.

You'll note some common themes in the descriptions. These invasive plants tend to be fast growing; they form dense thickets, a sort of non-compete strategy; they adapt to a wide range of habitats and



they have shiny, How the

invasive game usually plays out (Graphic: Tom Rawinski, USFS)brightly-colored fruit, a sure-fire reproductive strategy since birds ingest the fruit then excrete the seeds far and wide along with a little fertilizer.

Some of these plants were introduced accidentally, some on purpose, either as ornamentals or for erosion control. It wasn't until later, sometimes decades later, that the threat they posed was realized. However, even today, some, such as Norway maple and Japanese barberry, are staples of the nursery trade.

These forest invasives currently pose the greatest threat in southern Maine, say, south and west of Augusta. Not coincidentally that's where the most people live. In fact, these weedy plants tend to be closely associated with another weedy species: humans.

"The behavior of invasive plants follows human activity very closely. Humans are an edge species. Our yards are open. When we look to the woods we see the edge. Invasive plants thrive on the disturbance we humans create. We are bombarded by invasive plants that are basically just trying to heal the wounds that we inflict on the land," said Tom Rawinski, a botanist with the **U.S. Forest Service's Northeastern Area State and Private Forestry** program. He works on invasive plant issues throughout New England and New York.

Many invasive plants get their start at the edge where grasslands (read, lawns and fields) meet the

woods and Glossy buckthorn berries (Photo: Maine Natural Areas Program)sunlight is ample. For some it's just a beachhead to invade the forest. Sometimes we help them do it, by creating disturbance. A timber harvest is just such a disturbance.

Harvesting opens the canopy, flooding the forest floor with sunlight. If invasives like barberry or buckthorn are already present it's like throwing gasoline on a fire: they enjoy an explosion of growth.

"Many landowners come to us and ask for harvest oversight and don't realize they have invasives," said Williams. "We'll recommend that they treat the invasives first. And in some cases we won't administer the harvest if they're unwilling to so. In other situations, if they're young plants we'll do mechanical treatment in the spring when the soil is soft and you can pull them. In the worst situations we do recommend herbicide control."

Sometimes, humans create disturbances in other, more subtle, ways, by encouraging or favoring one species over another.

In southern New England burgeoning white-tailed deer populations have in some places wiped out native wildflowers and understory plants, essentially clearing the field for invaders like garlic mustard or Japanese stiltgrass, said Rawinski.

 On its way to Maine? Shade tolerant Japanese stilt grass. (Photo: Chuck Bargeron, University of Georgia, Bugwood.org) "The millions of acres of stiltgrass in the eastern U.S. is not the problem," he said. "The deer are the problem, because they've eaten all the natural competitors."

At **Laudholm Reserve in Wells** deer pressure resulted in an understory "where there is nothing but Japanese barberry. It's actually impenetrable. It's quite spectacular," said Ann Gibbs, the state horticulturist with the Maine Department of Agriculture, Conservation and Forestry and an expert on invasive plants.

One of the things that makes invasive plants so successful is that they're unpalatable to wildlife. Deer won't touch barberry. Ditto for black swallowwort.

While invasive plants can crowd out native species and alter an ecosystem beyond recognition in a few years, some pose an even more pernicious threat, to the very genome of related plants.

Asiatic bittersweet, for instance, hybridizes readily with American bittersweet. In parts of Massachusetts, said Rawinski, it's hard to find a pure American bittersweet anymore. It's a victim of "genetic swamping" by its Asian relative and saving it could require eliminating Asiatic bittersweet "for perhaps a mile, which is almost impossible," Rawinski said.

Invasive plants can be controlled, if detected early enough. If you suddenly wake up to discover you've got  Leaves of the shade tolerant, fast-spreading Norway maple. (Photo: Paul Wray, Iowa State University, Bugwood.org)acres and acres of glossy buckthorn in your forest, it's almost impossible to deal with, even with herbicides.

"Early detection and rapid response are the answers," said Gibbs. "Once you get something established in an area it's a major undertaking to control and very expensive. The best thing is to keep things out."

Think of your garden: if you wait until the weeds get established, reclaiming your cabbages and cucumbers may be just too much trouble, then you swap the tiller for the lawnmower.


In the field: The Nature Conservancy's Nancy Sferra leads an invasive plants workshop. (Photo: Tom Rawinski, USFS)Rawinski remembers a sugarbush in Putney, Vermont. It had "majestic old sugar maples, but essentially the whole understory was glossy buckthorn. The task of running the lines from tree to tree or just negotiating that sugarbush would have been a nightmare. That's a situation where, with early detection, you could have contained it."

The **Maine Forest Service**, SWOAM, and conservation organizations such as **Maine Audubon**, **Maine Coast Heritage Trust** and **The Nature Conservancy** have been working to educate people about invasive plants by offering workshops and field tours. A couple of good places to start your own education — the **National Invasive Species Information Center** website and the **Maine Natural Areas Program** invasive plants website.

The control issue is complicated by the fact that there is such a broad spectrum of invasive species and those invasives don't recognize the property lines we think are so important.

"It's a landscape problem, not an individual property problem," said Williams, the forester from Hollis. "The biggest hurdle is educating landowners, even the person who has a one-acre lot adjoining a property that's managed, and trying to get everyone to work together.

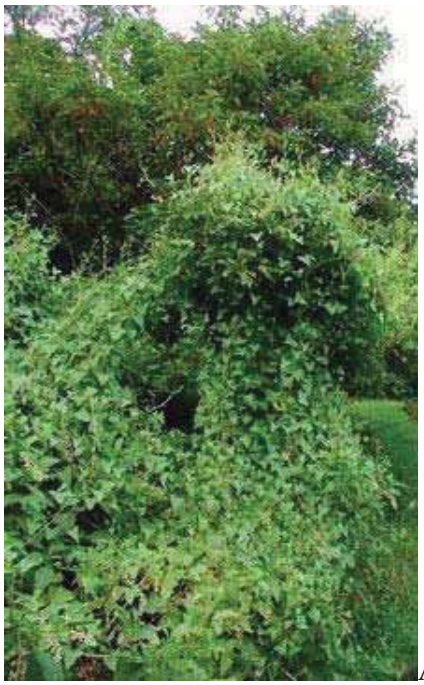
"We've had some luck going to neighbors and saying, 'are you willing to work with us and control these in a responsible manner?' And I've had landowners who are willing to pay for control of invasives on an abutting landowner's property just because they'll reap the benefit in the long term. And sometimes landowners will share the costs."


Berries of Japanese barberry. (Photo: Maine Natural Areas Program)And when it comes to most of these species that's what we're talking about — control. Nobody is talking eradication. And, in fact not every plant can be controlled in every area. The scale

of the problem is just too immense. On the one side you have plants that seed and sucker with abandon to spread their genes and on the other you have humans with limited financial resources to fight them. In other words, we need to pick our battles, knowing we won't ever be able to declare "mission accomplished."

"The greatest challenge is to make sure our limited resources and limited energy are directed appropriately and strategically," said Rawinski. To protect a beautiful hardwood forest, perhaps, or a marsh or a wetland with endangered native plant species, a community forest, park or a wildlife refuge.

It's not a battle for the faint of heart. As Gibbs points out, "These problems didn't happen overnight and you can't take care of them overnight. If you want to be successful and control an invasive plant population you have to be persistent and in it for the long haul."


A plague in the mid-Atlantic states: mile a minute vine has barbs and came by its common name honestly. (Photo: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org)And it's not as though the invaders we're fighting now are going to be the only ones. There are others on our doorstep or headed our way.

Among them is mile-a-minute vine (*Persicaria perfoliata*) — the common name gives you an idea of how fast it grows. It has barbs on the stem, is self-pollinating and a prolific seeder. It likes edges, but will grow in woods as well, where it climbs trees to get the sun it needs. Deer won't touch it.

Then there is Japanese stiltgrass (*Microstegium vimineum*), which now covers millions of acres in more than two dozen states. Stiltgrass is a prolific seeder and very tolerant of low light levels. Deer won't eat it, either. Stiltgrass is one of those stealth invasives. It looks like other native grasses. Even experts might not pick it out.

It's not the only one. Rawinski said Linden arrowwood (*Viburnum dilitatum*) an understory shrub that resembles our native arrowwood, is a common ornamental that can live in deep forest. "It's not on anyone's invasive plant list, but it probably should be," he said.

He feels the same about rusty willow (*Salix atrocinerea*), also known as large gray willow, which he's found in York and Cumberland counties. He calls it a "sneaky invader." First identified on Cape Cod a century ago, it's managed to spread widely in the northeast, choking the banks of ponds and lakes,

because it so closely resembles some native willows that even botanists don't give it a second glance.

Which brings us back to educating yourself about the trees, shrubs, wildflowers and vines in your woodlot or your community forest or the local park. Many people keep a list of birds they see on their property. Fewer have a plant list. But it's a good first step.

"You ought to learn to recognize the most common invasive plants, and then spend some time on your property," said Doak. "Don't always look up at the trees, look down as well. Get a sense of whether you have any of them and then learn whether you have a problem."

Joe Rankin writes forestry articles and keeps honeybees at his home in New Sharon.

BANGOR DAILY NEWS

Bee-killing pesticides found in 51 percent of "bee-friendly" plants in garden centers throughout U.S., Canada

Sam Hill | BDN

Phil Gaven, owner of the Honey Exchange and beekeeper, opens the top to one his hives to extract the queen bee for sale.
Buy Photo

By Danielle Walczak, BDN Staff
Posted June 25, 2014, at 6:16 p.m.

Fifty-one percent of plants sold at three major big-box stores across the U.S. and Canada contain a pesticide fatal to the pollinating insect, according to a new study by Friends of the Earth U.S., Pesticide Research Institute and SumOfUS. The study's results were released Wednesday at a press conference in Portland.

The Maine Organic Farmers and Gardeners Association assisted with conducting the pesticide sampling, the results of which were published in the report Gardeners Beware 2014. The report showed 36 of 71 garden plant samples purchased from top garden retailers — Home Depot, Wal-Mart and Lowes — in 18 cities in the U.S. and Canada contain neonicotinoid, or neonic, pesticides.

Neonic pesticides work systematically throughout the whole plant creating long-lasting prevalence in the plant and exposure of the pesticide to honeybees.

Several flowers in the study contained neonic levels lethal for bees, and researchers assumed comparable concentrations were also present in the flowers' pollen and nectar.

"The irony there is hard to ignore," MOFGA deputy director Heather Spalding said. "People are going out [and] growing these plants. There is an awareness of the decline in pollinator and bee populations. People think, '[I will] enrich my landscape with plants that will support the health of bees.' The very plants they are buying are filled with chemicals, killing bees."

According to the study, bee kills are a visible impact of systemic insecticides. It also states exposure to "levels of neonics that do not cause immediate bee death can still damage colonies." The immune system is affected, making bees more vulnerable to disease. Neonics affect the bees' ability to find food and return to the hive by impacting its learning and memory, as well as the bee's reproduction, reducing queen fertility and brood success.

"This class [of pesticides] is so widespread. It is taken up into every cell of the plant. It is there for life of the plant. It's not just applied. It's just there, working all the time, so there are many concerns of the harmful effects that it has — not only harmful to bees but other insects, butterflies and reptiles and birds," Spalding said.

Research director Lisa Archer, of the food and technology program at Friends of the Earth, said major producers should pay attention.

"Ultimately, this study is a snapshot of the market — it paints a picture. We really hope these companies will see this as a wake-up and see they need to take responsibility for the products on their shelf and take stand," she said. "There is no reason they shouldn't take action and begin urging suppliers to look for new alternatives."

Last year, the European Union banned three of the most widely used neonics based on other studies showing neonics can kill bees outright. BJ's Wholesale Club announced Wednesday it will require vendors to remove neonics from plants by the end of 2014.

"Clearly if these retailers can do that than the companies here can, too," said Archer, who cites thousands of grassroots campaigns and a petition signed by half a million people urging Lowes and Home Depot to stop selling neonics, as a driving force behind these changes.

The success of two-thirds of the food crops consumed by humans worldwide every day is reliant on pollinators such as bees.

These pollinators are in decline, according to the report.

"It's really a matter of basic decency and responsibility — being transparent with customers," Archer said.

Responsibility is what Peter Beckford of Rebel Hill Farm said he feels of the flowers he has been growing organically for the past 26 years on his Clifton farm. He focuses on plants native to Maine, at least from the eastern side of the Rocky Mountains.

"Everything we're growing is good for bees and pollinators," he said. "We're growing plants that the pollinators have a lot of use for because they are native plants."

Spalding and Archer suggest buying local, organic plants as an alternative to potentially neonics-ridden plants sold by major suppliers.

Despite Beckford's efforts to create a habitat for pollinators, the reality of food production is quite different, according to Meghan Gaven, owner of The Honey Exchange.

"I think a lot of people don't realize how we grow food. They don't realize that we take ten's of thousands, sometimes hundreds of thousands of hives and move them to a single crop," she said during a Wednesday press conference in front of her exchange on Stevens Avenue in Portland. "Over a million honeybee hives were moved to California to help with the almond bloom. Each hive has 50,000 bees in it. Because there are 750,000 acres devoted to almonds and when they're in bloom, you've got honeybees there. But when they're not in bloom, there's no point in having honeybees there because there's nothing for them to eat. So you have to move them there and then move them somewhere else," she said.

Pesticide use in agriculture is highly regulated, according to Tony Jabczak, Maine State Beekeeper at Maine's Department of Agriculture. Comparatively, homeowner use of pesticides is far more concentrated and left up to the consumer.

Jabczak said he thinks labeling and educating about pesticide use, versus a complete ban, can help combat the use of neonics. More specifically, it may spur more research regarding synergies, which occur when different types of pesticides are mixed together, significantly increasing the pesticide's toxicity.

"Plant material should be labeled, if nothing else, for consumer protection," Jabczak said. "We do a good job in training farmers, but the public has access to a lot of materials. You'd be surprised how little common sense is out there. Education is definitely a concern, as far as I'm concerned."

Jabczak cites the Varroa mite, introduced in the U.S. in 1985, for the decline in bee populations, which he said are rebounding. He said neonics is a complex issue that can be improved upon by more educated consumer choice and more research about synergies.

Last week, President Barack Obama announced a federal strategy to protect pollinators and called on the Environmental Protection Agency to assess the effect of pesticides, including neonics, on bees and other pollinators within 180 days.

Reps. Earl Blumenauer, D-Oregon, and John Conyers, D-Michigan, introduced the " Saving America's Pollinators Act" in 2013 and are seeking to suspend the use of neonics on bee-attracting plants.

The bill has bipartisan support and 68 co-sponsors.

BDN reporter Sam Hill contributed to this story.

http://www.centralmaine.com/2014/06/24/study-pesticides-making-bee-friendly-plants-bee-killers/

Kennebec Journal/Morning Sentinel, June 24, 2014

Study: Pesticides making 'bee-friendly' plants bee-killers

A press conference Wednesday in Portland will highlight the results of studies showing neonicotinoids, common in garden pesticides, are toxic to bees.

By North Cairn Portland Press Herald
ncairn@pressherald.com | 207-791-6325

A study by the environmental advocacy group Friends of the Earth to be released Wednesday in Portland shows that many home-garden plants, promoted as "bee-friendly," are pretreated with a class of pesticides that can kill bees and other pollinating insects.

Pesticide test results show that more than half of garden plants from major retailers in 18 cities in the U.S. and Canada, including Portland, contain neonicotinoids, commonly used garden pesticides that are toxic to bees and many other organisms, according to the study.

Erin MacGregor-Forbes, a master beekeeper, checks her hives in Portland. Many plants touted as "bee-friendly" are pretreated with a class of pesticides shown to harm and kill bees and other pollinating insects, according to a study to be released Wednesday at a press conference in Portland. Portland Press Herald photo by Derek Davis

Erin MacGregor-Forbes, a master beekeeper, touches a queen bee while checking her hives in Portland. Many plants touted as “bee-friendly” are pretreated with a class of pesticides shown to harm and kill bees and other pollinating insects, according to a study to be released Wednesday at a press conference in Portland. Portland Press Herald photo by Derek Davis

Chad Churchill, nursery manager at Highland Avenue Greenhouse & Farm Market in Scarborough can be seen through pac choi as he waters sugar snap peas in the greenhouse Tuesday. Portland Press Herald photo by Shawn Patrick Ouellette

The results will be made public by representatives of Friends of the Earth and Pesticide Research Institute, along with more than 20 consumer and environmental organizations and beekeeping and organic gardening associations, including Maine Organic Farmers and Gardeners Association. Of plant samples that tested positive for the pesticides, 40 percent contained two or more neonicotinoids.

The result of the widespread use of these pesticides means that many home gardens have likely become a source of harm for bees, the report concluded.

Test samples were gathered by environmental advocates from various organizations, beekeepers and researchers from various universities, said Tiffany Finck Haynes of Friends of the Earth. Testing of the samples was conducted by independent laboratories in each of the study cities in the U.S. and Canada, she said.

In addition, the damaging affects of these pesticides may be far more widespread than first thought, leaving a lasting imprint of injury to birds, mammals, humans and the soil, said a separate report released Tuesday in England, from the Bee Coalition, a collaboration of the main British environmental groups. The study, “Worldwide Integrated Assessment,” reviewed 800 studies from across the globe to create a worldwide profile of the impact of these pesticides on a wide range of invertabrate species in soil, vegetation, aquatic and marine habitats. The authors recommend a significant reduction global phasing out of the neonic pesticides.

GROWING CONCERNS

This week's reports join a growing body of studies linking neonics with colony collapse disorder, in which honeybees quit their hives for no apparent reason and do not return. A Harvard University study in May focused the collapse of honeybee colonies on neonicotinoids — insecticides that also function as nerve poisons and simulate the effects of nicotine. Scientists specifically examined low doses of two neonicotinoids — imidacloprid and clothianidin — to determine their effects on healthy bee hives over the course of a winter.

The results of the Harvard study supported the conclusion that even sub-lethal exposure to neonicotinoids is probably the main factor causing CCD to occur, the researchers wrote in their paper, published May 9 in the Bulletin of Insectology.

Neonicotinoid pesticides – also referred to as neonics – work by affecting the central nervous system of insects, causing paralysis and death, according to the U.S. Environmental Protection Agency.

The Friends of the Earth study – said to be based on the largest data samples to date – called on major retailers to stop selling plants containing neonics and urged consumers to buy only organic plants instead, to help deter the spread of problems associated with the use of such pesticides, including imidacloprid, a synthetic nicotine.

In addition, the sponsoring organizations are expected to offer homeowners and backyard gardeners tips on how to reduce exposure to the pesticides – known as neonicotinoids – and to protect bees.

Neonicotinoids are systemic pesticides, meaning that they affect not just the surface of leaves of treated plants but also are absorbed through the entire system, penetrating even into the soil, said Erin Forbes, a master beekeeper from Portland. They are persistent, too, lasting up to 15 years in soil, she said, describing neonicotinoids as "the most common class of pesticide mixtures in the world (and) the most common household pesticide." It is even found in many pet flea collars, Forbes said.

"They are absolutely a contributing factor to the increased decline of honeybee colonies in recent years," said Forbes. Most plants that are started in soil and transported from one state to another have neonicotinoids in the soil, she said. "Here in Maine that's the most common route of transmission."

Neonic pesticides have come under scrutiny in recent years due to the decline of honeybees, particularly from Colony Collapse Disorder. Entomologists and biologists have been working to unravel the multiple factors involved in the disorder, which have decimated bee populations worldwide. The problem has been particularly severe in Europe, where declines of more than 50 percent have been reported in some areas.

The mechanisms of the disorder and the factors in its steady spread remain unclear, but many possible causes have been suggested, including pesticides, particularly neonicotinoids; infections with certain mites; malnutrition; various pathogens; genetic factors; immune deficiencies; habitat loss; changing climate conditions and evolving beekeeping practices. Many scientists believe the disorder is erupting from a combination of these problems.

"There's a lot of factors in the mix," said Carol Cottrill of Rumford, president of the Maine State Beekeepers Association.

"Pesticides have always been part of the mix of things affecting pollinators," Cottrill said. "Neonicotinoids may be part of the problem but they aren't the whole problem."

Cottrill praised the new report, calling it "sane and sensible" in its focus on education of homeowners about how to avoid unwitting use of neonics and the need to check on the nursery stock they purchase. "You can buy plants that have not been pretreated," she said.

GREENHOUSES ON THE WATCH

David LeBlanc, general manager at Longfellow's Greenhouses in Manchester, said the nursery and garden center began using fewer chemical sprays several years ago, and one reason was concern about effects the sprays have on bees.

"We are probably 90 percent biological control," LeBlanc said. "We buy good bugs to go after our bad bugs. But if we have a problem that isn't controllable with our biological program, we have to go in sometimes and spray some material."

LeBlanc said some of the pesticides they use are neonicotinoids. He said there seems to be scientific disagreement about the cause of declining bee populations, and the evidence against neonicotinoids hasn't been clear enough to rule out using them.

At Highland Avenue Greenhouse in Scarborough, annual and perennial plants are free of neonicotinoids, because they are not grown in pretreated soil, said Christine Viscone, who co-owns the business with her husband Joe. Consumers concerned about pesticides in plants or soil would benefit from trying local garden centers and asking whether trees and shrubs, in particular – which often are imported from other states to Maine – are treated with neonicotinoids before they buy stock for their own gardens, she said.

"If we can educate people and let them make informed decisions, it will be helpful … better than a ban," Cottrill said. "If we ban something, I want to know what they're going to use to replace it. You've got to give (people) an alternative. My personal fear is that if they ban the neonics, what are they going to replace them with?"

A proposal to impose a temporary, two-year ban on the sale, distribution and use of neonicotinoid pesticides in Maine failed in the Legislature last year.

Concerns about the risks of neonicotinoids caused Wyman's of Maine, the nation's largest producer of wild blueberries, to opt out of use of the pesticides altogether on its 10,000 acres of berries, said Ed Flanagan, the company's president and CEO.

"We have never used them," Flanagan said. Beekeepers at Wyman's – one of whom, David Hackenberg, is credited as being among the early detectors of Colony Collapse Disorder in 2006 – expressed suspicions about the toxic effects of the pesticides, which weaken bees' immune systems. The decision was made early on to seek other alternatives, Flanagan said.

Last Friday, the White House issued a statement calling the decline of honeybees, native bees and other pollinators – including birds, bats and butterflies – a serious problem that "poses a significant challenge that needs to be addressed to ensure the sustainability of our food production systems, avoid additional economic impacts on the agricultural sector and protect the health of the environment."

President Barack Obama called for several measures, including the establishment of a task force charged with developing a national strategy to improve pollinator health.

The White House stopped short of singling out neonicotinoid pesticides but included "pesticide exposure" as one of several factors in bee decline.

Pollinators contribute more than $24 billion to the U.S. economy annually – with honeybees accounting for more than $15 billion, according to the White House statement.

“Honeybees enable the production of at least 90 percent of commercially grown crops in North America,” the statement said. Globally, animal pollinators enable the production of 87 of the leading 115 food crops, the White House estimated.

According to the Food and Agriculture Organization of the United Nations, shortages of bees in the U.S. have increased the cost to farmers renting them for pollination services by up to 20 percent.

Kennebec Journal writer Susan McMillan contributed to this story.

Bee Health 6:21 PM WED JUNE 25, 2014

Study: Pesticides in Nursery Plants Killing Bees

By PATTY WIGHT (/PEOPLE/PATTY-WIGHT)

(http://mediad.publicbroadcasting.net/p/mpbn/files/201406/6510010063_2cc839f323_m_0.jpg)

A honeybee comes in for a landing on the same flower occupied by a bumblebee.
Credit Martin LaBar

Bee-lovers who ply nurseries for welcoming plants may be bringing home more than just beautiful blossoms: A new study finds that as many as half of garden plants sold at top retailers contain neonicotinoid pesticides. "Neonics," as they're referred to, have been linked to recent declines in the honey bee population.

Listen 4:50

Patty Wight reports on the concern about nursery plants treated with pesticides that kill bees.

Now, some environmental and consumer groups want big retailers to stop supplying neonic-treated plants or require warning labels. But some gardening and bee experts say the evidence against using neonics is murky.

The report, called "Gardeners Beware," was spearheaded by Friends of the Earth US and the Pesticide Research Institute, and supported by other environmental and consumer organizations. The groups tested for pesticides in 71 plants purchased from large garden retailers across 18 cities, including Portland, says Charlotte Warren, spokesperson for the national Organic Consumers Association.

"The testing revealed that many home garden plants sold at Home Depot, Lowe's and Wal-Mart stores in the Portland area, have been pre-treated with pesticides shown to harm and kill bees," she said today at a press conference.

Master Maine Beekeeper Erin MacGregor-Forbes says plants treated with neonics retain the pesticide for their entire lives. "Neonicotinoids insecticides are systemic insecticides which are treated on the plant, absorbed into the plant, and then expressed through the pollen and nectar and the leaves of the plant," she said.

And many people who buy these plants, says Forbes, think they are bee friendly, when they may actually harm or kill them.

There's been worldwide concern over bee populations, which have declined by about a third since 2006, in a phenomenon called Colony Collapse Disorder. Though the decline has been attributed to a host of factors, Charlotte Warren says the report is part of a growing body of evidence that neonics play a major role.

Some big retailers are taking notice. BJ's Wholesale Club announced Wednesday they will require vendors to either stop supplying neonic-treated plants, or require warning labels.

Charlotte Warren says other retailers should follow BJ's lead. "We're here today to ask Home Depot, Lowe's and WalMart to do the same," she said.

"We don't want to hurt the environment - we hate spraying," says Tom Estabrook, vice president of Estabrooks Farm and Greenhouses in Yarmouth. He says there are conflicting studies on how much neonicotinoids harm bees. As the debate plays out, he says he'll follow state guidelines, which allow their use.

"Unfortunately, it's a part of our crop," he says. "We have to protect the investment that we've made. We have to make sure the plants are healthy for when they go home with you as a customer."

Estabrook isn't the only one who questions why neonicotinoids are so vilified. Maine State Apiarist Tony Jadzcak says neonicotinoids were developed to replace previous insecticides that were much more toxic.

"I mean, if we're going look at insecticides, maybe we out to look at all of them," Jadzcak says. "Because I think this class of insecticide is kind of taking a bad name, or getting too much bad publicity, compared to some of the other stuff that is commonly used."

Jadzcak says some neonicotinoids on their own are not that toxic. But they become significantly more so when mixed with certain fungicides. While Jadzcak supports better labeling for neonic-treated plants, he says asking big box retailers to end the pesticide's use could have unfortunate consequences.

"What materials will be put on those shelves in place of that?" he asks. "And my feeling on this is they're going to put some of the older chemistry materials back on the shelves, which we're currently trying to phase out for a variety of reasons."

Others point out that the focus on pesticides is too narrow, when bee population declines are due to a number of factors, including mites, viruses, habitat loss, and poor nutrition.

Master BeeKeeper Erin MacGregor-Forbes acknowledges the issue is complex. "But the neonicotinoids are the one that human beings can control," she says. "The problem is, the neonicotinoids are the one component actually earn somebody money, and that is the reason it's so difficult to fight."

One garden center says stopping their use may not be as difficult as it seems. Highland Avenue Greenhouse in Scarborough says they "grow naked" - meaning no pesticides. Co-owner Christine Viscone says it happened by accident - the greenhouse lost its pesiticide license when out-of-state credits didn't transfer to Maine.

"We decided, you know what? Instead of going back and taking the test again, we're going to implement what we've been learning for years in all of these pesticide credit seminars," she says. "They're teaching us about how to use biologicals."

Viscone says the change was surprisingly doable and it's in line with demand from eco-conscious customers. To what extent other greenhouses may need to change their pesticide policies will be decided in the near future. President Obama has asked the Environmental Protection Agency to assess the effect of pesticides like neonicotinoids on bees and other pollinators within the next six months.

TAGS: bee health (/term/bee-health) neonicotinoids (/term/neonicotinoids) MPBN (/term/mpbn)

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http://www.centralmaine.com/2014/06/25/study-plants-from-big-box-stores-in-augusta-contained-bee-harming-pesticides/

Kennebec Journal/Morning Sentinel, June 25, 2014

Study: Plants from big-box stores in Augusta contained bee-harming pesticides

Home Depot and Lowe's said they comply, or plan to comply, with federal regulations requiring proper labeling for plants that use the pesticides.

By Jesse Scardina Staff Writer
jscardina@centralmaine.com | @JesseScardina | 207-861-9239

On the shelf of a garden center in Fairfield Wednesday was a common pesticide brand that included imidacloprid.

Cathy Hebert, co-owner of Sunset Flowerland & Greenhouse, said she probably wouldn't have bought the pesticide if she'd known how harmful it is to bees.

Cathy Hebert, co-owner of Sunset Flowerland & Greenhouse said pesticides are important for greenhouses and large growers to produce crops of plants, and says the industry has responded to the need to inform consumers about potential harmful impacts. Staff photo by Jesse Scardina

Hebert, who operates 21 greenhouses at the Ridge Road business, said she is aware of pesticides that are considered harmful to bees, but she didn't know imadacloprid, the largest-selling pesticide in the country, was one of them.

“That’s one of the problems, (the pesticides) are coming in with this name,” Hebert said.

A nationwide study released this week said neonicotinoid, found in imadcloprid and other pesticides, kills honeybees as well as butterflies and birds. The study said that the pesticide is commonly found on plants sold at large retailers, such as Home Depot, Lowe’s and Walmart.

That study coincides with Environmental Protection Agency labeling standards that are beginning to take effect that more specifically say what’s in pesticides.

Representatives from Unity-based Maine Organic Gardener and Farmer’s Association bought four common landscaping plants from the two large home goods stores in Augusta — Home Depot and Lowe’s — as part of the study and found that three of them tested positive for neonicotinoid, or neonic, pesticides, deputy director Heather Spaulding said Wednesday.

Home Depot and Lowe’s both were quick to put out news releases Wednesday saying they comply, or plan to comply, with the federal regulations requiring that plants that use the pesticides are properly labeled.

“If giant purchasers of plants can demand that plants be neonic free, it can make an impact,” Spaulding said. “Applying systemic neonic pesticides is like taking antibiotics all the time to not get sick.”

The study, Gardeners Beware 2014, was led by the environmental advocacy group Friends of the Earth, and it focused on larger retailers because they make an impact on wholesale agricultural practices.

Neonic is a class of insecticides that can be harmful to honeybee colonies, and in 2013, the European Commission enacted a two-year ban on the use of the insecticide. One type of neonic insecticide commonly found in plants bought at the retail level is imidacloprid, the largest selling insecticide in the country, amounting over a billion dollars in sales in 2009, according to the Journal of Agricultural and Food Chemistry.

Yet, Hebert said, large-scale growing and greenhouse operations need some level of pesticide treatment.

“In a greenhouse environment, everything is protected, so insects can go rampant,” she said. “In a greenhouse environment, the bugs would go crazy. The plants would be destroyed.”

Hebert said that her family has owned and operated greenhouses since the 1950s as pesticide treatments have evolved with more research and studies.

“It’s becoming more aware,” she said. “We pay attention to the studies, and we try to do a lot more.”

Of the four different perennials MOFGA bought — two each from Home Depot and Lowe’s in Augusta — both flowers from Lowe’s tested positive for the insecticide, while one of the two from Home Depot tested positive.

Both national chains quickly issued statements Wednesday supporting the research and the recent Pollinator Health Task Force, established by the Obama administration to focus efforts on research aimed toward helping pollinating species such as bees recover from population declines.

Home Depot is taking steps to require live goods suppliers to label plants that have been treated with neonics by fourth quarter of 2014, according to Catherine Woodling, Home Depot’s corporate communications manager.

“We’re also glad to provide customers with alternative products for their insecticide needs and are actively working with our live goods suppliers to find alternative insecticides for protecting live goods and bees,” Woodling said in a statement.

Lowe's issued a statement stating it has been monitoring the latest science from various sources, including the U.S. Department of Agriculture and environmental groups. The statement also said the company expects all its vendors to abide by Environmental Protection Agency guidelines regarding insecticides.

In 2013, the EPA issued new labeling standards for neonic pesticides, including a Bee Advisory Box, that highlights the need to protect pollinators.

"This product can kill bees and other insect pollinators," the label states in bold, red lettering.

While those labeling changes are still months away from the marketplace in some instances, Spalding suggested that the best way for consumers to know what products have been used on plants is to simply ask.

"We encourage folks to talk to the garden center and be sure it's not in the soil," Spalding said.

Hebert said that not many customers ask for specific information such as the types of pesticides used; however, it's something they would answer.

"Not many people have approached us asking that, but we would talk to anyone about it," she said.

And while pollination will eventually limit a plants flowering ability, Hebert said bees play a vital role in vegetation and gardening.

"For seed production, you need the pollinators," she said. "How would I buy seeds if I don't have pollination?"

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NEWS Posted June 24 | Updated June 24

Study: Pesticides making 'bee-friendly' plants bee-killers

A press conference Wednesday in Portland will highlight the results of studies showing neonicotinoids, common in garden pesticides, are toxic to bees.

BY NORTH CAIRN PORTLAND PRESS HERALD
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centralmaine.com
KENNEBEC JOURNAL | Morning Sentinel

Wednesday in Portland shows that many home-garden plants, promoted as "bee-friendly," are pretreated with a class of pesticides that can kill bees and other pollinating insects.

Pesticide test results show that more than half of garden plants from major retailers in 18 cities in the U.S. and Canada, including Portland, contain neonicotinoids, commonly used garden pesticides that are toxic to bees and many other organisms, according to the study.

ADDITIONAL IMAGES

Erin MacGregor-Forbes, a master beekeeper, checks her hives in Portland. Many plants touted as "bee-friendly" are pretreated with a class of pesticides shown to harm and kill bees and other pollinating insects, according to a study to be released Wednesday at a press conference in Portland. *Portland Press Herald photo by Derek Davis*

The results will be made public by representatives of Friends of the Earth and Pesticide Research Institute, along with more than 20 consumer and environmental organizations and beekeeping and organic gardening associations, including Maine Organic Farmers and Gardeners Association. Of plant samples that tested positive for the pesticides, 40 percent contained two or more neonicotinoids.

The result of the widespread use of these pesticides means that many home gardens have likely become a source of harm for bees, the report concluded.

Test samples were gathered by environmental advocates from various organizations, beekeepers and researchers from various universities, said Tiffany Finck Haynes of Friends of the Earth. Testing of the samples was conducted by independent laboratories in each of the study cities in the U.S. and Canada, she said.

In addition, the damaging affects of these pesticides may be far more widespread than first thought, leaving a lasting imprint of injury to birds, mammals, humans and the soil, said a separate report released Tuesday in England, from the Bee Coalition, a collaboration of the main British environmental groups. The study, "Worldwide Integrated

Daily Reporter
Greenfield, Indiana

Ore. Agriculture Department adopts new pesticide rule to protect bees

THE ASSOCIATED PRESS
First Posted: June 26, 2014 - 11:38 pm
Last Updated: June 26, 2014 - 11:40 pm

SALEM, Oregon — Alarmed by multiple incidents of bee deaths this summer, the Oregon Agriculture Department has temporarily restricted the use of pesticides containing two active ingredients that are dangerous to bees.

In a statement Thursday, the department said it's banning the use of products containing dinotefuran and imidacloprid on linden and similar trees.

The agency says the rule applies to all users, including professional applicators and homeowners.

After high profile bee deaths last year, the Agriculture Department ordered that pesticide labels be revised for 2014 to note that use of the ingredients was prohibited on trees that bees like. However, the agency says two recent bee death incidents — in Eugene and in Beaverton — involved the use of product with an older label, which just noted that the product is highly toxic to bees.

The agency says its temporary rule goes into effect immediately and will be enforced for six months while it completes its bee death investigation.

The Agriculture Department last week suspended the pesticide license of the tree care service responsible for spraying an insecticide blamed for killing 1,000 bees at a Eugene apartment complex.

News
From the Oregon Department of Agriculture

ODA issues new pesticide restrictions to protect pollinators

June 26, 2014... The Oregon Department of Agriculture is taking additional steps to protect bees and other pollinators from exposure to specific pesticide products following multiple incidents of bee deaths this summer. In adopting a temporary rule, ODA is prohibiting the use of pesticide products containing the active ingredients dinotefuran and imidacloprid on linden trees or other species of Tilia.

The rule applies to all users, including professional applicators and homeowners.

"Although we took significant steps last year to restrict the use of these pesticide products, we've seen more cases involving bumblebees attracted to blooming linden trees and pesticide applications," says ODA Director Katy Coba. "In order to protect our pollinators, we feel it's important to adopt additional restrictions."

Last year, based on high profile incidents of bee deaths, ODA adopted a required label statement on pesticide products containing imidacloprid and dinotefuran prohibiting the application of these products on linden trees and other Tilia species. For 2014, newly-labeled products distributed into Oregon are required to state the restriction. Products with pre-2014 labels are still in commerce and, prior to the temporary rule, could be used when plants were not in bloom. Two recent incidents of large bee deaths– one in Eugene, the other in Beaverton– involved the use of imidacloprid products with an older label, which alerts the user that the product is "highly toxic to bees exposed to direct treatment or residues." To address confusion or misunderstanding caused by having two different label statements, ODA is simply prohibiting the application of any product containing imidacloprid or dinotefuran on linden, basswood, and other trees of Tilia species.

Failure to comply with the new rule could result in license suspension or revocation as well as imposition of a civil penalty.

The temporary rule, which goes into effect immediately, will be enforced for 180 days and will protect pollinators while allowing ODA to complete its investigation of recent bee death incidents as well as determine any future regulatory actions.

ODA is contacting all pesticide license holders in Oregon regarding the new rule and will continue to provide outreach and education on pollinator protection. Additional information can be found on the ODA website at <http://www.oregon.gov/ODA/PEST/Pages/Pollinator.aspx>.

Media contact: Bruce Pokarney, (503) 986-4559

From: Nancy Oden [mailto:cleanearth@tds.net]
Sent: Tuesday, June 24, 2014 10:14 PM
To: Jennings, Henry
Subject: Insecticides put world food supplies at risk, say scientists | Environment | The Guardian

Henry - Please put this article in Board's packets after you print it out. These are SCIENTISTS saying this, not me. thanks. - Nancy Oden
http://www.theguardian.com/environment/2014/jun/24/insecticides-world-food-supplies-risk

Insecticides put world food supplies at risk, say scientists

Regulations on pesticides have failed to prevent poisoning of almost all habitats, international team of scientists concludes

Damian Carrington
The Guardian, Monday 23 June 2014

Jump to comments (570)

Farmers use helicopters to spray insecticide and fertilizer on wheat crops in Henan province, China. Photograph: TPG/Getty Images

The world's most widely used insecticides have contaminated the environment across the planet so pervasively that global food production is at risk, according to a comprehensive scientific assessment of the chemicals' impacts.

The researchers compare their impact with that reported in Silent Spring, the landmark 1962 book by Rachel Carson that revealed the decimation of birds and insects by the blanket use of DDT and other pesticides and led to the modern environmental movement.

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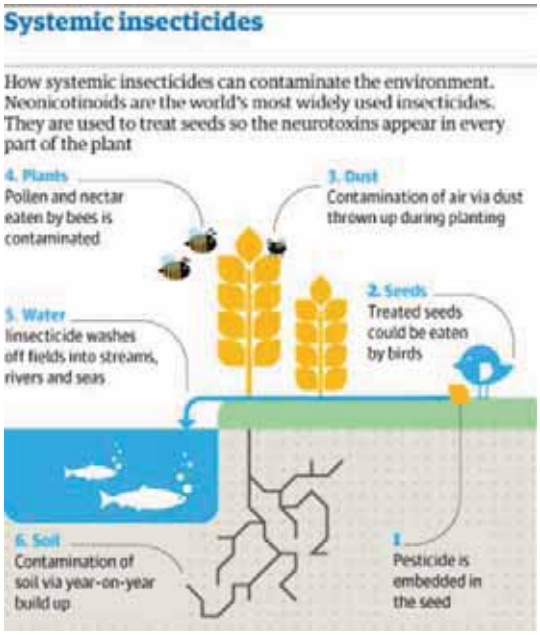
Do farmers really need bee-harming insecticides?
Syngenta says some farmers have no choice but to use banned neonicotinoids, which are linked to declining bee populations. But is it true that no alternatives exist? With your help, **Karl Mathiesen**

Billions of dollars' worth of the potent and long-lasting neurotoxins are sold every year but regulations have failed to prevent the poisoning of almost all habitats, the international team of scientists concluded in the most detailed study yet. As a result, they say, creatures essential to global food production – from bees to earthworms – are likely to be suffering grave harm and the chemicals must be phased out.

The new assessment analysed the risks associated with neonicotinoids, a class of insecticides on which farmers spend $2.6bn (£1.53bn) a year. Neonicotinoids are applied routinely rather than in response to pest attacks but the scientists highlight the "striking" lack of evidence that this leads to increased crop yields.

"The evidence is very clear. We are witnessing a threat to the productivity of our natural and farmed environment equivalent to that posed by organophosphates or DDT," said Jean-Marc Bonmatin, of the National Centre for Scientific Research (CNRS) in France, one of the 29 international researchers who conducted the four-year assessment. "Far from protecting food production, the use of neonicotinoid insecticides is threatening the very infrastructure which enables it." He said the chemicals imperilled food supplies by harming bees and other pollinators, which fertilise about three-quarters of the world's crops, and the organisms that create the healthy soils which the world's food requires in order to grow.



Systemic insecticides. Photograph: /Guim

Professor Dave Goulson, at the University of Sussex, another member of the team, said: "It is astonishing we have learned so little. After Silent Spring revealed the

investigates.

Syngenta seeks 'emergency' exemption to use banned insecticide on UK crops

Neonicotinoids are the new DDT killing the natural world

unfortunate side-effects of those chemicals, there was a big backlash. But we seem to have gone back to exactly what we were doing in the 1950s. It is just history repeating itself. The pervasive nature of these chemicals mean they are found everywhere now.

“If all our soils are toxic, that should really worry us, as soil is crucial to food production."

The assessment, published on Tuesday, cites the chemicals as a key factor in the decline of bees, alongside the loss of flower-rich habitats meadows and disease. The insecticides harm bees’ ability to navigate and learn, damage their immune systems and cut colony growth. In worms, which provide a critical role in aerating soil, exposure to the chemicals affects their ability to tunnel.

Dragonflies, which eat mosquitoes, and other creatures that live in water are also suffering, with some studies showing that ditchwater has become so contaminated it could be used directly as a lice-control pesticide.

The report warned that loss of insects may be linked to major declines in the birds that feed on them, though it also notes that eating just a few insecticide-treated seeds would kill birds directly.

One of the last living male dusky seaside sparrows is seen in this 1981 file photo while in captivity at Santa Fe Community College in Gainesville, Florida. DDT pesticide spraying since the 1940s contributed to the extinction of this species. Photograph: Nathan Benn/Corbis

“Overall, a compelling body of evidence has accumulated that clearly demonstrates that the wide-scale use of these persistent, water-soluble chemicals is having widespread, chronic impacts upon global biodiversity and is likely to be having major negative effects on ecosystem services such as pollination that are vital to food security,” the study concluded.

The report is being published as a special issue of the

peer-reviewed journal Environmental Science and Pollution Research and was funded by a charitable foundation run by the ethical bank Triodos.

The EU, opposed by the British government and the National Farmers Union, has already imposed a temporary three-year moratorium on the use of some neonicotinoids on some crops. This month US president Barack Obama ordered an urgent assessment of the impact of neonicotinoids on bees. But the insecticides are used all over the world on crops, as well as flea treatments in cats and dogs and to protect timber from termites.

However, the Crop Protection Association, which represents pesticide manufacturers, criticised the report. Nick von Westenholz, chief executive of the CPA, said: “It is a selective review of existing studies which highlighted worst-case scenarios, largely produced under laboratory conditions. As such, the publication does not represent a robust assessment of the safety of systemic pesticides under realistic conditions of use.”

Von Westenholz added: “Importantly, they have failed or neglected to look at the broad benefits provided by this technology and the fact that by maximising yields from land already under cultivation, more wild spaces are preserved for biodiversity. The crop protection industry takes its responsibility towards pollinators seriously. We recognise the vital role pollinators play in global food production.”

A Bulgarian beekeeper grabs dead bees during a demonstration in Sofia to call for a moratorium on the use of neonicotinoid pesticides in April. Photograph: Dimitar Dilkoff/AFP/Getty Images

The new report, called the Worldwide Integrated Assessment on Systemic Pesticides, analysed every peer-reviewed scientific paper on neonicotinoids and another insecticide called fipronil since they were first used in the mid-1990s. These chemicals are different from other pesticides because, instead of being sprayed

over crops, they are usually used to treat seeds. This means they are taken up by every part of the growing plant, including roots, leaves, pollen and nectar, providing multiple ways for other creatures to be exposed.

The scientists found that the use of the insecticides shows a “rapid increase” over the past decade and that the slow breakdown of the compounds and their ability to be washed off fields in water has led to “large-scale contamination”. The team states that current rules on use have failed to prevent dangerous levels building up in the environment.

Almost as concerning as what is known about neonicotinoids is what is not known, the researchers said. Most countries have no public data on the quantities or locations of the systemic pesticides being applied. The testing demanded by regulators to date has not determined the long-term effect of sub-lethal doses, nor has it assessed the impact of the combined impact of the cocktail of many pesticides encountered in most fields. The toxicity of neonicotinoids has only been established for very few of the species known to be exposed. For example, just four of the 25,000 known species of bee have been assessed. There is virtually no data on effects on reptiles or mammals.

From: Nancy Oden [mailto:cleanearth@tds.net]
Sent: Tuesday, June 24, 2014 10:17 PM
To: Jennings, Henry
Subject: Study further confirms link between autism and pesticide exposure | The Verge

Henry - Please also print out this article and put it Board's packets. No need to attach my name to either one of these articles.....hopefully they will look at them and maybe, perhaps, possibly, someday see the light - that is, that manmade chemical pesticides must be phased out because they're causing mass killing of earth's creatures. Thanks. - Nancy Oden
http://www.theverge.com/2014/6/23/5832142/study-further-confirms-link-between-autism-and-pesticide-exposure

http://www.theverge.com/2014/6/23/5832142/study-further-confirms-link-between-autism-and-pesticide-exposure

THE VERGE

Study further confirms link between autism and pesticide exposure

Living near farms and fields can put a fetus at risk

By Arielle Duhaime-Ross on June 23, 2014 12:01 am Email @ArielleDRoss 162**Comments**

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(Andrew Stawarz / Flickr)

Complications during pregnancy, viral infections, and genetic disorders have all been associated with autism. But for the past few years, an increasing number of researchers have started to focus their attention on another important risk factor: environmental pollutants. These neurotoxins, which include everything from pesticides, to mercury and diesel, are thought to alter brain development in fetuses. Now, a new study further confirms this link by showing that pregnant women who live within a mile of farms and fields where pesticides are employed see their risk of having a child with autism increase by 60 percent — and that risk actually doubles if the exposure occurs in the third trimester.

"Pesticides are one of the toxicants that appear to have the strongest association with autism," says Dan Rossignol, an autism expert at Jeff Bradstreet's International Child Development Resource Center in Florida who did not participate in the study, published today in *Environmental Health Perspectives*. These latest results, he says, "strengthen that association."

In the study, researchers linked data from the California Pesticide Use Report to the residential addresses of 970 children participating in the ongoing Childhood Autism Risks from Genes and Environment (CHARGE) study. This allowed the scientists to make connections between various developmental delays, and the types of chemicals that mothers may have been exposed to before conception, and during pregnancy. They also took note of prenatal vitamin intake, socio-economic status, and metabolic disorders during pregnancy to avoid interference by possible confounders.

the risk could go up "as much as threefold."

"Women who live within a mile of organophosphate or pyrethroids agricultural pesticide applications were more likely to have a child with autism spectrum than women living further away," said Janie Shelton, an epidemiologist at the University of California Davis and lead author of the study, in an email to *The Verge*. Currently, 1 in 68 American children have some form of autism spectrum disorder. But the risk could go up "as much as threefold" when women are exposed to organophosphates later in pregnancy, Shelton said. This means that scientists need to "investigate [these results] further, while taking preventive steps to decrease exposure to women during and just prior to conception."

For Rossignol, "the only type of study that would have been better" would have been a study "where women were followed before, during, after pregnancy — as well as their babies — to determine if, over time, those higher exposure to pesticides had a higher risk of autism." Richard Frye, an autism researcher at the University of Arkansas who was not involved in the study, agrees with Rossignol, and pointed out in an email that "there could be bias in the sample of patients because the participants volunteered for the study." This means that these participants are the kinds of people that that "seek medical care for their children" — which isn't necessarily representative of all parents. But overall, both scientists praised the study's design.

pregnant women should avoid contact with agricultural pesticides

Shelton and her team would like to continue the research — if they can get more funding. One of their goals is to find out if certain sub-groups are more vulnerable to pesticide exposure. But,

regardless of the outcome, Shelton thinks the message is clear: Pregnant women should avoid contact with agricultural pesticides.

"The neurotoxicity of many agricultural agents have been suspected from animal studies for sometime," Frye said, so "this information needs to be taken seriously for not only expecting women, but women who are planning to become pregnant." He thinks that taking steps to prevent autism and other developmental delays is "much better for society" than treating children "once they have been born with such abnormalities." But to do that, he said, we need to proactively educate mothers about the risks — and what they can do to fight back. "Simple things like proper nutrition and folate supplement [intake] is still suboptimal in some areas," but these are "simple factors that can have a large impact at preventing autism and developmental disorders."

- **Source** Environmental Health Perspectives

Mosquito spraying may have killed bees

Carcasses litter Wakefield school

By Yasmeen Abutaleb

| GLOBE CORRESPONDENT JULY 09, 2014

DAVID L RYAN/GLOBE STAFF

It is unclear what killed the insects, but several beekeepers across the state have experienced similar losses.

WAKEFIELD — Dead bumblebees littered the sidewalk in front of Wakefield's Saint Joseph School. Some were still dying, while others were found in clusters around trees and shrubs that decorated the front of the school.

One local homeowner reported seeing “hundreds if not thousands” of dead and dying bees over the weekend in an e-mail to the Pollinator Stewardship Council, a group that helps protect bees across the country.

While it is unclear what killed the insects, several beekeepers across the state have experienced similar losses — losing up to 10,000 bees at a time — which they have attributed to pesticide spraying.

At this time of year, communities often spray areas where mosquitoes breed to prevent the spread of mosquito-borne illnesses, such as West Nile virus and Eastern equine encephalitis. The pesticides typically contain toxic ingredients that kill bees and other insects and animals.

Saint Joseph has never sprayed pesticides on its plants or trees, said Alyne Flynn, a school administrator.

But the East Middlesex Mosquito Control Project, which oversees spraying in Wakefield, sprayed sumithrin on residential streets about 2 to 3 miles from Saint Joseph starting at 8:15 p.m. on three evenings last week, said David Henley, the group’s superintendent. The pesticide is also known by the brand name Anvil 10+10.

Henley said that mosquito control sprayed because trappings showed high numbers of mosquitoes, but the group has not identified disease-carrying insects.

Sumithrin is highly toxic to bees, specialists said, and it was sprayed when bees could still be out foraging for pollen. Bumblebees can travel up to 5 miles, so a traveling community could have become infected, leading to the rapid die-off, said Dr. Alex Lu, associate professor of environmental exposure biology at the Harvard School of Public Health.

“Sumithrin is not a good choice for mosquito control, especially in the area with dense population,” Lu said.

State health officials conduct aerial spraying of disease-carrying mosquitoes when they are most prevalent, which is typically in late July or August. The spraying has faced criticism from farmers and beekeepers who worry about the pesticide’s unintended victims.

Beekeepers across the country have also reported dramatic losses to pesticide control, Lu said, adding that bees are needed to pollinate nutritious foods such as apples, blueberries, and strawberries. Bees have been dying off in alarming numbers over the past several years, leaving the nation with too few hives.

“There have been mass bee deaths that have been unexplained,” said Kimberly Klibansky, a beekeeper in Rowley.

Klibansky and her husband, also a beekeeper, both lost whole hives in 2012, about 100,000 bees. “Farmers are going out to their fields and the bees are just gone,” she said. “There’s no evidence of dead bees at their hives.”

Lauren Mangarelli, an 8-year-old student at Saint Joseph, said she noticed many dead bees in the parking lot and in front of the school over the past couple of days.

“It’s kind of weird because I see them everywhere,” Mangarelli said. “It’s freaking me out. They’re everywhere, and we’re barefoot a lot, and I don’t want to step in them.”

Bee activists said local pesticide groups can work with farmers and beekeepers to protect both public health and bee populations by spraying pesticides only late at night when it is completely dark. Local governing bodies and the state can also allow some beekeepers to opt out of having areas near their hives sprayed, they said.

“Bees are the canary in the coal mine,” said Michele Colopy, program director of Pollinator Stewardship Council. “We understand that the public health concerns and protections will always trump concerns for non-target species, and beekeepers realize that, but there are ways we can work together to protect bees from mosquito spray.”

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***NATURE* | LETTER**

Declines in insectivorous birds are associated with high neonicotinoid concentrations

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Recent studies have shown that neonicotinoid insecticides have adverse effects on non-target invertebrate species[1, 2, 3, 4, 5, 6]. Invertebrates constitute a substantial part of the diet of many bird species during the breeding season and are indispensable for raising offspring[7]. We investigated the hypothesis that the most widely used neonicotinoid insecticide, imidacloprid, has a negative impact on insectivorous bird populations. Here we show that, in the Netherlands, local population trends were significantly more negative in areas with higher surface-water concentrations of imidacloprid. At imidacloprid concentrations of more than 20 nanograms per litre, bird populations tended to decline by 3.5 per cent on average annually. Additional analyses revealed that this spatial pattern of decline appeared only after the introduction of imidacloprid to the Netherlands, in the mid-1990s. We further show that the recent negative relationship remains after correcting for spatial differences in land-use changes that are known to affect bird populations in farmland. Our results suggest that the impact of neonicotinoids on the natural environment is even more substantial than has recently been reported and is reminiscent of the effects of persistent insecticides in the past. Future legislation should take into account the potential cascading effects of neonicotinoids on ecosystems.

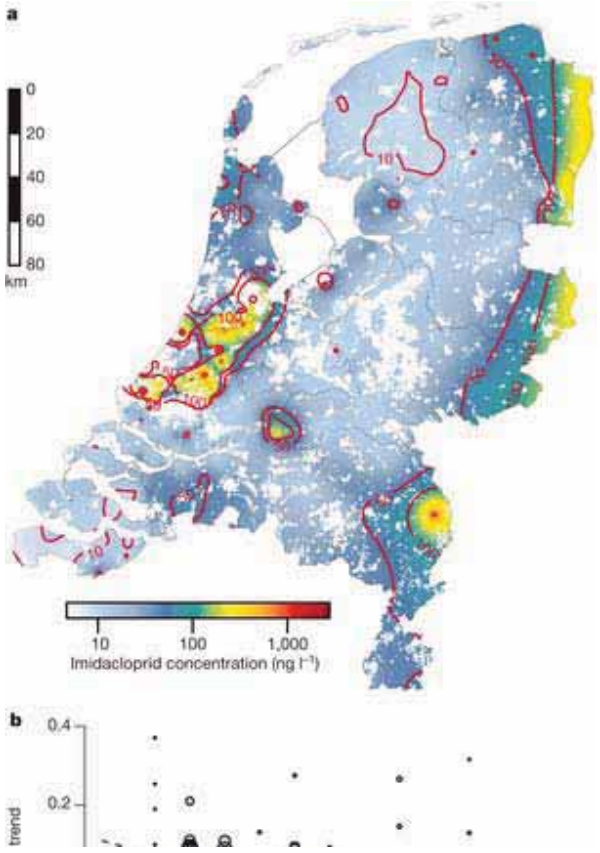
Main

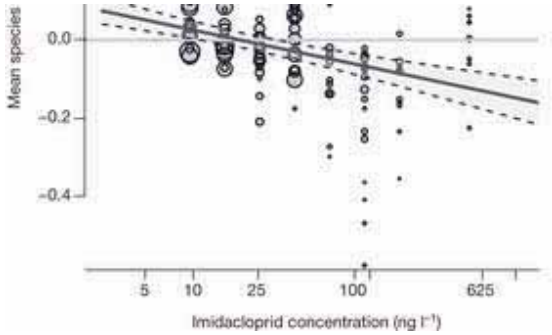
Although concerns have been raised about the direct effects of neonicotinoids on non-target vertebrate species[8], neonicotinoids are in general thought to be less harmful to mammals and birds than to insects. The main mode of action of neonicotinoids occurs through binding nicotinic acetylcholine receptors in the central nervous system of invertebrates[9], and neonicotinoids bind with substantially less affinity to these receptors in vertebrates[10]. This property has made neonicotinoids highly favoured agrochemicals worldwide over the past two decades[11]. In the Netherlands, imidacloprid was first administered by the Board for the Authorisation of Plant Protection Products and Biocides (Ctgb) in August 1994. Annual use increased rapidly from 668 kg in 1995 to 5,473 kg in 2000 and 6,332 kg in 2004 (ref. 12). Since 2003, imidacloprid has ranked consistently in the top three pesticides that exceed the environmental concentrations permitted by quality standards in the Netherlands[4, 13].

As neonicotinoids have relatively long half-lives in soil and are water soluble, they have the potential to accumulate in soils and to leach into surface water and ground water. Their systemic property (that is, their ability to spread through all of the tissues of the plants under treatment), together with their widespread use, indicates that many organisms in agricultural environments are likely to become exposed[8]. Indeed, studies have shown, both in experimental and in field conditions, that neonicotinoids may affect non-target invertebrate species across terrestrial and aquatic ecosystems[4, 5, 6]. The question remains, however, whether the effects are sufficiently severe to affect ecosystems through trophic interactions: that is, beyond the direct lethal and sublethal effects on individual species. In the past, the introduction of insecticides has caused prey-base collapses, which in turn affected avian populations[14, 15, 16], showing that pesticide-induced declines in invertebrate densities can cause food deprivation for birds. Thus, if natural insect communities are indeed affected by neonicotinoids to the extent of causing disruptions in the food chain, we may expect insectivorous bird species to be affected as well.

The present study takes advantage of two standardized, long-term, country-wide monitoring schemes in the Netherlands (see Methods)—the Dutch Common Breeding Bird Monitoring Scheme[17] and surface-water quality measurements[4]—to investigate the extent to which average concentrations of imidacloprid residues in the period 2003–2009 spatially correlate with bird population trends in the period 2003–2010. We selected 15 passerine species that are common in farmlands and depend on invertebrates during the breeding season (Extended Data Table 1 and Supplementary Methods). We interpolated concentrations of imidacloprid in surface water to bird monitoring plots (Extended Data Figs 1, 2, 3, Supplementary Data and Supplementary Methods) and examined how local bird trends correlate with these concentrations (Fig. 1).

Figure 1: Effect of imidacloprid on bird trends in the Netherlands.





a, Interpolated (universal kriging) mean logarithmic concentrations of imidacloprid in the Netherlands (2003–2009). **b**, Relationship between the average annual intrinsic rate of population increase over 15 passerine bird species and imidacloprid concentrations in Dutch surface water. Each point represents the average intrinsic rate of increase of a species over all plots in the same concentration class, whereas the size of the point is scaled proportionally to the number of species–plot combinations on which the calculated mean is based. Binning into classes was performed to reduce scatter noise and aid in visual interpretation. Actual analysis, and the depicted regression line, was performed on raw data (n = 1,459). The regression line is given by 0.1110 − 0.0374 (s.e.m. = 0.0066) × log[imidacloprid] (P < 0.0001). Dashed lines delineate the 95% confidence interval.

The average intrinsic rate of increase in local farmland bird populations was negatively affected by the concentration of imidacloprid (Fig. 1b, linear mixed effects regression (LMER): d.f. = 1,443, t = −5.64, P < 0.0001). At the separately tested individual species level, 14 out of 15 of the tested species had a negative response to interpolated imidacloprid concentrations, and 6 out of 15 had a significant negative response at the 95% confidence level after Bonferroni correction (Table 1 and Extended Data Fig. 4). Thus, higher concentrations of imidacloprid in surface water in the Netherlands are consistently associated with lower or negative population growth rates of passerine insectivorous bird populations. From our analysis, the imidacloprid concentration above which bird populations were in decline was 19.43 ± 0.03 ng l^{-1} (mean ± s.e.m.) (Fig. 1b). In areas with imidacloprid measurements above this concentration, bird populations declined by 3.5% on average annually.

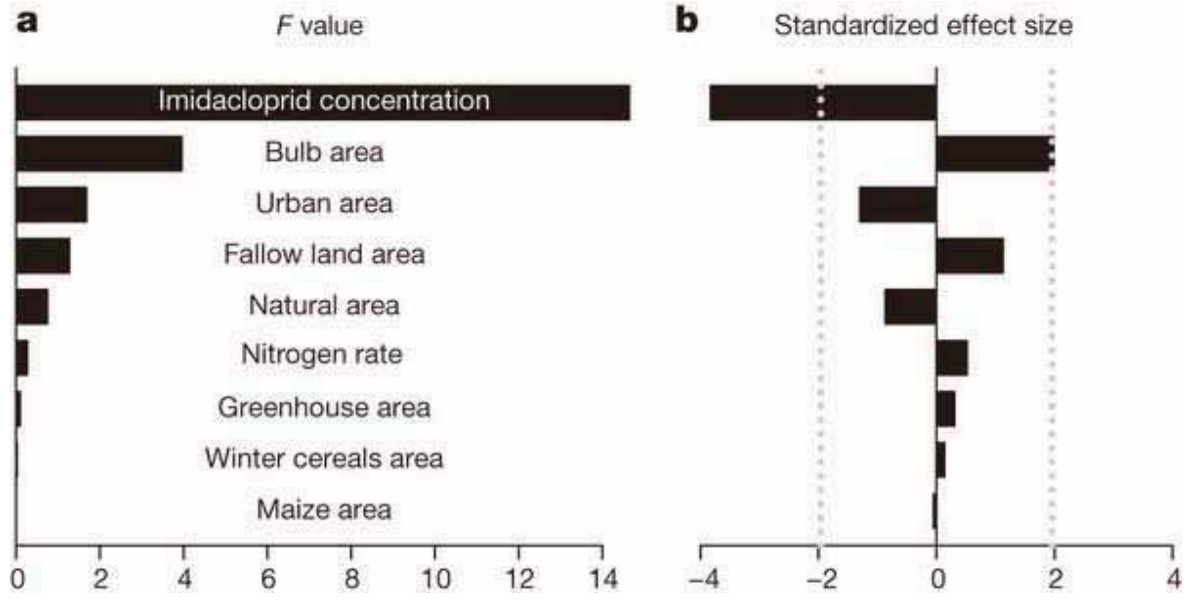
Table 1: Effect of imidacloprid on insectivorous bird species population trends

We checked whether two alternative explanations could have caused spurious correlations between imidacloprid concentrations and bird population trends over the period 2003–2010. First, it is possible that our results could simply reflect a spatial pattern of local farmland bird declines that started before the introduction of imidacloprid[18]. Therefore, we tested whether declines were present before the introduction of imidacloprid, in 1994. In contrast to the strongly negative relationship between imidacloprid concentration and bird population trends in 2003–2010 (Fig. 1b), the 2003–2009 imidacloprid concentrations were not significantly associated with bird trends in the period 1984–1995 (t = −1.43, P = 0.15 for $LMER_{<1995}$; t = −2.16, P = 0.031 for $LMER_{>2003}$; using plots only with trend data for both periods, d.f. = 365; see Extended Data Fig. 6 and Supplementary Methods). Overall, bird population trends in these two periods, paired by plot and species, were uncorrelated (r = −0.028, Pearson product moment test; t = −0.5455, d.f. = 379, P = 0.56). We can thus conclude that the spatial pattern observed does not reflect long-term ongoing local declines caused by other

factors. This finding suggests that imidacloprid is likely to have contributed to the declining population trend of the local birds.

Second, we tested whether spatial differences in land-use changes related to agricultural intensification confounded the effects of imidacloprid in our analyses. We performed multiple mixed effects regression analyses in which we included the local changes in land area use (urban area, natural area, and the production areas of maize, winter cereals and fallow land) and the amount of fertilizer applied (nitrogen in kg ha^{-1}) as fixed explanatory variables (see Supplementary Data), in addition to imidacloprid concentrations. These variables have been put forward frequently as causal factors related to farmland bird declines[19, 20, 21], although their major effect may have already occurred earlier in the twentieth century. As imidacloprid usage is likely to be related to horticulture and greenhouses[4], spatial changes in these variables may confound the effects of imidacloprid on bird trends. We therefore also incorporated changes in the area of greenhouses and the area of flower bulb production in our analysis. The results indicate that the concentration of imidacloprid and the changes in urban and natural areas were negatively correlated with local population trends, whereas the changes in the bulb and fallow land were positively correlated (Fig. 2). However, only imidacloprid and bulb area were significantly correlated with local trends (Extended Data Table 2).

Figure 2: Comparison of the effect of agricultural land-use changes and the effect of imidacloprid on bird population trends.



a, The marginal variance ratio (*F*) of each effect was estimated from a mixed effects model with all species data pooled. **b**, The standardized effect size (*t* value) for each covariate from the mixed effects model. The vertical dotted lines represent significance thresholds at $\alpha = 0.05$ (two-sided test). The imidacloprid concentrations and the proportional changes in bulb production areas were the only variables that had significant effects (LMER: d.f. = 1,349, $t = -3.825$, $P = 0.0001$ for imidacloprid; and $t = 1.989$, $P = 0.0468$ for bulbs).

So far, the suggested potential risks of neonicotinoids for birds have focused on the acute toxic effects caused by direct consumption[8]. Our results suggest another possibility: that is, that the depletion of insect food

resources has caused the observed relationships. Two lines of evidence seem to support this. First, 9 out of 15 species tested in the present study are exclusively insectivorous. All 15 species feed their young (almost) exclusively with invertebrates, and food demand is the highest in this period. Adult skylarks, tree sparrows, common starlings, yellowhammers, meadow pipits and mistle thrushes are also granivorous to some extent and may thus directly consume coated seed. However, meadow pipits and mistle thrushes forage on seeds only outside the breeding season, and for all 15 species the bulk of the diet during the breeding season consists of invertebrates[7]. Second, recent *in situ* research involving the same areas as the present study revealed strong declines in insect macrofauna, including species that have a larval stage in water, where imidacloprid concentrations were elevated[4]. These insects (particularly Diptera, Ephemeroptera, Odonata, Coleoptera and Hemiptera) are an important food source in the breeding season for the bird species that we investigated[7]. However, as our results are correlative, we cannot exclude other trophic or direct ways in which imidacloprid may have an effect on the bird population trends. Food resource depletion may not be the only or even the most important cause of decline. Other possible causes of decline include trophic accumulation of this neonicotinoid through consumption of contaminated invertebrates and, for the six partly granivorous species involved, sublethal or lethal effects through the ingestion of coated seeds[8]. The relative effect sizes of these pathways urgently need to be investigated.

Farmland birds have experienced tremendous population declines in Europe in the past three decades, with agricultural intensification as the primary causal factor[19, 20, 21, 22]. Among aspects of intensification, pesticides are known to be a major threat to farmland birds[15, 23, 24]. Neonicotinoids have recently replaced older intensively used insecticides such as carbamates, pyrethroids and organophosphates. After neonicotinoids were introduced to the Netherlands in the mid-1990s, their application was intensified, and the concentrations found in the environment frequently exceeded environmental standards, despite these concentrations being shown to have severe detrimental effects on several insect communities. Our results on the declines in bird populations suggest that neonicotinoids pose an even greater risk than has been anticipated. Cascading trophic effects deserve more attention in research on the ecosystem effects of this class of insecticides and must be taken into account in future legislation.

Methods

Data

We derived population trends for 15 insectivorous farmland passerine species (see Supplementary Data, Supplementary Methods and Extended Data Table 1 for the list of species) using long-term breeding bird data from the Dutch Common Breeding Bird Monitoring Scheme, a standardized[25, 26] monitoring scheme maintained and coordinated by Sovon, Dutch Centre for Field Ornithology, in collaboration with Statistics Netherlands[17]. The scheme has been running in the Netherlands since 1984. Data originating from these monitoring plots are generally considered to be adequately representative and reliable for population trend estimation[17, 18, 25, 27, 28]. The monitoring plots are well scattered throughout the Netherlands and range in size between 10 ha and 1,000 ha (Extended Data Fig. 2).

We used previously described information on imidacloprid concentrations in Dutch surface water[4]. This data set was collected by the Dutch waterboard authorities as part of the regular monitoring of surface-water

pesticide contamination[13] (see Supplementary Data for details). Imidacloprid concentration measurements throughout the Netherlands are available (Extended Data Fig. 1); hence, this data set is considered an adequate representation of the actual water contamination levels in the Netherlands. The geographical locations of the two monitoring programs do not generally spatially coincide. To combine the data sets, we interpolated imidacloprid concentrations from water quality measurement locations to bird monitoring plots (see Supplementary Data).

Statistical analysis

To assess the overall effects of expected concentrations on all species simultaneously, we used linear mixed effects models with species- and plot-specific population trends (intrinsic rates of increase or $log[\lambda]$) as the response, log[concentration of (interpolated) imidacloprid] as the fixed explanatory variable and species as a random factor. Additionally, we performed linear regressions of the population trends against the logarithm of the imidacloprid concentrations for each species separately using weighted least squares. The trends per plot were weighted by the mean species population size of the plot, to avoid the large influence of the demographic stochasticity of small populations. Population trends were calculated as the slope of log[territory counts] versus year of sampling (that is, a continuous trend) (see Supplementary Data). Regressions were performed using all monitoring plots located less than 5 km between the edge of a plot and an imidacloprid measurement location. This cut-off point of 5 km balanced the preferable proximity between bird and imidacloprid measurements with the amount of data retained in the analyses. However, regardless of how we varied the cut-off value between 1 and 25 km (that is, including between 7% and 99% of the bird monitoring plots, respectively), the effect size of imidacloprid on bird population trends remained strongly significantly negative (see Supplementary Methods and Extended Data Fig. 5). We examined potential confounding of the spatial imidacloprid concentrations with several different candidate explanatory variables that have been postulated as possible causes of farmland bird declines[19] and that are relevant to the Netherlands[17]. We used eight variables[12] that are potentially confounded with the introduction of imidacloprid: namely, proportional change in the area of maize, proportional change in winter cereal cropping area, proportional change in flower bulb area, change in the amount of fertilizer application (nitrogen in kg ha^{-1}), proportional change in greenhouse area, proportional change in urban area, proportional change in natural habitat area and proportional change in fallow land area (Supplementary Data). We compared the significance of all explanatory variables using a multiple mixed effects model (with species intercept as a random effect) paired with *F* tests based on single term deletions of the full model (Fig. 2a). In addition, we compared standardized effect sizes (coefficient/s.e.m.) between explanatory variables based on single species multiple linear regression models (Fig. 2b and Supplementary Methods).

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Contributions

C.A.H. performed the statistical analysis. C.A.H., R.P.B.F., C.A.M.v.T., H.d.K. and E.J. wrote the manuscript.

Competing financial interests

The authors declare no competing financial interests.

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Extended data figures and tables

Extended Data Figures

1. Extended Data Figure 1: Distribution of the 555 imidacloprid measurement averages over the period 2003–2009, as used in the main analysis. (471 KB)
   The data are taken from refs 4 and 13.

2. Extended Data Figure 2: Distribution of the 354 bird monitoring plots in the Netherlands. (233 KB)
   The figure depicts the spatial distribution of bird monitoring plots from which local species-specific trends were calculated.

3. Extended Data Figure 3: Spatial and serial (yearly) autocorrelation of imidacloprid measurements. (89 KB)
   a, Semivariance (dots) and Matern variogram model (fitted line) used in the interpolation of the concentrations (nugget = 0.1901, sill = 1.6989, range = 13.2 km). **b**, Serial correlation (between years) of imidacloprid concentrations. Each value gives the number of pairs of measurements at each year lag that were used to calculate the coefficients. Serial correlations remain invariant with respect to temporal lag, indicating high temporal consistency in local imidacloprid concentrations.

4. Extended Data Figure 4: Population trends as a function of imidacloprid concentration per individual bird species. (444 KB)
   The red lines depict the weighted mean trend, also given as slope coefficients (β) and with corresponding P values.

5. Extended Data Figure 5: Robustness check for the effect of the cut-off value for the distance between bird monitoring plots and water measurement locations (varied between 1 and 25 km). (106 KB)
   The larger the cut-off distance, the more species–plot annual rates of increase are retained in the analysis subset of the total database of 3,947 records (**a**) but at the cost of increased noise in the response and a decrease in the effect of imidacloprid on the bird trends (**b**). However, in all cases, the effect of imidacloprid was significant and negative ($P < 0.0001$).

6. Extended Data Figure 6: Bird species trends before and after imidacloprid introduction. (125 KB)
   Comparison of the relationship of bird species trends in the periods 1984–1995 (**a**) and 2003–2010

(**b**) with the imidacloprid concentrations in 2003–2009, based on all plots monitored in both time periods. Each point in the scatter plot represents the average intrinsic rate of increase of a species over all plots in the same concentration class. Binning into classes was performed to reduce scatter noise and aid in visual interpretation. The actual analyses and the depicted significant regression line were based on raw data. The bird trends were significantly affected by the imidacloprid concentration in 2003–2010 (t = −2.16, d.f. = 365, P = 0.031) but were not significantly affected in the period before imidacloprid administration (t = −1.43, d.f. = 365, P = 0.15).

Extended Data Tables

1. Extended Data Table 1: Species information (381 KB)

2. Extended Data Table 2: Multiple mixed effects regression of population trends (pooled over 15 species, n = 1,926) (353 KB)

Supplementary information

PDF files

1. Supplementary Information (158 KB)
   This file contains Supplementary Data, Supplementary Methods and Supplementary References.

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Chronic impairment of bumblebee natural foraging behaviour induced by sublethal pesticide exposure

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Summary

1. Insect pollination is a vital ecosystem service that maintains biodiversity and sustains agricultural crop yields. Social bees are essential insect pollinators, so it is concerning that their populations are in global decline.

2. Although pesticide exposure has been implicated as a possible cause for bee declines, we currently have a limited understanding of the risk these chemicals pose. Whilst environmental exposure to pesticides typically has non-lethal effects on individual bees, recent reports suggest that sublethal exposure can affect important behavioural traits such as foraging. However, at present, we know comparatively little about how natural foraging behaviour is impaired and the relative impacts of acute and chronic effects.

3. Using Radio-Frequency Identification (RFID) tagging technology, we examined how the day-to-day foraging patterns of bumblebees (*Bombus terrestris*) were affected when exposed to either a neonicotinoid (imidacloprid) and/or a pyrethroid (λ-cyhalothrin) independently and in combination over a four-week period. This is the first study to provide data on the impacts of combined and individual pesticide exposure on the temporal dynamics of foraging behaviour in the field over a prolonged period of time.

4. Our results show that neonicotinoid exposure has both acute and chronic effects on overall foraging activity. Whilst foragers from control colonies improved their pollen foraging performance as they gained experience, the performance of bees exposed to imidacloprid became worse: chronic behavioural impairment. We also found evidence, suggesting that pesticide exposure can change forager preferences for the flower types from which they collect pollen.

5. Our findings highlight the importance of considering prolonged exposure (which happens in the field) when assessing the risk that pesticides pose to bees. The effects of chronic pesticide exposure could have serious detrimental consequences for both colony survival and also the pollination services provided by these essential insect pollinators.

Key-words: bumble bee colony, crop pollination, imidacloprid, insect pollinator, lambda-cyhalothrin, neonicotinoid, pyrethroid

Introduction

Understanding and mitigating the causes of global insect pollinator declines has important consequences for food security and the global economy (Kremen & Ricketts 2000; Biesmeijer *et al.* 2006; Potts *et al.* 2010). Insect pollinators not only provide an essential ecosystem service for maintaining healthy and diverse wild plant populations (Ollerton, Winfree & Tarrant 2011), but also ensure effective pollination of *c.* 75% of agricultural crop species with an estimated global economic value of over $150 billion per annum (Gallai *et al.* 2009; Hein 2009). Social bees (honeybees, bumblebees and stingless bees) are key insect pollinators (Greenleaf & Kremen 2006; Winfree *et al.* 2007, 2008), so it is particularly worrying that populations have experienced significant declines in recent years (Oldroyd 2007; vanEngelsdorp *et al.* 2008; Goulson, Lye & Darvill 2008; Brown & Paxton 2009; Cameron *et al.* 2011; Burkle, Marlin & Knight 2013). Multiple factors have been implicated as causes of bee declines (Vanbergen *et al.* 2013) including habitat loss (e.g. Carvell *et al.* 2006; Kremen *et al.* 2007), pathogens and disease (e.g. Cox-Foster

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et al. 2007; Cameron *et al*. 2011; Meeus *et al*. 2011) and pesticides (e.g. Thompson 2001; Desneux, Decourtye & Delpuech 2007).

Although the risks posed by a 'pesticide exposure landscape' (Osborne 2012) have received a great deal of recent interest, we know comparatively little about the possible impacts that such chemicals may be having on individual bees, their colonies and populations (Godfray *et al*. 2014). As current agricultural practices rely heavily on pesticides to sustain high crop yields, insect pollinators can be exposed to multiple chemicals in the environment. Bees foraging on treated crops are exposed to pesticides both when they touch flowers (topical exposure) to extract nectar or pollen and when consuming these floral rewards (oral exposure). When these bees return to their nest, with pesticide residues on their cuticle and/or in the nectar or pollen they are carrying, other colony members (workers, males and the queen) and brood are also likely to be exposed. Indeed, recent studies report more than 30 different pesticides inside individual honeybee (*Apis mellifera*) colonies (Johnson *et al*. 2010; Mullin *et al*. 2010) and neonicotinoid residues in the nectar stores of bumblebee (*Bombus terrestris*) colonies placed in the field next to oilseed rape fields grown from untreated seed (Thompson *et al*. 2013). The level of pesticide to which bees are exposed depends on the amount applied to the target crop. Pesticide application guidelines are currently informed by a hazard quotient based on ecotoxicological tests assessing the lethal dosage (LD_{50}) for a range of indicator taxa (including *A. mellifera* as the only bee species). The objective is to provide application guidelines that kill target pests whilst avoiding lethal effects for essential insect pollinators, such as foraging bees. A growing criticism of this risk assessment procedure is that it does not consider potential sublethal effects (Thompson & Maus 2007), in spite of a growing body of evidence indicating that pesticide exposure, at levels found in treated crops, can lead to behavioural effects in bees (see Thompson 2003; Desneux, Decourtye & Delpuech 2007; Cresswell 2011; Blacquière *et al*. 2012; Gill, Ramos-Rodriguez & Raine 2012) and/or increase their susceptibility to parasites (Alaux *et al*. 2010; Vidau *et al*. 2011; Aufauvre *et al*. 2012; Pettis *et al*. 2012; Fauser-Misslin *et al*. 2014; but see Baron, Raine & Brown 2014).

Social bees rely on the cooperation of many individuals carrying out a multitude of tasks to ensure the colony functions efficiently. Foraging is a fundamental task because colony growth relies on a continuous food supply; therefore, any factors that impair foraging behaviour may have serious consequences for colony survival (Gill, Ramos-Rodriguez & Raine 2012; Bryden *et al*. 2013) and reproduction (Whitehorn *et al*. 2012). Laboratory and semi-field studies of honeybees indicate that exposure to field-realistic pesticide concentrations can cause neuronal inactivation (Palmer *et al*. 2013), affect motor function (Williamson *et al*. 2013), learning performance (e.g. Decourtye *et al*. 2004, 2005; Williamson & Wright 2013), communication (Eiri & Nieh 2012) and also impair homing ability and foraging behaviour (e.g. Yang *et al*. 2008; Mommaerts *et al*. 2010; Henry *et al*. 2012; Schneider *et al*. 2012; Fischer *et al*. 2014). However, the vast majority of studies to date have focused on the behavioural effects that follow acute exposure (i.e. within 48 hours), yet bees in the field are likely to be exposed to pesticide residues over extended periods of time (Garthwaite *et al*. 2012a,b). Therefore, it is important for us to increase our understanding of both the potential acute and chronic effects on individuals induced by prolonged exposure to field pesticide levels.

A recent study by Gill, Ramos-Rodriguez & Raine (2012) examined the effect of chronic exposure to two pesticides (a neonicotinoid and a pyrethroid) on bumblebee (*B. terrestris*) colonies. This study used pesticide exposure levels within the range found in the field, and bees were able to forage freely for pollen and nectar in the field. Using Radio-Frequency Identification (RFID) tagging technology, they collected detailed information on when individual foragers left and re-entered each colony and the amounts of pollen collected. These data showed that overall foraging performance was impaired after prolonged pesticide exposure (4 weeks) with knock-on effects for colony growth. Whilst this study was one of the first to quantify the impact of pesticides on natural foraging behaviour in insect pollinators, it did not report the temporal dynamics of behavioural impairment, nor did it discriminate between acute and chronic exposure effects. Such information is important because it (i) improves our understanding of how persistent sublethal pesticide exposure might affect the efficiency of beneficial pollinators; (ii) identifies whether subtle pesticide induced behavioural impairments might accumulate over time; and (iii) can be used to inform risk assessment protocols about the appropriate time period over which ecotoxicological testing should be conducted to detect sublethal effects and subsequently minimize the risks of pesticide exposure for foraging bees.

Here, we present a detailed analysis of the day-to-day foraging patterns of 259 *B. terrestris* foragers (Fig. 1) from 40 colonies over 28 days in the field. In this analysis, we examine how the temporal dynamics of foraging behaviour are affected following prolonged exposure to either a neonicotinoid (imidacloprid), a pyrethroid (λ-cyhalothrin), or the combination of both pesticides. Colonies were exposed to these two commonly used pesticides at levels approximating field exposure over a 4-week period (Gill, Ramos-Rodriguez & Raine 2012). Our results provide new insights, showing that prolonged pesticide exposure has both acute and chronic effects on fundamental aspects of forager behaviour and performance.

Materials and methods

EXPERIMENTAL SET-UP

The forty *B. terrestris* colonies used in the experiment each had a queen and an average of four workers (range = 0–10) at the start

Fig. 1. *Bombus terrestris* worker foraging on a Dahlia flower (photo: RJG).

of the experiment (day-0). These colony sizes reflect a realistic developmental stage of natural colonies when many agricultural crops come into flower in Europe (see Thompson 2001; Brittain & Potts 2011) and when the majority of pesticide treatments are applied (March to June: Garthwaite *et al*. 2012a,b). We used a split block design to control for variation in colony size. Before the experiment began, we ranked colonies by size according to the number of workers and pupae present, with the four highest ranked (largest) colonies being assigned to block 1, the next four highest ranked to block 2, and so on. Within each block, the four treatments [*n* colonies: control = 10; imidacloprid (*I*) = 10; λ-cyhalothrin (*LC*) = 10; imidacloprid and λ-cyhalothrin: mixed (*M*) = 10] were randomly assigned among the four colonies, and we confirmed there was no significant difference among treatments in colony size (Kruskal–Wallis: $H = 1{\cdot}79$, $P = 0{\cdot}62$).

Colonies were each housed in a two-chambered wooden nest box (28 × 16 × 11 cm). The rear chamber housed the nest (the 'brood chamber'), and a front chamber was used for pesticide exposure (the 'food chamber'). Colonies were kept at room temperature in a naturally lit laboratory throughout the experiment (although the brood chamber was covered when not being observed to mimic the darkness of a subterranean nest). Nest boxes were connected to the outside environment through an outlet tube leading to an exit hole in the laboratory window, allowing natural foraging behaviour. The laboratory is situated on the Royal Holloway University of London campus in Egham, Surrey (a 135 acre parkland site containing a diversity of wild and horticultural flowers), with further parkland areas, abundant privately owned gardens and some agricultural land adjacent to the campus within flight range of *B. terrestris*. Running the experiment from July onwards, however, minimized worker exposure to pesticides in the environment outside the laboratory as application to flowering crops visited by bees is low at this time of year (Garthwaite *et al*. 2012a,b), and the agricultural land within bumblebee flight range of campus did not contain a flowering crop during the experimental period.

Between the outlet tube and nest box were three sections of transparent Perspex tubing allowing us to observe the bees as they left or entered the nest box (setup described in Gill, Ramos-Rodriguez & Raine 2012). Between these three tube sections were two RFID readers that automatically monitored the passage of all tagged workers as they entered and left the colony. Two RFID readers were required per colony to establish whether the bee was entering or leaving the nest box, recording the tag (bee) ID number and exact time it passed underneath with at least 99% accuracy (Molet *et al*. 2008), with minimal disturbance to natural foraging patterns.

PESTICIDE TREATMENT

In the food chamber was a gravity feeder (used for the sucrose treatment) placed on a petri dish (90 mm diameter) lined with filter paper (used for the spray treatment). Bees did not have to collect sucrose solution from the feeder as they had free access to collect nectar from flowers in the field; nor did bees have to walk over the filter paper lining the petri dish as they had enough room to walk around the dish. Thus, all bees could choose to ignore the filter paper and sucrose solution feeder.

The feeder contained either a control sucrose solution (control and *LC* colonies) or 10 ppb imidacloprid sucrose solution (*I* and *M* colonies). This concentration falls within the range found in the pollen and nectar of flowering crops visited by bees (also see Gill, Ramos-Rodriguez & Raine 2012). During the experiment, the sucrose treatment was applied every 2 days (or 3 days over the weekends) between 13:00 and 14:00 ($n = 12$ feeder replenishments per colony during the 28-day period). We provided 10 mL of sucrose treatment per application in week 1, with a 2 mL increment at the start of each subsequent week (week 2 = 12 mL, week 3 = 14 mL and week 4 = 16 mL) to reflect an increase in colony demand as they developed. Before sucrose feeders were refilled, they were thoroughly rinsed and dried to remove any remaining residues.

The spray treatment was applied using a hand sprayer following the E.P.A. OPPTS 850:3030 application guidelines (http://www.regulations.gov/#!documentDetail;D = EPA-HQ-OPPT-2009-0154-0017). The filter paper received $0{\cdot}69 \pm 0{\cdot}05$ mL of either a control solution (control and *I* colonies) or a 37·5 ppm λ-cyhalothrin solution (*LC* and *M* colonies), the maximum label-guidance concentration for spray application to oilseed rape in the UK. Spray treatments were applied once at the start of each experimental week using a new piece of filter paper for each application. This follows label guidance for the minimum time period between re-applications of λ-cyhalothrin to crops (i.e. at least 7 days between spraying events and a maximum of four applications within the flowering season).

OBSERVATIONS AND MEASUREMENTS

Colony inspections, feeding and monitoring foraging performance

Colonies were inspected once per day from Monday to Saturday to assess the number of newly eclosed (callow) workers, the number of dead workers (removed and frozen) and queen condition. All dead workers and newly eclosed males ($n = 4$ males) were removed and frozen (−20 °C). The volume of sucrose solution we provided colonies was *c*. 50% of the sugar that would be typically brought back by foragers (assuming colonies having an average of 9–10 foragers and each foraging for 8 h day^{-1}: Peat & Goulson 2005; Raine & Chittka 2008; Gill, Ramos-Rodriguez & Raine 2012). Additionally, colonies were not provided with any pollen during the experiment. Therefore, bees had to collect all their pollen and *c*. 50% of their nectar (sugar) from real flowers in the field.

All workers present at the start of the experiment (precise age unknown) were individually tagged with RFID transponders glued

to the dorsal part of the thorax (for details see Supporting Information). Similarly, during the experiment, all newly eclosed workers were tagged within 1–3 days of eclosion (precise age known). In total, 854 workers were tagged, with each tag providing a unique (16-digit) code for unambiguous identification. We used separate sets of equipment (forceps and marking cages) to tag and handle the bees from each treatment to prevent artificial cross-contamination. Any workers that eclosed between day 26 and day 28 ($n = 206$) were not tagged, because they would be very unlikely to forage before the end of the experiment (Goulson 2010). Workers that lost their tag during the experiment ($n = 19$ bees: 2·2% of tagged individuals) were re-tagged with a new tag as soon as tag loss was observed. We classified a foraging bout as a period of at least five minutes between a worker leaving and re-entering a colony and specified that workers must perform at least four foraging bouts during the 28-day experiment to be considered a forager (see Gill, Ramos-Rodriguez & Raine 2012). We set this threshold to ensure that our analyses only included motivated foragers (excluding workers that only explored the tube or the vicinity outside the laboratory window).

Pollen foraging was observed for 1 h day^{-1} (5 days week^{-1}) for each colony. Observation periods were always two (*c.* 16:00) and 21 h (*c.* 10:00 the following day) after treatment application/renewal. We identified which individual workers brought back pollen loads by timing when they passed underneath the RFID readers (using a stopwatch synchronized with the RFID reader), and then matching this observed time with RFID records. We scored the amount of pollen in each forager's corbiculae (pollen baskets) as none (zero), small (score = 1), medium (score = 2) or large (score = 3) relative to the size of the worker. Scoring pollen loads using this method accounted for the fact that smaller workers are unable to carry as much pollen as larger workers because they have smaller corbiculae (Goulson *et al.* 2002; Spaethe & Weidenmüller 2002). In addition, we recorded the colour of all pollen loads collected using pollen identification cards (Kirk 2010) to help identify the source.

End of the experiment

Nest box entrances were closed after dark on day 28 and the colonies frozen. Window exits remained open for a further 18 h with each outlet tube connected to an individual bottle trap to catch any returning foragers. All tagged workers present in the frozen colonies were identified using their RFID tag, and all recently eclosed (untagged) workers were assumed to have developed in the colony in which they were found. Untagged workers (those that eclosed on, or after, day 26) were assumed to have eclosed on day 26 when analysing worker size. Worker size was assessed by measuring thorax width three times per bee using digital callipers and then averaging these values.

DATA ANALYSIS

Queen loss occurred in 14 colonies, either because the queen went outside and did not return (presumed to have got lost or died whilst out foraging) or the queen was found dead inside the nest box. In 11 colonies, queen loss occurred within the first 2 weeks (mean = day 6, range = day 2–day 9). We accounted for the effect of early queen loss by considering it as a potential explanatory factor in our statistical analyses, and previous analysis showed there was no effect of treatment on the loss of queens (Gill, Ramos-Rodriguez & Raine 2012). The remaining three colonies that experienced queen loss later in the experiment (mean = day 20, range = day 16–day 23) were pooled with queen-right colonies ($n = 3 + 26 = 29$ colonies). Two colonies did not survive the full 28 days (WB28 and WB32, both in the *M* treatment group) and were deemed to have failed (see Supporting information for details). Data from these two colonies were included in our analyses until the day they failed (from day 4, we included nine, and from day 9, we included eight *M* colonies).

When assessing both the daily number of foragers and the number of foraging bouts each forager performed, we included all foragers that had completed at least one foraging bout on that day. For analyses of foraging bout duration, we excluded the lower and upper extreme values for each treatment group (i.e. the shortest and the longest foraging bout) for each treatment group per day to normalize the data. For the analysis of successful pollen foraging bouts (in which pollen was observed in corbiculae), we included only those bouts in which a forager returned to the same colony it left (without visiting any other in between). The rationale for this was to match the bout duration from RFID records to the size of pollen load collected. However, when analysing the colour of pollen loads, we included all successful foraging bouts. Body size could only be obtained from individuals either present in colonies at the end of the experiment or found dead during the experiment.

The first step of the data analysis was to examine trends in foraging behaviour within each treatment group over the course of the experiment. To do this, we examined the relationship between specific foraging performance measures (number of foragers, number of foraging bouts and bout duration per day) and the time since the start of the experiment for all colonies within a treatment. Trends across treatment groups were then explored by comparing their respective regression slopes (β) from a linear regression. For analysis of pollen foraging, we calculated the mean size of pollen loads each forager collected per day. As pollen load size was scored on a four-point scale (0, 1, 2, and 3), we used a Spearman's rank correlation for each treatment. These analyses were carried out in MINITAB (v.13; State College, PA, USA).

To investigate potential differences over time among treatments, we carried out a linear mixed effects model (LMER function; R Core Development Team) with treatment (categorical), queen loss (categorical) and day (integer) as fixed factors, and block as a random factor. This analysis focused on weekly time points (week 1 = days 1–7; week 2 = days 8–14; week 3 = days 15–21; week 4 = days 22–28) because daily analysis of foraging behaviour is susceptible to natural stochastic variation in the timing of worker eclosion and forager death and/or losses outside the colony. For count data (number of foragers and foraging bouts), we used a Poisson distribution, with the *P*-value calculated from a *Z*-value. For pollen score data, we calculated the value as a proportion of the maximum possible load the forager could have collected. As the minimum load was 0 (no pollen) and maximum was 3 (large): we divided the average pollen load score by the range [=3] to give a proportional value. For our analysis of successful foraging bouts the minimum load considered in the analysis was small (score = 1) and the maximum load was large (score = 3). To obtain proportional values we subtracted 1 from each score, yielding adjusted values of 0 for small loads, 1 for medium loads and 2 for large loads. Taking these adjusted values, we then calculated the mean pollen load size per worker and divided this average value by the range [=2]. These proportional data were arcsine square-root transformed, and *P*-values from the LMER analysis were calculated from a *t*-value and associated degrees of freedom. Our analysis considered days to be nested within each week. For each day, we provided either a single value per colony (i.e. number of foragers), or a value per forager nested within colony (i.e. number of foraging bouts, foraging duration or pollen score per forager). To provide values for foraging bout duration, we took the average time across all foraging bouts completed by each forager per day, and to provide a load score, we calculated the mean score for all pollen loads brought back each day per forager.

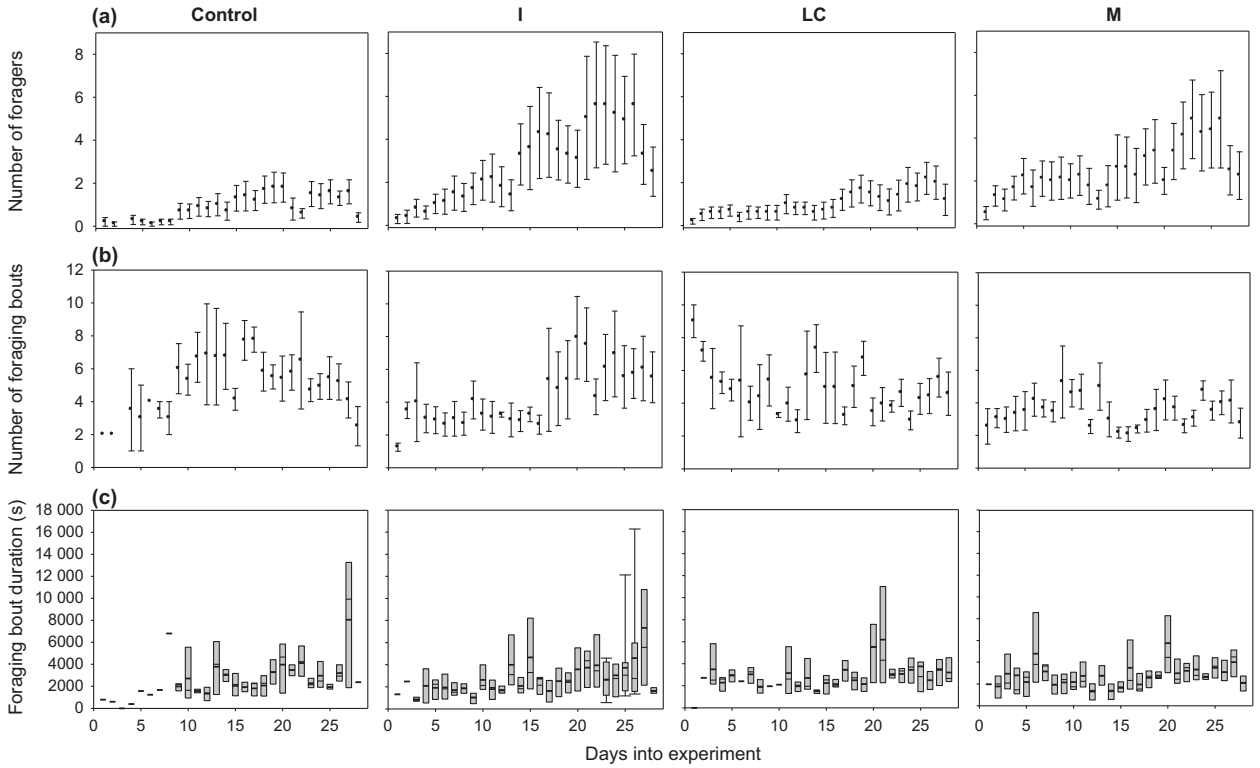

Fig. 2. Forager activity. Daily measure of foraging activity for all colonies in each treatment [left to right; control (n = 10); I = imidacloprid (n = 10); LC = λ-cyhalothrin (n = 10); M = mixed (days 1–3: n = 10; days 4–8: n = 9; days 9–28: n = 8)]. Row (a): mean (±SEM) number of foragers per colony per day. Row (b): mean (±SEM) number of foraging bouts carried out per colony (the value for each colony is the average number of foraging bouts carried out by foragers per day). Row (c): box and whisker plots (the thick and thin horizontal lines represent the mean and median values, the box indicates lower and upper quartiles, and whiskers represent 5% and 95% confidence limits) showing foraging bout duration (values per colony per day were obtained by taking the daily average duration of all foraging bouts carried out per forager, and averaging across all foragers).

Results

FORAGING ACTIVITY

Daily records of foraging activity (n = 259 foragers in total) showed a general increase in the average number of foragers per colony in all four treatments as the experiment progressed (linear regression: $F_{1,1074} = 64{\cdot}6$, $P < 0{\cdot}001$). We found that average colony size (defined as the cumulative number of workers eclosed minus those found dead) was positively correlated with the daily number of foragers as the experiment progressed (n = 40 colonies; linear regression: $F_{1,27} = 73{\cdot}4$, $P < 0{\cdot}001$; Fig. S1, Supporting information). The rate at which the number of foragers increased over time varied among treatments (Fig. 2a), with a greater rate of increase in I and M compared with LC and control colonies [linear regression with slopes (β): control: $\beta = 0{\cdot}053$, $F_{1,279} = 26{\cdot}6$, $P < 0{\cdot}001$; I: $\beta = 0{\cdot}180$, $F_{1,279} = 24{\cdot}9$, $P < 0{\cdot}001$; LC: $\beta = 0{\cdot}057$, $F_{1,279} = 25{\cdot}6$, $P < 0{\cdot}001$; M: $\beta = 0{\cdot}077$, $F_{1,234} = 11{\cdot}1$, $P = 0{\cdot}001$; Fig. S2a, Supporting information). There were already significantly higher numbers of foragers in I and M colonies compared with control colonies in week 1 of the experiment (LMER: $Z \geq 3{\cdot}44$, $P < 0{\cdot}001$; when excluding LC colonies), and these treatment differences remained significant for I and M colonies for the rest of the experiment ($Z \geq 2{\cdot}08$, $P \leq 0{\cdot}04$). In contrast, there was no significant difference between LC and control colonies in either weeks 2 or 3 ($Z \leq 1{\cdot}02$, $P \geq 0{\cdot}31$), but there was in week 4 ($Z = 2{\cdot}16$, $P = 0{\cdot}03$; see Table S1A for all analyses, Supporting information).

The number of foraging bouts carried out by foragers from control, LC and M colonies (Fig. 2b) remained relatively consistent throughout the experiment (linear regression: control: $\beta = -0{\cdot}0007$, $F_{1,110} = 0{\cdot}026$, $P = 0{\cdot}87$; LC: $\beta = -0{\cdot}004$, $F_{1,125} = 1{\cdot}50$, $P = 0{\cdot}22$; M: $\beta = 0{\cdot}0008$, $F_{1,155} = 0{\cdot}081$, $P = 0{\cdot}78$; Fig. S2b, Supporting information), whereas there was a steady increase in the daily number of foraging bouts carried out by I colonies (markedly from day 17; linear regression: $\beta = 0{\cdot}012$, $F_{1,157} = 10{\cdot}03$, $P < 0{\cdot}01$). There were no differences across all treatments in the daily number of foraging bouts performed during week 1 (LMER: $Z \leq 1{\cdot}57$, $P \geq 0{\cdot}12$). However, I foragers carried out significantly fewer foraging bouts than controls in week 2 (I: $Z = -6{\cdot}62$, $P < 0{\cdot}001$), LC foragers significantly fewer in weeks 2 and 4 ($Z \geq 2{\cdot}52$, $P \leq 0{\cdot}01$) and M foragers significantly fewer in weeks 2–4 ($Z \geq 3{\cdot}87$, $P < 0{\cdot}001$: Fig. 2b, Table S1B, Supporting information).

The average foraging bout duration increased significantly over time in all treatments (Fig. 2c; linear

regression: control: $\beta = 0{\cdot}014$, $F_{1,189} = 16{\cdot}4$, $P < 0{\cdot}001$; *I*: $\beta = 0{\cdot}013$, $F_{1,664} = 35{\cdot}1$, $P < 0{\cdot}001$; *LC*: $\beta = 0{\cdot}0050$, $F_{1,214} = 5{\cdot}3$, $P = 0{\cdot}02$; *M*: $\beta = 0{\cdot}0049$, $F_{1,155} = 7{\cdot}2$, $P < 0{\cdot}01$; Fig. S2c, Supporting information). When comparing across treatments we found that, on average, *LC* foragers carried out significantly longer foraging bouts than controls in week 1 ($t = 2{\cdot}99$, $P < 0{\cdot}01$) and *M* foragers carried out longer bouts than controls in weeks 1 and 4 ($t \geq 2{\cdot}37$, $P \leq 0{\cdot}02$: Table S1C, Supporting information).

POLLEN FORAGING

Due to the small size of colonies, we observed only 57 pollen foraging bouts during week 1 of which only two were performed by control foragers. This low control sample size meant that we could not compare pollen loads between treatments during week 1 due to lack of statistical power. The average size of pollen loads brought back by foragers (including foraging bouts with no pollen; Fig. 3a) showed no significant trend within treatment (Spearman's rank: control: 0·095, d.f. = 114, $P = 0{\cdot}31$; *I*: −0·089, d.f. = 349, $P = 0{\cdot}10$; *LC*: 0·068, d.f. = 118, $P = 0{\cdot}46$; *M*: −0·112, d.f. = 202, $P = 0{\cdot}11$). However, comparing among treatments, we found that *I* foragers collected less pollen than control foragers: although this difference was not quite significant in week 2 (LMER: $t = 1{\cdot}93$, $P = 0{\cdot}06$), *I* foragers brought back significantly less pollen in weeks 3 and 4 ($t \geq 4{\cdot}97$, $P < 0{\cdot}001$). Similarly, *M* foragers brought back significantly less pollen than controls in weeks 2–4 ($t \geq 2{\cdot}19$, $P \leq 0{\cdot}03$; Table S1D, Supporting information).

When examining the average size of pollen loads collected by 'successful' foragers (i.e. excluding all foraging bouts resulting in no pollen being brought back to the colony; Fig. 3b), we found no significant trend within treatment (Spearman's rank: control: 0·004, $P = 0{\cdot}98$; *I*: 0·15, $P = 0{\cdot}18$; *LC*: −0·20, $P = 0{\cdot}18$; *M*: 0·08, $P = 0{\cdot}54$). The only noteworthy difference among treatments was that *M* foragers brought back significantly smaller pollen loads than control foragers in week 2 (LMER: $t = 2{\cdot}64$, $P = 0{\cdot}01$; Table S1E, Supporting information). On average, successful foragers in control, *I* and *M* colonies took longer to collect pollen as the experiment progressed (linear regression: control: $\beta = 0{\cdot}016$, $F_{1,36} = 5{\cdot}4$, $P = 0{\cdot}03$; *I*: $\beta = 0{\cdot}013$, $F_{1,78} = 12{\cdot}4$, $P < 0{\cdot}01$; *M*: $\beta = 0{\cdot}008$, $F_{1,59} = 6{\cdot}1$, $P = 0{\cdot}02$; Fig. S3, Supporting information), with no change in mean bout duration in *LC* colonies

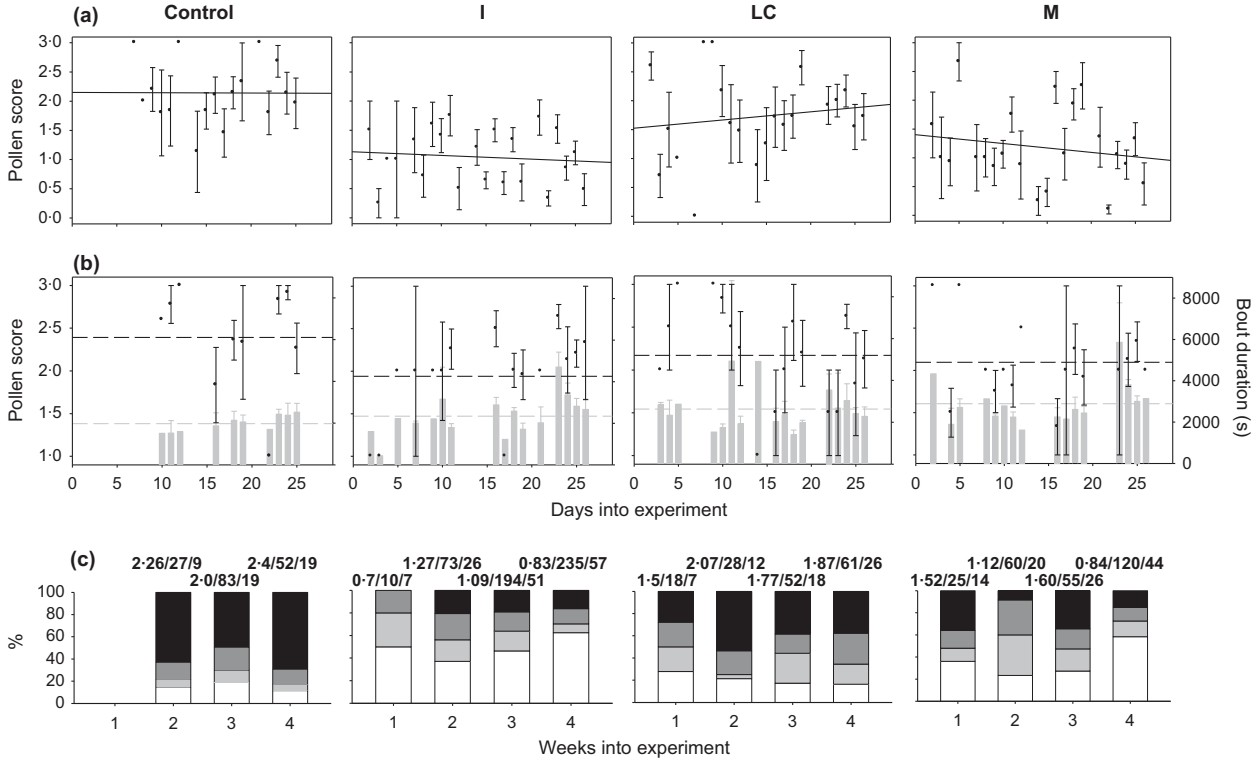

Fig. 3. Daily measures of pollen foraging performance by treatment. Row (a) Mean (±SEM) pollen load size brought back by all foragers per colony during foraging observations (total foragers/colonies: control = 30/7; *I* = 80/9; *LC* = 45/8; *M* = 75/7) with fitted regression line for comparison. Row (b) Mean (±SEM) pollen load size (scatter plot) brought back during successful pollen foraging bouts (i.e. all bouts from which bees returned with no pollen are excluded; total foraging bouts/foragers/colonies: control = 136/26/5; *I* = 243/66/8; *LC* = 129/40/6; *M* = 144/52/7). Columns represent mean (±SEM) duration of successful foraging bouts. Horizontal lines indicate mean pollen load size (black dashed line) and mean bout duration (grey dashed line) for all data points during the 4-week experiment. Rows (a) and (b): daily values for each colony were obtained by taking the mean score across all foraging bouts carried out by each forager, and then averaging across foragers. Row (c): The percentage of foraging bouts from which workers returned with either no pollen (score = zero; white), small pollen loads (score = 1; light grey), medium pollen loads (score = 2; dark grey) or large pollen loads (score = 3; black). Values above columns indicate the mean pollen score/total number of foraging bouts observed/number of foragers per week.

($\beta = 0{\cdot}00042$, $F_{1,44} = 0{\cdot}01$, $P = 0{\cdot}92$). Comparing bout durations across treatments, we found that *I* and *M* foragers did not differ from controls in either week 2 or 3 (*I*: $t \leq 1{\cdot}38$, $P \geq 0{\cdot}18$; *M*: $t \leq 1{\cdot}87$, $P \geq 0{\cdot}08$), but they took significantly longer to collect pollen in week 4 ($t \geq 2{\cdot}33$, $P \leq 0{\cdot}02$).

Compared with control, *I* and *M* foragers made 2·5 and 1·6 times more unsuccessful pollen foraging bouts in week 2, respectively, 2·4 and 1·4 times in week 3 and markedly increased to 5·4 and 5·1 more in week 4 (Fig. 3c; χ^2 test: week 2: $P = 0{\cdot}03$ and $P = 0{\cdot}36$; week 3: $P < 0{\cdot}001$ and $P = 0{\cdot}27$; week 4: $P < 0{\cdot}001$ and $P < 0{\cdot}001$; see Table S2A for all analyses, Supporting information). Furthermore, compared with control, *I* and *M* foragers brought back 3·1 and 7·6 times fewer large-sized pollen loads (score = 3) in week 2, 2·6 and 1·4 times fewer in week 3 and 4·3 and 4·6 times fewer in week 4 (Fig. 3c; χ^2 test: week 2: $P < 0{\cdot}001$ and $P < 0{\cdot}001$; week 3: $P < 0{\cdot}001$ and $P = 0{\cdot}09$; week 4: $P < 0{\cdot}001$ and $P < 0{\cdot}001$; see Table S2B for all analyses, Supporting information).

We identified 19 different colours of pollen from the 1093 loads we observed being brought into colonies during the experiment (Fig. S4, Table S3, Supporting information). Four of these colours represented 86% of all pollen loads, indicating that foragers were probably concentrating on four plant species (Fig. 4). These four colours were consistent with pollen load colours collected by honeybees from Dahlia spp. (DH), Himalayan Balsam *Impatiens glandulifera* (HB), Michaelmas Daisies *Aster* spp. (MD) and Oilseed rape *Brassica napus* (OSR). Whilst we cannot confirm unequivocally that the pollen originated from these species, we know that HB, DH and MD were flowering on the university campus. However, it is very unlikely that pollen was collected from OSR as it was not flowering during the experiment, thus we presume it came from another species that has a similar pollen colour. The percentage of foraging bouts returning with HB pollen was similar across all treatments (see Table S4A for details of analysis, Supporting information). In contrast, there was a striking difference in the preference for DH pollen across treatments: whilst it was only collected in 11% of the foraging bouts in both control and *LC* colonies, it was collected in 37% and 35% of foraging bouts in *I* and *M* colonies (control vs. *I*: $\chi^2 = 17{\cdot}1$, $P < 0{\cdot}001$; control vs. *M*: $\chi^2 = 13{\cdot}6$, $P < 0{\cdot}001$; Table S4B, Supporting information). Our results also suggest that *I*, *LC* and *M* colonies had a less strong preference for MD pollen compared with control colonies (Fig. 4; Table S4C, Supporting information), and whilst OSR pollen was hardly collected by control, *I* and *M* colonies (0–1·4% of foraging bouts), it was collected in 16% of *LC* colony pollen foraging bouts.

FORAGER AGE

Initially, we examined whether treatment affected the age at which workers first started foraging. Considering all workers that eclosed after the start of experiment, we found that the mean (±SEM) age to begin foraging across all treatments was $3{\cdot}8 \pm 0{\cdot}2$ days ($n = 214$ bees) after workers had been tagged (workers were tagged 1–3 days after eclosion) with no significant difference among treatments (mean ± SEM age in days: control = $3{\cdot}8 \pm 0{\cdot}4$; *I* = $3{\cdot}6 \pm 0{\cdot}3$; *LC* = $3{\cdot}6 \pm 0{\cdot}3$; *M* = $4{\cdot}2 \pm 0{\cdot}4$ LMER: $Z \leq 1{\cdot}32$, $P \geq 0{\cdot}19$). We then compared the total number of foraging bouts carried out by each worker and worker age when carrying out their last foraging bout to examine whether age was associated with level of foraging experience (considering only workers that eclosed after treatment started; $n = 212$ bees). We found a significant positive correlation between forager age and foraging experience either within each treatment (control: $\beta = 4{\cdot}8$, $F_{1,30} = 18{\cdot}0$, $P < 0{\cdot}001$; *I*: $\beta = 6{\cdot}0$, $F_{1,77} = 32{\cdot}6$, $P < 0{\cdot}001$; *LC*: $\beta = 2{\cdot}9$, $F_{1,39} = 14{\cdot}7$, $P < 0{\cdot}001$; *M*: $\beta = 2{\cdot}5$, $F_{1,65} = 18{\cdot}6$, $P < 0{\cdot}001$) or when analysing all foragers across treatments (linear regression: $F_{1,213} = 86{\cdot}7$, $P < 0{\cdot}001$). Subsequently, we examined whether the size of pollen load collected changed as foragers aged and whether this varied among treatments (Fig. 5). We found that older foragers from control colonies brought back significantly larger pollen loads (Spearman's rank coefficient: control: 0·19, d.f. = 112, $P = 0{\cdot}05$), whilst there was no change in load size with forager age in *LC* colonies (*LC*: 0·02, d.f. = 118, $P = 0{\cdot}81$). In contrast, we found a significant negative trend between pollen load size and forager age for both *I*

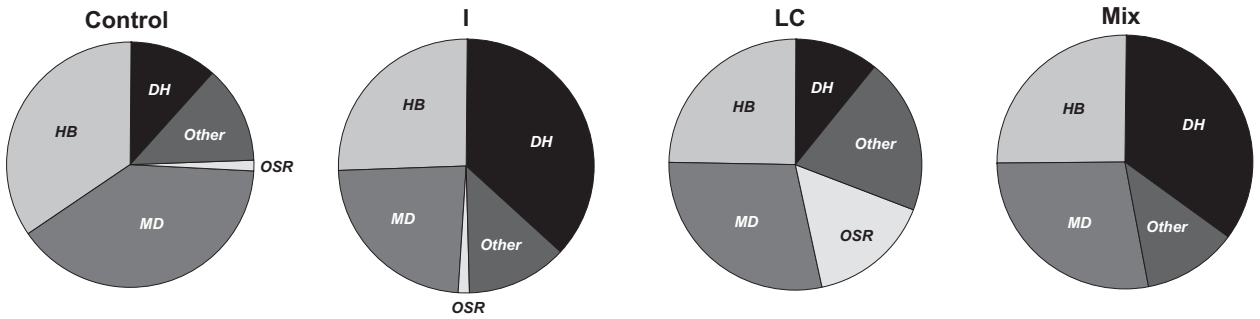

Fig. 4. Variation in pollen sources visited among treatment groups. Pie charts show the proportion of bouts in which bees visited each plant type based on pollen colour by treatment group: DH = Dahlia varieties; HB = Himalayan balsam; MD = Michaelmas daisies; OSR = Oilseed rape; Other = the 15 other identified pollen colours (see Supporting information for plant types representing 'Other').

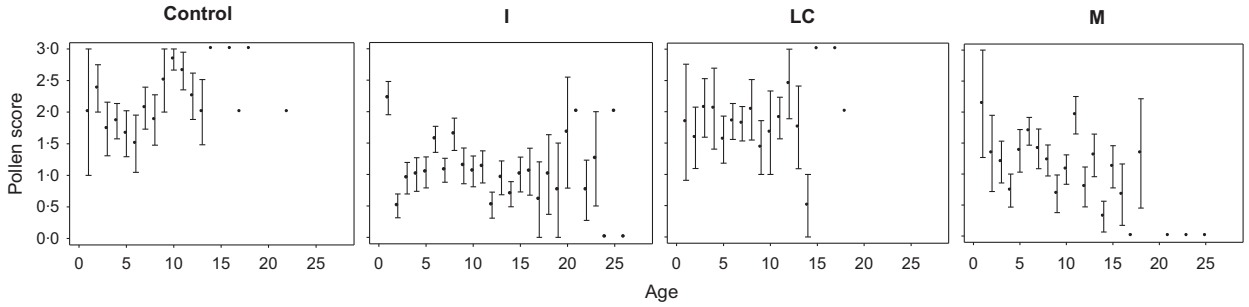

Fig. 5. Pollen foraging success as a function of forager age. Plots show the mean (±SEM) pollen score collected by foragers as they aged per treatment ['age' defined as the number of days after a worker had been Radio-Frequency Identification (RFID) tagged].

and *M* colonies (*I*: −0·12, d.f. = 343, $P = 0{\cdot}02$; *M* −0·16, d.f. = 200, $P = 0{\cdot}02$). We found a very similar pattern when we compared pollen load size with a measure of individual foraging experience (Fig. S5, Supporting information), defined by the number of days since each forager undertook its first foraging bout (Spearman's rank coefficient: control: 0·28, d.f. = 112, $P < 0{\cdot}01$; *I*: −0·09, d.f. = 343, $P = 0{\cdot}01$; *LC*: 0·046, d.f. = 118, $P = 0{\cdot}62$; *M*: −0·155, d.f. = 200, $P = 0{\cdot}03$).

WORKER SIZE

At the end of the experiment, the 40 colonies had produced 1060 workers [152 workers were present before the start ('pre-workers'), and 908 workers eclosed during the experiment ('eclosed workers')] of which we measured thorax widths for 808 individuals (67 pre-workers and 741 eclosed workers; the remaining 252 workers were either lost outside when foraging or were too decayed to measure accurately). We found no significant difference in worker body size between pre-workers and eclosed workers for control, *I* and *LC* colonies (control = 4·25 ± 0·12 vs. 4·10 ± 0·04 mm; *I* = 4·33 ± 0·11 vs. 4·23 ± 0·05 mm; *LC* = 4·42 ± 0·15 vs. 4·22 ± 0·04 mm; GLM: $F \leq 3{\cdot}31$, $P \geq 0{\cdot}07$), but in *M* colonies pre-workers were significantly larger than eclosed workers (mean ± SEM thorax width: 4·58 ± 0·09 vs. 4·16 ± 0·05 mm; GLM: d.f. = 1, $n_1 = 19$, $n_2 = 156$, $F = 8{\cdot}44$, $P < 0{\cdot}01$). There was no difference in the size of either pre-workers (LMER: $t \leq 0{\cdot}94$, $P \geq 0{\cdot}35$) or eclosed workers (LMER: $t \leq 1{\cdot}61$, $P \geq 0{\cdot}11$) among treatments. Intriguingly, however, eclosed worker size was more variable towards the end of the experiment compared with the start (coefficient of variation for workers that eclosed between days 1–7 vs. days 22–28: control = 0·130 vs. 0·182; *I* = 0·102 vs. 0·156; *LC* = 0·105 vs. 0·159; *M* = 0·124 vs. 0·152; also see Fig. S6, Supporting information).

We also examined whether the size of workers that became foragers varied as the experiment progressed (considering only eclosed workers; $n = 144$ foragers available to measure after the experiment). We found that average forager size increased as the experiment progressed in *I* and *LC* colonies (linear regression: *I*: $\beta = 0{\cdot}034$, $F_{1,32} = 4{\cdot}48$, $P = 0{\cdot}042$, *LC*: $\beta = 0{\cdot}021$, $F_{1,34} = 8{\cdot}42$, $P < 0{\cdot}01$). Forager size showed a positive (though not significant) trend over time in control colonies ($\beta = 0{\cdot}030$, $F_{1,43} = 3{\cdot}29$, $P = 0{\cdot}08$), with no clear trend for *M* colonies ($\beta = 0{\cdot}011$, $F_{1,31} = 0{\cdot}75$, $P = 0{\cdot}39$). There was also no significant difference when comparing forager size across all treatments per week [LMER: week 2: $t \leq 1{\cdot}23$, $P \geq 0{\cdot}23$; week 3: $t \leq 0{\cdot}89$, $P \geq 0{\cdot}38$; *NB* foragers that eclosed during weeks 1 and 4 could not be compared due to low sample size ($n = 20$ and 12 foragers available)].

Discussion

Our analyses provide valuable information about the acute and chronic effects of pesticide exposure on the temporal dynamics of bumblebee (*B. terrestris*) foraging in the field. Initial exposure to the neonicotinoid and pyrethroid pesticides (when colonies were at an early stage of development) had subtle, but detectable, effects on pollen foraging behaviour. However, prolonged exposure to these pesticides, particularly the neonicotinoid (imidacloprid), also resulted in significant chronic impairment of individual foraging performance.

We found that as colonies grew, the number of foragers per colony increased in all treatments; perhaps, an expected result given that colony growth increases both food demands (Pelletier & McNeil 2004; Lopez-Vaamonde *et al.* 2009) and the number of workers potentially available for foraging. However, colonies exposed to imidacloprid (*I* and *M*) had significantly higher numbers of foragers compared with control colonies in all 4 weeks of the experiment. A possible explanation could be that individual foragers were carrying out fewer foraging bouts, and subsequently colonies responded by recruiting more foragers to make up for this shortfall in food intake rate. Whilst *M* foragers did carry out significantly fewer foraging bouts than control foragers in weeks 2, 3 and 4, we found no such difference between *I* and control foragers throughout the whole experiment. These observations support the view that the increase in the number of workers going out to forage in *I* and *M* colonies during the early stages of this experiment is likely due to an acute effect of imidacloprid exposure on worker activity, rather than a colony response (increased worker recruitment). In other

words, it suggests that imidacloprid-exposed workers have a greater 'desire' to go out and forage. Imidacloprid is known to act as a neuronal partial agonist (Deglise, Grünewald & Gauthier 2002) that can acutely increase neuronal activity (Matsuda *et al*. 2001), which may explain why we observe increased forager activity (i.e. hyperactivity: Suchail, Guez & Belzunces 2001).

We also observed that the rate at which the number of foragers increased over time was greater in imidacloprid-exposed colonies (*I* and *M*) compared with control colonies, such that the number of foragers increasingly diverged from control levels during the experiment. Given that *I* and *M* colonies were similar in size to control colonies during the first two weeks and smaller during the latter 2 weeks (Gill, Ramos-Rodriguez & Raine 2012), this was not an effect due to differential colony size, showing that imidacloprid-treated colonies were allocating a higher proportion of workers to the task of foraging: an effect that became even more pronounced during the final 2 weeks of the experiment. Thus, in addition to the acute effect observed, prolonged exposure to imidacloprid appears to have a chronic effect on colony foraging activity. Given that the average age at which workers started foraging did not differ across treatments, this supports the view that imidacloprid-treated colonies were not selectively recruiting younger foragers, but recruiting a higher proportion of workers of all ages.

Our analysis also showed a decrease in pollen foraging efficiency of imidacloprid-exposed foragers (*I* and *M*), with their performance increasingly diverging away from that of control bees as the experiment progressed. On average, imidacloprid-exposed foragers brought back smaller pollen loads in week 4 than during the previous 3 weeks, suggesting this pesticide has a chronic effect on pollen foraging. Our findings support the hypothesis raised by Gill, Ramos-Rodriguez & Raine (2012), suggesting that increased forager recruitment and higher forager activity in imidacloprid-exposed colonies is a response to chronic impairment of individual pollen foraging ability.

The chronic effect on the size of pollen loads collected by foragers could be due to foraging performance of individual bees deteriorating with persistent pesticide exposure as adults, and/or that workers eclosing (and becoming foragers) later in the study were exposed for longer periods during brood development. In this study, we are unable to test the latter hypothesis because it was impossible to control the pesticide exposure for each individual (both during larval development or post-eclosion) or the age at which a forager first performed a foraging bout. However, our results provide support for the former hypothesis as prolonged adult pesticide exposure did significantly affect pollen foraging performance. In control colonies, foragers brought back larger pollen loads per bout as they got older, and more experienced (also see Fig. S5, Supporting information). These findings are consistent with a previous study showing that pollen collection rate increased with each subsequent bout for *B. terrestris* workers foraging on poppy flowers in a greenhouse (Raine & Chittka 2007a). However, our data go further to show longer-term individual improvement in pollen foraging efficiency over multiple days under field conditions. However, foragers exposed to pesticides did not show the same improvement in foraging performance. The pollen loads brought back by *LC* foragers did not increase in size as foragers got older, suggesting that prolonged exposure to λ-cyhalothrin may be preventing experience-dependent improvement in pollen foraging ability. Moreover, *I* and *M* foragers brought back smaller pollen loads as they gained experience, suggesting that exposure to imidacloprid results in deterioration of foraging performance with age and/or experience.

Analysing the colour of pollen loads collected by foragers (using pollen identification cards) revealed differences among treatments in the flowers visited. We found that imidacloprid-exposed colonies (*I* and *M*) had a significantly greater preference for Dahlia varieties, and a lower preference for Michaelmas Daisy and Himalayan Balsam than control foragers (Fig. 4). Whilst this study does not allow us to pinpoint the specific mechanism(s) underlying this differential preference, we suggest that imidacloprid could be affecting either individual forager's innate preference for specific flower types or colours (Raine & Chittka 2007b) and/or could be impairing their ability to find flowers, associate floral cues (as predictors of reward) or learn the motor skills required to handle specific flower types (Raine *et al*. 2006; Raine & Chittka 2008). For example, Dahlia varieties could be more abundant, easier to find and/or easier to extract pollen from than either Himalayan Balsam or Michaelmas Daisy. These hypotheses require further investigation, but previous research has reported that exposure to imidacloprid can affect bee learning performance (e.g. Decourtye *et al*. 2004; Williamson & Wright 2013) and flight ability and foraging behaviour (e.g. Yang *et al*. 2008; Mommaerts *et al*. 2010; Henry *et al*. 2012; Schneider *et al*. 2012; Fischer *et al*. 2014) all of which are important for successful foraging.

Whilst the size of workers was not affected by exposure to either imidacloprid or λ-cyhalothrin alone, the size of workers that eclosed in *M* colonies after the start of treatment with both pesticides were significantly smaller than workers present prior to pesticide application. These results suggest that multiple pesticide exposure can cause a decrease in the size of workers produced. In contrast, *B. terrestris* colonies chronically exposed to field-realistic levels of λ-cyhalothrin via spray-treated pollen, rather than walking across treated filter paper, show a significant reduction in worker body mass under *ad libitum* food conditions in the laboratory (Baron, Raine & Brown 2014). This suggests colony-level impacts of single pesticides could vary considerably depending on precise methods and profiles of exposure. Although we did not find an effect on the size of workers that became foragers during the 28 days of our experiment, the overall reduction in the size of workers eclosing in *M* colonies could eventually mean

smaller foragers being recruited later in the colony cycle. Large workers are more likely to forage, whereas smaller workers have a greater tendency to perform tasks within the nest (e.g. brood care Goulson *et al*. 2002; Jandt, Huang & Dornhaus 2009). This could in part be due to the fact that larger workers have greater visual acuity and antennal sensitivity which is important for foraging (Spaethe & Chittka 2003; Spaethe *et al*. 2007) and are able to carry much larger pollen loads per foraging trip (Goulson *et al*. 2002; Spaethe & Weidenmüller 2002). Taking this information together with our findings that *M* foragers carried out fewer foraging bouts and had chronically impaired pollen foraging ability, this suggests that multiple pesticide exposure can have a severe effect on the amount of pollen being brought into colonies after 3 or 4 weeks of exposure.

The acute and chronically impaired pollen foraging performance induced by neonicotinoid exposure shown in this study has implications for colony growth and survival. It is possible that colonies have sufficient redundancy in their worker force to be able to buffer the smaller acute effect of exposure that is either sporadic or lasts only a short time (i.e. 1–2 weeks) and/or if colonies are larger. But colonies are more likely to suffer significantly, and become more susceptible to colony failure, if exposure is persistent and/or colonies are smaller (Bryden *et al*. 2013). The increased number of foragers recruited in neonicotinoid-exposed colonies (*I* and *M*) seems to be a response to chronic impairment of the pollen foraging ability of individual bees, yet it is interesting that the rate at which forager numbers increased over time in *M* colonies was lower than for *I* colonies. A possible explanation for this is that *M* colonies were less able to recruit additional foragers compared with *I* colonies because of the additional effect(s) of λ-cyhalothrin exposure, such as a lower number of available workers due to increased mortality (Gill, Ramos-Rodriguez & Raine 2012).

In this experiment, we used early-stage colonies (containing an average of four workers) because this is the approximate size *B. terrestris* colonies are likely to be when a substantial amount of pesticides are applied to crops attractive to bees (Thompson 2001; Brittain & Potts 2011; Garthwaite *et al*. 2012a,b). Unlike perennial honeybee colonies, that overwinter as a colony and can start the spring with a work force of several thousand individuals, bumblebees have an annual life cycle in which newly produced gynes (unmated queens) emerge in the summer, mate and then hibernate alone overwinter. The following spring, these same queens must individually establish a new colony, requiring them to locate a suitable nest site, to produce and incubate at least their first batch of workers, and to forage extensively for nectar and pollen to feed themselves and their hungry offspring (Sladen 1912; Goulson 2010). In our experiment, we found that the queen from 11 of our 40 colonies went out to forage and subsequently did not return (even though workers were present in their colony nest box). In the earliest stages of nest searching and founding, queens will be flying around the landscape and are therefore likely to come into contact with pesticides when collecting nectar and pollen from treated crops. Such pesticide exposure could affect the queen's ability to return to the colony (e.g. Henry *et al*. 2012; Fischer *et al*. 2014), affect fecundity (e.g. Laycock *et al*. 2012; Elston, Thompson & Walters 2013) or impair nesting, brood rearing and/or foraging behaviour. Taking these possible impacts into consideration we might consider a lone queen performing this wide variety of tasks (without any workers to help) would be less able to buffer any detrimental effects of pesticide exposure with potentially serious consequences for future colony fitness (either through early queen loss or significant behavioural impairment).

Social bee colony (i.e. brood) development is reliant on a steady income of food from foraging workers. Pollen is the essential protein source required for brood development, in particular the rearing of gynes critical for the fitness of the colony (Sladen 1912; Free & Butler 1959). It is therefore concerning that we found a significant impact on pollen foraging performance. Indeed, just 2 weeks of imidacloprid exposure at a relatively early stage of colony development appears to be sufficient to significantly reduce the total number of gynes that were successfully reared by *B. terrestris* colonies 6 weeks later (Whitehorn *et al*. 2012). Our results provide a potential mechanism to explain these findings, and we also show that whilst imidacloprid exposure does not stop the flow of pollen into the colony, the rate at which it can be collected becomes reduced following a period of chronic exposure. Our findings also support the idea that even if colonies were able to continue recruiting foragers to compensate for impaired individual foraging efficiency, then other essential tasks may be affected. Therefore, it may not just be a lack of pollen but the knock-on effects to colony functioning as a whole, that cause reduced growth, survivorship and reproductive output in imidacloprid-exposed colonies (Gill, Ramos-Rodriguez & Raine 2012; Whitehorn *et al*. 2012; Bryden *et al*. 2013).

A concern for bees about the use of neonicotinoids is the systemic nature of their application, which means that pesticide residues are taken up by all tissues in treated plants including the nectar and pollen (Cresswell 2011; Blacquière *et al*. 2012). These residues can persist in the nectar and pollen for the entirety of the blooming period, meaning that bees are potentially exposed for long periods (likely >28 days of this study) during the year (Rortais *et al*. 2005; Halm *et al*. 2006). Moreover, neonicotinoid residues are known to be found in nearby non-agricultural plants (for example in field borders, Krupke *et al*. 2012) and have been found to persist in soils at high concentrations (see Goulson 2013). Therefore, to achieve a more complete understanding of the risk posed by specific pesticides, such as neonicotinoids, to bees (and other insect pollinators), it is imperative that we assess the exposure profile in the field. This does not simply mean measuring the concentration of pesticide to which bees are exposed at

a single time point (e.g. Mullin *et al*. 2010; Thompson *et al*. 2013), but understanding the likely frequency and duration of exposure in the field to single and multiple pesticides. Currently the honeybee is the only insect pollinator for which validated ecotoxicological testing protocols exist. Even for this species, higher tier semi-field and field studies are not designed to specifically assess potential sublethal chronic effects of plant protection products on individual bees (which could perhaps be revealed by monitoring activity patterns of individuals using RFID technology) and are unlikely to detect colony-level effects as monitoring periods during these studies are often relatively short. Pesticide regulatory bodies must consider the chronic effect of specific pesticides on foraging performance of bees (and other pollinators) not only as this is important for bee colony success, but also because it is likely have fundamental consequences for the essential pollination services they provide.

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Authors' contribution

RJG and NER designed and carried out the experiment and wrote the paper; RJG conducted data analysis; and NER conceived the project.

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Supporting Information

Additional Supporting information may be found in the online version of this article:

Data S1. Supporting methods and results.
Fig. S1. Forager number as a function of effective colony size.
Fig. S2. Daily measures of foraging activity per colony by treatment.
Fig. S3. Daily mean duration of successful pollen foraging bouts conducted by a single forager.
Fig. S4. Weekly analysis (weeks 2, 3 and 4) of pollen collected by foragers from different plant types represented as proportions of all observed successful pollen foraging bouts.
Fig. S5. Relationship between pollen load size brought back by foragers and previous forager experience per treatment.
Fig. S6. Box and whisker plots showing thorax width of workers that were present before pesticide treatment(s) started (pre-workers), and workers that eclosed during weeks 1, 2, 3 and 4 of the experiment (eclosed workers).
Table S1. Weekly analyses: statistical outputs from a Linear Mixed Effects model (LMER) are comparisons of treatment- with control colonies ('intercept').
Table S2. Weekly analyses: statistical outputs from pairwise chi-square tests (χ^2) comparing control against each treatment (*I*, LC and *M*) groups in terms of the proportion of foraging bouts in which (A) no pollen (unsuccessful) or (B) large pollen loads (size = 3) were collected.
Table S3. Diversity and frequency of pollen types collected by foragers from each treatment group.
Table S4. Statistical outputs from chi-square tests (χ^2) showing comparisons between control and treatment (*I*, LC and *M*) colonies.

NEWS

Posted **12:01 AM**
Updated at **6:57 AM**

Maine towns on lookout for signs of mosquito-borne viruses

With positive test results for West Nile and EEE coming in from other states, some think this might be a rough year here.

BY **NORTH CAIRN** STAFF WRITER
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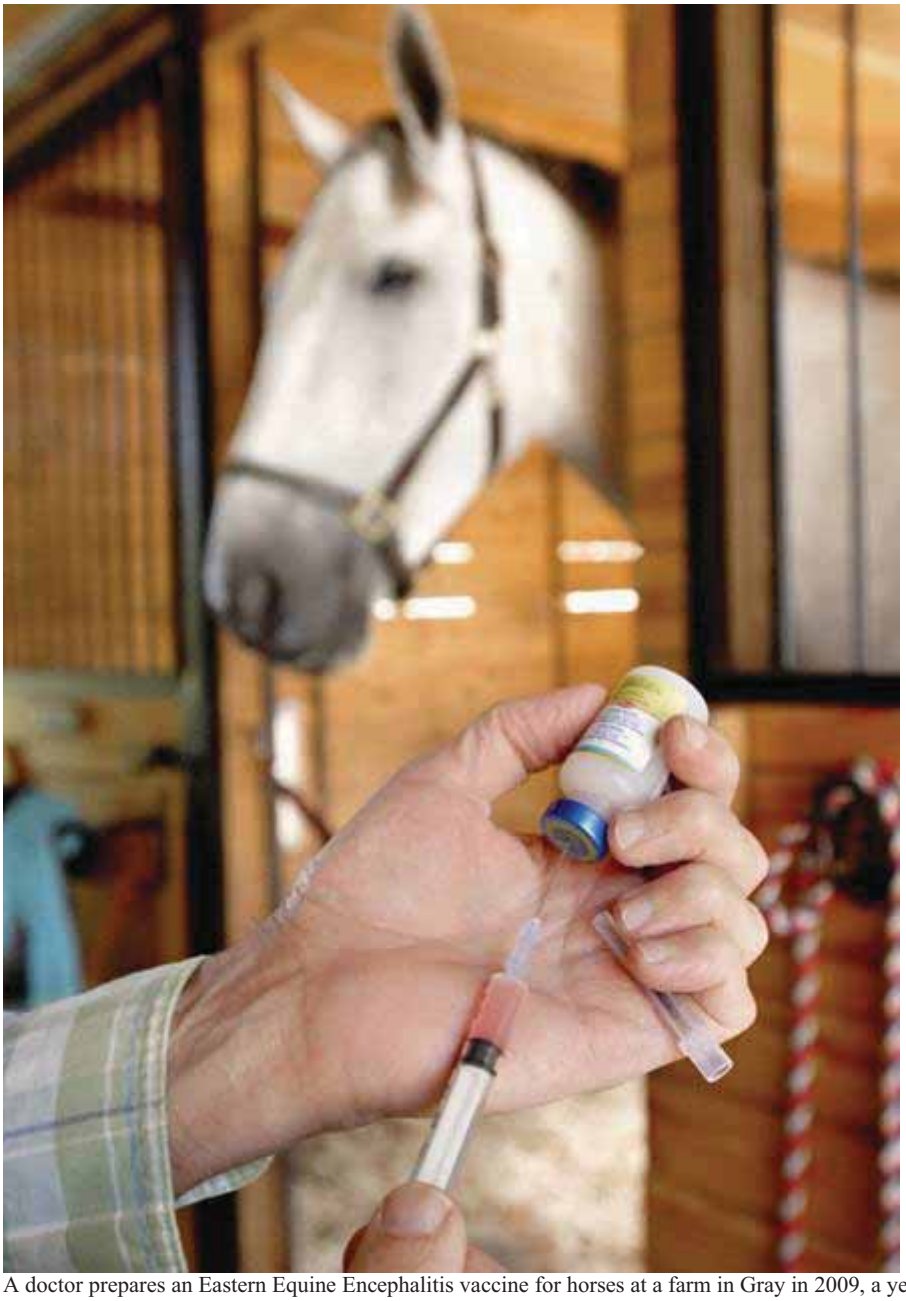
Prompted by recent positive test results for mosquito-borne diseases in other New England states, some Maine communities are gearing up for what some local officials fear might be a particularly nasty year for Eastern Equine Encephalitis and West Nile virus.

“We could be in for a bad year,” said Rob Yandow, town manager in York, where testing of mosquito pools was started June 1, about four to six weeks earlier than in many Maine towns and cities.

ADDITIONAL IMAGES



A doctor prepares an Eastern Equine Encephalitis vaccine for horses at a farm in Gray in 2009, a year when Maine experienced an unprecedented rate of EEE, which infected 19 animals. *2009 Press Herald file photo/John Patriquin*

In Maine, both viruses were first detected in 2001 in birds, and in 2012 – a particularly bad year for the viruses – the state reported the first human case of West Nile believed to be contracted here.

In New Hampshire, health officials this week identified two human cases of the mosquito-transmitted virus chikungunya in a couple who had been traveling in the Caribbean. Relatively rare and only recently detected in the U.S., this virus is seldom fatal but it can be debilitating, with symptoms that include headache, muscle pain, joint swelling and rash, according to the state's Department of Health and Human Services.

The earliest detection of EEE ever recorded in Vermont occurred June 17 at a mosquito test site in a county bordering Canada – surprising for being so early and so far north, health officials said.

High season for mosquito-borne diseases tends to run from July 15 through August, Maine health officials said. Some cases are still found in the fall before the first frost knocks down mosquito populations.

“We had a really bad year last year,” Yandow said. Tests of pools containing mosquito larvae in York last summer turned up more than two dozen positive results, the majority for EEE and about 25 percent for West Nile, he said.

“We had one mosquito pool that had both,” Yandow said.

Statewide, more than 25 testing sites are strategically located from southern Maine to Bangor, said Dr. Sheila Pinette, director of the Maine Center for Disease Control and Prevention. “We suspect that (EEE) is here already,” she said.

Over the course of the summer, she said, the state can test 1,000 pools. Test sites are chosen based on where livestock or wildlife, such as horses, deer and moose, have tested positive for viruses in the past.

In 2009, Maine experienced an unprecedented rate of EEE incidence with 19 animals and two mosquito pools testing positive for the virus. In fall 2008, a man vacationing in Cumberland County died of the disease, though it was never confirmed that he was infected while in Maine.

In 2013, Maine reported EEE in horses in Oxford and Somerset counties, as well as a horse, an emu, a pheasant and 26 mosquito pools in York County. Thirty pheasants in Lebanon died after being infected in 2012.

EEE is the more dangerous of the two viruses. It occurs in the eastern half of the nation, and causes disease in humans, horses and some bird species, according to the state CDC. Many people infected with EEE will experience no obvious symptoms. Those who do become ill may have symptoms ranging from mild-flu like illness to inflammation of the brain, coma and death. Among those developing severe cases of EEE, up to 33 percent die and most survivors suffer some brain damage, according to the federal Centers for Disease Control and Prevention.

West Nile occurs throughout the U.S., and has been prevalent in Southern states, particularly Texas, in recent years. It can cause disease in humans as well as birds and other mammals. Many

persons infected with West Nile virus will have no obvious symptoms. In those persons who do become ill, symptoms include headache, high fever, altered mental state, tremors, convulsions and rarely, paralysis. West Nile virus can also cause meningitis/encephalitis and be fatal.

“But no panic, no panic, no panic,” said Pinette. She emphasized that although the positive test result in Vermont was unusually early for that state, it reflected a consistent trend throughout New England over the past several years, with early detections found under very different conditions and habitats. In Maine, the first positive test in a mosquito pool generally is found at the end of July, she said.

Based on statewide and local history of the diseases in Maine and New England, Yandow issued what he now considers a routine precaution at the regular York Board of Selectmen’s meeting this week. The town began testing mosquito pools for EEE and West Nile virus about a month to six weeks early.

“We haven’t had a human case (ever),” Yandow said. “But it’s just a matter of time, I think.”

Other communities that have begun testing earlier than usual include Kittery, which with York is one of only two communities licensed by the state to use larvacide, a pesticide designed to kill mosquitoes before they reach their adult stage and begin to bite.

Mosquito-borne diseases are transmitted by infected insects through biting, which spreads the illnesses into human blood.

Lebanon, also in York County, is not testing or spraying at this point, said Cherry Lord, executive assistant to the city manager. “Typically, we don’t see it until mid- to late August,” she said.

Last year, Lebanon became the center of some public debate and controversy when officials authorized spraying near elementary schools as a preventive measure to protect children as young as 6 and through middle school. The spraying was deemed necessary, because the town’s two elementary schools are separated by a 100-foot-wide thicket of woods with a brook.

School officials in Lebanon were not available to comment Thursday on whether spraying might be considered this year, but the town does no testing. Only state test sites are set up there.

In nearby Sanford, testing has not yet begun, said City Manager Steven Buck. That community in the past has opted for a regional forum to promote public awareness, and in 2012 the school department sprayed around buildings and playing fields, he said.

Town and health officials emphasized the need for preventive measures in and around homes. People should avoid being outside at dawn or dusk, when the insects are especially active, and health officials recommend the proper use of insect repellents – synthetic or organic.

They advised residents to dispose of tin cans, plastic containers, ceramic pots or other water-holding containers. Leaf debris should be removed and brush trimmed to reduce mosquito-attracting habitat.

As the weather gets warmer, parents are advised to turn over plastic wading pools and wheelbarrows when they are not in use. It is recommended that birdbaths be kept clean – and empty when not in use.

Birds are also affected by the mosquito diseases. Health officials this year, as in the past, have asked that people report findings of three or more dead birds together in one location to the Maine CDC.

Parasites & Vectors IMPACT FACTOR 3.25

Research

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The effectiveness of permethrin-treated deer stations for control of the Lyme disease vector *Ixodes scapularis* on Cape Cod and the islands: a five-year experiment

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Abstract

Formula display: MathJax

Background

The use of animal host-targeted pesticide application to control blacklegged ticks, which transmit the Lyme disease bacterium between wildlife hosts and humans, is receiving increased attention as an approach to Lyme disease risk management. Included among the attractive features of host-targeted approaches is the reduced need for broad-scale pesticide usage. In the eastern USA, one of the best-known of these approaches is the corn-baited "4-poster" deer feeding station, so named because of the four pesticide-treated rollers that surround the bait troughs. Wildlife visitors to these devices receive an automatic topical application of acaricide, which kills attached ticks before they can reproduce. We conducted a 5-year controlled experiment to estimate the effects of 4-poster stations on tick populations in southeastern Massachusetts, where the incidence of Lyme disease is among the highest in the USA.

Methods

We deployed a total of forty-two 4-posters among seven treatment sites and sampled for nymph and adult ticks at these sites and at seven untreated control sites during each year of the study. Study sites were distributed among Cape Cod, Martha's Vineyard, and Nantucket. The density of 4-poster deployment was lower than in previous 4-poster studies and resembled or possibly exceeded the levels of effort considered by county experts to be feasible for Lyme disease risk managers.

Results

Relative to controls, blacklegged tick abundance at treated sites was reduced by approximately 8.4%, which is considerably less than in previous 4-poster studies.

Conclusions

In addition to the longer duration and greater replication in our study compared to others, possible but still incomplete explanations for the smaller impact we observed include the lower density of 4-poster deployment as well as landscape and mammalian community characteristics that may complicate the ecological relationship between white-tailed deer and blacklegged tick populations.

Keywords: *Ixodes scapularis*; Tick; Permethrin; 4-poster; Feeding station; Host-targeted control; Lyme disease; *Borrelia burgdorferi*; *Odocoileus virginianus*; White-tailed deer; Blacklegged tick

Background

Blacklegged ticks (*Ixodes scapularis*) are the primary vector of Lyme disease between wildlife and human populations in eastern North America, so their abundance during periods of outdoor human activity is a key determinant of Lyme disease risk [1]. Methods to control this abundance are the focus of this study. Another key determinant, which we do not address, is the proportion of these ticks that are infected with the Lyme disease bacterium, *Borrelia burgdorferi.* The biology of this spirochete and the multi-host two year life cycle of blacklegged ticks have produced a highly complex ecological system that continues to challenge ecologists, public health experts, natural resource managers, integrated pest management (IPM) practitioners, and land use planners. Risk management solutions are in various stages of development, some of which require changes in land use practices or the use of biocontrol agents or pesticides that may be harmful to non-target organisms. However, because of the complexity of the Lyme disease ecological system [2] and the limitations and potentially negative impacts of sole reliance on

any single available method, it is likely that successful control strategies will require judicious application of an integrated approach consisting of multiple tactics. This necessitates knowledge about the efficacy of specific techniques in varying ecological settings.

White-tailed deer (*Odocoileus virginianus*) are important hosts for adult blacklegged ticks seeking bloodmeals, so their overabundance in the eastern US was historically assumed to be a significant determinant of Lyme disease risk [3]. Massachusetts, like other northeastern states, has seen dramatic increases in white-tailed deer populations. The Massachusetts Audubon Society estimates that fewer than 1000 white-tailed deer existed in the state in 1900; the current estimate is 90,000 (~4.5 km^{-2}) [4]. Extirpation of natural predators and increases in forage associated with forest clearing are considered the primary long-term drivers of deer overabundance, with restrictions on hunting in developed areas playing an increasingly important role (reviewed in [5]). However, there is little consensus on the feasibility or effectiveness of specific management techniques for deer population control [6]. Moreover, the mandates of private organizations and local, state, and federal managers of deer and their habitats frequently conflict in ways that complicate coordination [7]. These challenges are exacerbated by the considerable uncertainty about the impact of deer abundance on Lyme disease risk (reviewed in [2]).

As an alternative to direct population control of white-tailed deer, the use of deer-targeted pesticide application via "4-poster" feeding stations to control tick populations is now included among the risk management techniques being tested and in some cases implemented in areas of high Lyme disease incidence [8]. Because of their intended host specificity, 4-posters have the potential to reduce Lyme disease incidence as well as to reduce reliance on residential practices such as broad-spectrum acaricide application. To address the keen interest in quantifying 4-poster effectiveness, we conducted a 5-year controlled study of their effects on blacklegged tick populations on Cape Cod, Nantucket, and Martha's Vineyard, all of which are in coastal Massachusetts.

White-tailed deer frequently carry heavy burdens of adult stage blacklegged ticks seeking their final blood meal. However, blacklegged ticks have a complex life cycle involving multiple hosts (reviewed in [2]). After feeding to repletion, mated female ticks overwinter and deposit their eggs in the spring. On Cape Cod, deposited eggs typically hatch into larvae in late July and early August and then seek their first blood meal. If this search results in a blood meal from a host infected with the Lyme disease bacterium, *Borrelia burgdorferi,* and if transmission occurs, then the larva becomes infected. After feeding to repletion, larvae moult into nymphs. After overwintering, each nymph seeks a new host for what is typically the second blood meal in its life cycle. This second host is an additional opportunity for the tick to acquire the Lyme disease spirochete. In late summer, these nymphs moult into the adult stage and seek their final blood meal. All stages of feeding ticks are potentially affected by exposure of their hosts to 4-poster treatments, but this exposure is expected to be highest for adult ticks because of their relatively high abundance on large vertebrates. The impacts of 4-posters include direct mortality to larvae or nymphs attached to 4-poster visitors and reduced numbers of eggs due to reductions in adult populations. Our study was designed to estimate the magnitude of these effects by repeated sampling of nymph and adult ticks at 4-poster sites and untreated control sites.

Several previous studies have reported large reductions in tick abundance in areas treated with 4-posters relative to untreated control areas. Most notably, a coordinated six-year study in the northeastern US reported approximately 70% reduction in nymphs at the end of the study [9-13]. Only one of the five separately published studies contained independent within-site replication, so meta-analysis of the five sites became an important basis for inference about 4-poster effectiveness. Although the meta-analysis by Brei *et al*. [12] appears to have treated multiple samples from each site as statistically independent samples, the results at the northeast regional scale are compelling.

The northeast regional study deployed > 100 4-posters across its five study areas at a density of 4 to 5 stations km^{-2} (0.016 stations $acre^{-1}$). We were interested in estimating 4-poster efficacy for coastal southeastern Massachusetts and used a single controlled experiment with site replication. We expected our study to produce a geographically narrower but more statistically robust confirmation of the broader regional findings reported by Pound *et al*.[11]. In addition, we sought to refine design considerations for longer term deployment of 4-poster devices in southeastern Massachusetts. Given the rapid and dramatic effects seen in previous studies, we anticipated that 4-poster deployment at 1–2 stations km^{-2} (< 0.007 stations $acre^{-1}$), or approximately 40% of the density used in the northeast regional study, would produce measurable effects at a more feasible deployment density for area resource managers.

We conducted our 4-poster study in southeastern Massachusetts, where Lyme disease poses a serious health risk. Massachusetts ranks among the top 10 states in Lyme disease annual reporting to the US Centers for Disease Control [14]. In recent reporting, these top 10 states accounted for more than 93% of the total cases reported nationally over the 15 yr period documented in the report. Two counties in the region of southeastern Massachusetts where our study was conducted were among the top 10 counties nationally for average rate of Lyme disease incidence (reported cases) during the period 1997–2006 [14]. Our study was motivated by these factors and the need for environmentally sustainable management practices for reducing Lyme disease risk.

Methods

Deer 4-poster stations were activated in the fall of 2007 (mid August to mid November) and in spring (mid March to mid June) and fall of all subsequent years (2008–2011) at precisely the same locations each year (within 2 m of initial locations). Closure of stations during winter was partly the result of regulations prohibiting wildlife provisioning during the hunting season. At each site, multiple stations were distributed at approximately one station per 150 acres (1.65 stations km^{-2}), based in part on results from previous studies [15].

Selection of sites for this study was based on: 1) history of an active blacklegged tick population; 2) evidence of white tailed deer; 3) accessibility for maintenance and input of corn bait and permethrin; and 4) distance from residences (> 91 m). This resulted in seven treatment sites on Nantucket, Martha's Vineyard and Cape Cod (Figure 1). Comparable control sites (i.e., without 4-poster stations) were chosen based on location (> 1.6 km from treated sites), habitat, and presence of blacklegged ticks. This relatively low density of sites and of 4-poster stations within these sites (1–2 stations km^{-2}) was considered indicative of what tick control programs can realistically be expected to maintain in the study area.

Figure 1. Locations of treated sites (triangles) and controls (filled circles) in the 5-year study of 4-poster deer feeding station effects on blacklegged tick abundance. Treated sites had multiple 4-poster stations; all sites had multiple tick drag sampling locations. Site abbreviations are: SC = Shawme Crowell; BU = Burgess; BC = Bridge Creek; DP = Dennis Pond; SY = Syrjala; PH = Punk Horn; BN = Bell's Neck; JP = Jehu Pond; FM = Fulling Mill; CT = Cedar Tree Neck; SP = Sepiessa Point; CH = Chappaquiddick; LO = Loring Nature Center; and AP = Almanack Pond.

During periods of activation, each station was maintained weekly or biweekly, with corn added *ad libidum* and permethrin acaricide added to rollers at a rate of 7.5 ml per 50 lbs (23 kg) of corn consumed. Inputs to each station, including the amount of corn consumed monthly, the amount of permethrin added, the number of station visits, as well as any necessary replacements or repairs were recorded. Beginning in spring 2007 (before station deployment), nymph ticks were sampled at all treatment and control sites in May, June and July of each year using a cloth dragging procedure [16] whereby a 0.46 m^2 (50.8 × 90.4 cm) double-sided white flannel cloth was dragged along the ground at the edge of a trail or wooded road for 30 seconds at approximately one yard per second. This procedure was repeated along fixed transects in October and November of each year for collection of adult ticks. This resulted in a total of 9890 drags approximately evenly distributed

across sites (Table 1). Thus, each site was sampled 4–5 times between 1 May and 10 Nov of each year, for a total of approximately 24 sampling events (30 drags per visit per site for each site over the study period; see Table 1 for deviations). This is a relatively high sampling frequency and was intended to overcome under-sampling problems [17].

Table 1. Number of tick drag samples by treatment, site, and year for Cape Cod, Martha's Vineyard and Nantucket

For statistical analyses and prediction, we used log-linear negative binomial models with random effects (GLMM; generalized linear mixed effects models). Life stage, treatment, and time were treated as fixed effects. Each statistical formulation was fitted using either days or years elapsed since the beginning of the study. Each of the 42 transects in the study was assigned a unique ID and treated as a random effect. The random effects were modeled as effects on intercepts only and were included because of the expected correlation between repeated samples taken from each transect over the course of the study. This is intended to address microclimate or other unknown but persistent differences between sites. The negative binomial distribution was used because of the high variance to mean ratio in the data, as is common in tick sampling data due to patchy spatial distribution (see [17] for analysis of sampling implications). Because of the two-year semelparous life cycle, nymphs and adults sampled in a given year are predominantly descendents of nymphs and adults sampled two years earlier. Thus, the longest time series for a given population in our study is represented by samples from 2007, 2009 and 2011 (Figure 2). Our statistical analyses focused on these samples.

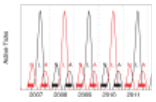

Figure 2. Diagram of sampling schedule (filled rectangles) superimposed on expected abundances of active ticks, *Ixodes scapularis*), which breeds only at the end of its two-year life cycle. Two overlapping populations are present at any given time and are represented here as different shades. N, L, and A denote periods of nymph, larval, and adult activity. Relative abundances are based on Figure eight in Ostfeld [2].

These log-linear models were used to evaluate statistical evidence for 4-poster treatment effects on nymphal and adult tick abundances and to estimate the size of these effects. Each of the candidate statistical models represented a specific hypothesized explanation of the data. Thus, the set included a 'no effects' model, a 'treatment only' model, a 'time only' model, a 'treatment + time' model, and a 'treatment × time' model. Evidence for 4-poster effects would be indicated by strong statistical support for models containing treatment effects. Support for a 'time only' model would indicate a regional change in tick abundance unrelated to 4-poster effects. Each model was fitted as a GLMM using the R implementation of AD Model Builder [18,19]. Support for each model was assessed using corrected Akaike Information Criteria (AICc; see Section 2.2 in [20]). AIC*c* weights were used to compute model-weighted predictions of tick density and unconditional standard errors for 95% confidence limits (eqn 6.12 in [20]). This so-called information-theoretic approach enables fuller extraction of the information contained in the data and allows evidence-based ranking of candidate models. When multiple models are supported (i.e., knowledge of the study system is uncertain), the final estimate of effect size (i.e., 4-poster effect) and its confidence limits incorporate the influence of all supported models. For this reason, the rejection of models via *p*-value cutoffs does not arise in our analysis.

We used Abbott's formula [21] to compute percent reduction of ticks relative to controls for comparison to other studies e.g., [13]. Specifically,

$$\mathrm{PctControl} = 100 \times \left(1 - \frac{E_{0,\mathrm{cntrl}} \times E_{t,\mathrm{trt}}}{E_{t,\mathrm{cntrl}} \times E_{0,\mathrm{trt}}}\right)$$

represents the effect of treatments between time $t = 0$ and $t = \mathrm{t}$, where E denotes mean abundance at control (cntrl) and treated (trt) sites predicted from the statistical models.

Pelage swab samples from white-tailed deer carcasses were collected prior to meat processing at hunter check-in stations on Chappaquiddick Island, Edgartown, MA, which we assume supports a closed deer population (no immigration or emigration). These samples were collected by wiping a cotton gauze pad on the neck, throat and chin area of each deer for thirty seconds. The samples were placed in amber glass vials and stored frozen. Samples were shipped on ice by overnight delivery to the Massachusetts Pesticide Analysis Laboratory for permethrin residue analysis using hexane extraction followed by gas chromatography with electron capture detection and mass spectrometry. Data from island hunters were used with these residue analyses to estimate the proportion of deer treated topically within the treatment zone.

Results

The model containing interactions between 4-poster treatment and time was the best fitting (based on log likelihood) and most parsimonious (based on AICc) of the models we used to analyze tick sampling data (Table 2). The interaction term in this model is interpreted as evidence that the treatments caused a stronger tick decline than was observed at the control sites. However, there was modest support in the data for two models without the interaction (i.e., $\Delta\mathrm{AIC}c < 2$; Table 2), leading to model selection uncertainty [20]. As a result of this uncertainty, we used AIC*c*-weighted model averaging to make predictions about treatment effects on tick abundance (Figure 3).Using Abbott's formula with the model-averaged estimates of treatment effects, our estimate of Pct Control was 8.4%, which is substantially lower than that reported for other studies. This estimate increases to 20% when only the interaction model is used by itself (rather than model-averaged estimates), but as already noted, inference based solely on this model is not supported by our data. Visual representation of aggregated drag counts (Figure 4) is consistent with the small effect detected in our statistical analyses.

Table 2. AIC statistics for models of tick treatment effects on tick drag sample abundances[1]

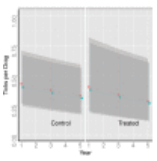

Figure 3. Predicted counts and 95% confidence limits (shaded areas) for blacklegged tick nymphs (red) and adults (blue) during 30-second drags on June 1 (nymphs) and October 1 (adults) during years 1, 3, and 5 of the study. Predictions are computed using AIC*c*-weighted averaging of all candidate log-linear generalized mixed effects models, but standard errors used for confidence intervals are based on fixed effect variance only.

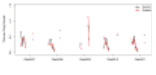

Figure 4. Graphical summary of tick drag data aggregated into means for 15-day intervals. Each point is the mean of all drags within the 15-day window for all 7 sites of the given treatment level. Average number of drags for each point is 330. See Methods section and Table 1 for additional details on distribution of sampling effort.

The rates of pesticide residue detections on pelage swabs (gauze pads; detection limit = 0.02 ug residue pad^{-1}) collected from harvested deer on Chappaquiddick

Island were 0.12, 0.69, 0.47, and 0.7 detections per deer for 2007, 2008, 2010, and 2011, respectively. The low number for 2007 and low rate of corn replenishment during station maintenance in that year suggest the possibility of a period of low deer usage during initial habitation to the station locations.

Discussion

We detected a relatively modest effect of 4-posters on blacklegged tick abundances in our coastal Massachusetts study area. Thus, our experiment supports previous findings that 4-posters reduce tick abundance, but the effect size we observed was smaller (Figure 3). Our study is the first to our knowledge that combines: 1) sampling over multiple generations and across multiple control and treatment replicates; 2) analysis of all nymph and adult tick data for a cohort population in a single count-based statistical model; and 3) detailed treatment of the repeated measures sampling design. The importance of these analytical considerations is described by Carroll *et al*. [9]. Although they dissected their analysis into separate comparisons between pairs of years, differences in effect size between our results, those of Carroll *et al*.[9] and other findings from the USDA Northeast Regional Study [11], are probably not due solely to differences in statistical methods or levels of replication. Uncertainty was also larger in our study compared with the meta-analytic results of Brei *et al*.[12], perhaps because we addressed model selection uncertainty and did not treat co-located stations or transects as statistically independent samples. Large deer home range size may reduce statistical independence of our study sites, but is considered less than 1.6 km in radius within seasons and possibly decreases in areas of high deer density (reviewed in [22]; also see [23]). Distances between our treated and control sites were always at least twice this radius, but note that any violation of the independence assumption would mean that our uncertainty estimate (i.e., the width of confidence limits in Figure 3) is too low and differences between our results and those of the USDA study may be even larger than what we have reported here. However, despite these potentially important analytical differences, we suspect that most of the difference between our results and those of others is due to the wider spacing of our 4-poster devices (1–2 stations km^{-2} vs. 4–5 stations km^{-2} in the USDA study). Other differences between studies may include deer densities and the operational periods for which the stations were maintained. Also, our study used permethrin as the acaricidal ingredient whereas the USDA study used amitraz. We are unaware of any known differences in effectiveness of these ingredients when used in 4-posters, but permethrin has been shown to be considerably more toxic than amitraz to several species of *Amblyomma* ticks [24,25].

In the region of our study, the Commonwealth of Massachusetts seeks to manage white-tailed deer abundances at a density of 6–8 deer mi^{-2} (2.8 – 3.1 deer km^{-2}), primarily through recreational hunting allowances [4]. However, significant variation in deer abundance likely exists among our three study areas (Cape Cod, Martha's Vineyard and Nantucket). Although our study was not designed to detect differences in 4-poster deer visitation among these areas, average annual corn consumption differed considerably based on rates of 4-poster replenishment (81, 182, and 326 kg $station^{-1}$ yr^{-1} for Cape Cod, Martha's Vineyard and Nantucket, respectively). Since station density was similar across sites, these consumption rates should be roughly indicative of deer density if relative corn consumption by non-target species is also similar across sites. Indeed, the State of Massachusetts estimates deer densities on Cape Cod to be much closer to its management goal than on the islands, where densities may be more than 15 deer km^{-2}[26].

Experimental exclusion of deer has been shown to affect the density of blacklegged ticks [27,28] (but see [29]), but the effects of these and other deer control experiments on human disease risk are not clear [2,30]. This is partly because deer are ineffective hosts of Lyme disease – Telford *et al*.[31] reported that only about 1% of ticks became infected after feeding on deer – and thus, as members of a larger host community, may contribute to a dilution effect on infection prevalence among questing ticks (demonstrated theoretically in [32]; empirical evidence for dilution in other disease systems is reviewed in [33]). If the role of deer in supporting tick populations is as large as commonly believed, successful management of tick abundance through technologies such as the 4-poster device could reduce the assumed need for deer eradication. However, the number of surviving, untreated deer that would be sufficient to support high tick abundance is difficult to estimate. The highest per capita deer treatment rate observed in our pelage residue samples from Chappaquiddick was 70%. Since the frequency distribution of ticks on deer is poorly known, it is possible that only a few untreated deer could weaken 4-poster effects. If such incomplete herd treatment does occur, social exclusion of subdominant individuals from feeding stations may also be important to consider (*personal communication*, M. Maquire, Cape Cod Cooperative Extension). These complexities, the existence of alternative tick hosts that might support tick abundance in the absence of deer or compensate for high mortality on treated deer, and the unknown degree to which these other hosts visit the 4-posters are all potentially important factors in the interpretation of tick abundance data such as ours.

Since there is no currently available pharmacological solution to Lyme disease, risk management focuses on reducing the likelihood of tick bites. The suite of management techniques includes modification of landscapes to reduce habitat suitability for ticks and their hosts, hunting programs to control deer populations, application of pesticides to the landscape, application of pesticides targeted to potential hosts (e.g., 4-posters) and increase of human awareness to modify behavior and promote personal protection practices. Some of these methods have been shown to affect the Lyme disease ecology (and presumably risk), but to varying degrees that depend on the ecological context, scale, and other details of the application. Landscape-scale experimental and observation programs that incorporate ecological and epidemiological approaches would help to identify those critical contextual details that should inform the balance of techniques. At that point, holistic and sustainable risk management strategies would be within reach.

Conclusions

The relatively modest effect of 4-posters on tick abundance in this five-year experiment, compared to larger effects seen in other studies, can possibly be explained by landscape characteristics, deer density and vertebrate host community composition in our study area, and the density of 4-poster stations we deployed. An important management implication is that the role of deer in the Lyme disease system may be more complicated than previously expected. It is important to weigh this possibility against concerns from the wildlife management community about the effects of wildlife provisioning and increased social contact between wildlife visitors at the 4-poster stations (e.g., wildlife disease transmission). This means that 4-posters deserve further study, experimental application, and refinement, but do not represent a low cost 'silver bullet' in the control of Lyme disease except perhaps under specific circumstances that remain to be identified. This is unsurprising given the complexity of the Lyme disease ecological system. 4-posters should be considered part of a broader suite of strategies, the most sustainable of which in the long term will embrace the strong linkages between ecological health and human disease risk and will support the differing mandates of environmental stewardship, wildlife management, and public health organizations.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All authors made substantial contributions to conception and design of this study and the interpretation of results. In addition, RK, BH and RH contributed to the review and oversight of field research. LD carried out and/or supervised the 4-poster station maintenance and tick and deer residue sampling. JG designed and performed the statistical analyses and modeling, prepared the manuscript and coordinated its review and revision by the participating authors, all of whom read and approved the final version.

Acknowledgments

We dedicate this work to the memory of David Simser, whose passions about sustainable solutions to Lyme disease led him to lay the foundation for this study. We also thank Peter McCormack and David Thompson for their tireless effort and dedication in the field work and William Clark for his contributions to planning discussions and outreach. Dan Campbell, Betty Kreakie, and Brenda Rashleigh provided thoughtful comments on an earlier version of the manuscript. This manuscript was submitted with tracking number ORD-004097 by the Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development, U. S. Environmental Protection Agency (EPA). Although the research described in this article was funded by EPA, it has not been subjected to agency review and does not necessarily reflect the views of the agency.

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Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: a systematic literature review and meta-analyses

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Abstract

Demand for organic foods is partially driven by consumers' perceptions that they are more nutritious. However, scientific opinion is divided on whether there are significant nutritional differences between organic and non-organic foods, and two recent reviews have concluded that there are no differences. In the present study, we carried out meta-analyses based on 343 peer-reviewed publications that indicate statistically significant and meaningful differences in composition between organic and non-organic crops/crop-based foods. Most importantly, the concentrations of a range of antioxidants such as polyphenolics were found to be substantially higher in organic crops/crop-based foods, with those of phenolic acids, flavanones, stilbenes, flavones, flavonols and anthocyanins being an estimated 19 (95 % CI 5, 33) %, 69 (95 % CI 13, 125) %, 28 (95 % CI 12, 44) %, 26 (95 % CI 3, 48) %, 50 (95 % CI 28, 72) % and 51 (95 % CI 17, 86) % higher, respectively. Many of these compounds have previously been linked to a reduced risk of chronic diseases, including CVD and neurodegenerative diseases and certain cancers, in dietary intervention and epidemiological studies. Additionally, the frequency of occurrence of pesticide residues was found to be four times higher in conventional crops, which also contained significantly higher concentrations of the toxic metal Cd. Significant differences were also detected for some other (e.g. minerals and vitamins) compounds. There is evidence that higher antioxidant concentrations and lower Cd concentrations are linked to specific agronomic practices (e.g. non-use of mineral N and P fertilisers, respectively) prescribed in organic farming systems. In conclusion, organic crops, on average, have higher concentrations of antioxidants, lower concentrations of Cd and a lower incidence of pesticide residues than the non-organic comparators across regions and production seasons.

Key words: **Organic foods: Conventional foods: Composition differences: Antioxidants/(poly)phenolics**

Abbreviations: BS, basket study; CF, comparison of matched farms; EX, controlled field experiment; GRADE, Grading of Recommendations, Assessment, Development and Evaluation; MPD, mean percentage difference; MRL, maximum residue level; SMD, standardised mean difference.

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Increased public concerns about the negative environmental and health impacts of agrochemicals (pesticides, growth regulators and mineral fertilisers) used in crop production have been major drivers for the increase in consumer demand for organic foods over the last 20 years[1–3].

Organic crop production standards prohibit the use of synthetic chemical crop protection products and certain mineral fertilisers (all N, KCl and superphosphate) to reduce environmental impacts (nitrate (NO_3^-) leaching and P run-off and pesticide contamination of groundwater) and the risk of pesticide residues being present in crop plants[4]. Instead, they prescribe regular inputs of organic fertilisers (e.g. manure and composts), use of legume crops in rotation (to increase soil N levels), and application of preventative and non-chemical crop protection methods (e.g. the use of crop rotation, more resistant/tolerant varieties, mechanical and flame weeding, and biological disease and pest control products). However, organic standards permit the use of certain plant or microbial extract and/or mineral (e.g. Cu- and S-based) crop protection products[5,6].

As a result, organic and conventional crop production may differ significantly in crop rotation designs and fertilisation and crop protection protocols as well as in the type of crop varieties used[6–10]. Apart from minimising the risk of agrochemical residues being present in crops, the agronomic protocols used in organic farming systems may also affect mineral uptake patterns and metabolic processes in crop plants. Recent studies have shown that the switch from mineral to organic fertilisers results in significant differences in gene and protein expression patterns and, as a result, in secondary metabolite profiles; for example, approximately 10 % of proteins have been found to be either up- or down-regulated in response to contrasting fertiliser inputs in potato and wheat[10–15]. Also, a switch from pesticide-based conventional to organic crop protection protocols has been shown to have a significant, but more limited effect than fertilisation regimens, and there were some statistically significant interactions between fertilisation and crop protection protocols with respect to gene and protein expression pattern[10–15].

Over the last 20 years, a large number of scientific studies have compared the concentrations of nutritionally relevant minerals (e.g. Fe, Zn, Cu and Se), toxic metals (e.g. Cd and Pb), pesticide residues, macronutrients (e.g. proteins, fats and carbohydrates) and secondary metabolites (e.g. antioxidants, (poly)phenolics and vitamins) in crops from organic and conventional production systems (see the online supplementary material for a list of publications).

There is particular interest in antioxidant activity/concentrations, as there is strong scientific evidence for health benefits associated with increased consumption of crops rich in (poly)phenolics and other plant secondary metabolites with antioxidant activity (e.g. carotenoids and vitamins C and E)[16–18]. Most importantly, a substantial number of human dietary intervention studies have reported an increased dietary intake of antioxidant/(poly)phenolic-rich foods to protect against chronic diseases, including CVD, certain cancers (e.g. prostate cancer) and neurodegenerative diseases; a detailed description of the evidence has been given in recent reviews by Del Rio *et al.*[16] and Wahlqvist[17]. Also, these plant secondary metabolites are increasingly being recognised to contribute significantly to the health benefits associated with increased fruit, vegetable and whole grain consumption[16–18].

Several systematic literature reviews have recently analysed the available published information, using both qualitative and quantitative methods, with the aim of identifying the potential effects of organic and conventional production protocols on the nutritional quality of crops[19–21]. However, these systematic reviews (1) used different methodologies (e.g. weighted and unweighted meta-analyses) and inclusion criteria, (2) did not cover most of the large amount of information published in the last 4–5 years, (3) provided no structured assessment of the strength of the evidence presented, and (4) came to contrasting conclusions. As a result, there is still considerable controversy as to whether the use of organic production standards results in significant and consistent changes in the concentrations of potentially health-promoting (e.g. antioxidants, (poly)phenolics, vitamins and certain minerals) and potentially harmful (e.g. Cd and Pb) compounds in crops and crop-based foods[7,19–22]. However, there is increasing evidence and more widespread acceptance that the consumption of organic foods is likely to reduce exposure to pesticide residues[21,23,24].

There are major research synthesis challenges to assessing differences in crop composition resulting from farming practices. Most importantly, the studies available for meta-analyses (1) have used different experimental designs (e.g. replicated field experiments, farm surveys and retail surveys) and (2) have been carried out in countries/regions with contrasting agronomic and pedo-climatic background conditions (see the online supplementary material for a list of publications). This heterogeneity is likely to increase the amount of published data required to detect and understand variation in composition parameters resulting from the use of contrasting crop production methods. An additional problem is that many studies do not report measures of variation, which reduces the within-study power of unweighted analyses and the between-study power of weighted analyses. Weighted meta-analyses are widely regarded as the most appropriate statistical approach for comparing data sets from studies with variable experimental designs[25,26]. However, some studies have used unweighted analytical methods[19] to avoid the loss of information associated with conducting weighted meta-analyses on a subset of the available information.

Therefore, the main objectives of the present study were to (1) carry out a systematic literature review of studies focused on quantifying composition differences between organic and conventional crops, (2) conduct weighted and unweighted meta-analyses of the published data, (3) carry out sensitivity analyses focused on identifying to what extent meta-analysis results are affected by the inclusion criteria (e.g. using mean or individual data reported for different crop varieties or experimental years) and meta-analysis method (e.g. weighted *v.* unweighted), and (4) discuss meta-analysis results in the context of the current knowledge about the nutritional

impacts of compounds for which significant composition differences were detected.

The present study specifically focused on plant secondary metabolites (especially antioxidants/(poly)phenolics and vitamins), potentially harmful synthetic chemical pesticides, toxic metals (including Cd, As and Pb), NO_3^-, nitrite (NO_2^-), macronutrients (including proteins, amino acids, carbohydrates and reducing sugars) and minerals (including all plant macro- and micronutrients). Metabolites produced by micro-organisms on plants (e.g. mycotoxins) were not the subject of the present systematic literature review and meta-analyses.

Materials and methods

Literature search: inclusion criteria and search strategy

The literature search strategy and meta-analysis protocols used were based on those previously published by Brandt *et al.*[27], and flow diagrams of the protocols used are shown in Figs. 1 and 2. Relevant publications were identified through an initial search of the literature with Web of Knowledge using the following search terms: (1) organic* or ecologic* or biodynamic*; (2) conventional* or integrated; (3) names of ninety-eight relevant crops and foods (see online supplementary Table S1 for a full list). Publications in all languages, published in peer-reviewed journals, and reporting data on both desirable and undesirable composition parameters were considered relevant for inclusion in the meta-analyses. The search was restricted to the period between January 1992 (the year when legally binding organic farming regulations were first introduced in the European Union) and December 2011 (the year when the project ended) and provided 17 333 references. An additional 208 publications (published between 1977 and 2011) were found by (1) studying lists of references or (2) directly contacting the authors of the published papers and reviews identified in the initial literature search. The abstracts of all publications were then examined to determine whether they contained original data obtained by comparing composition parameters in organic and conventional plant foods. This led to the identification of 448 suitable publications. Of these, 105 papers were subsequently rejected, because reading of the full papers indicated that they did not report suitable data sets or contained the same data as other studies.

Data sets were deemed suitable if the mean concentrations of at least one mineral, macronutrient, secondary metabolite or NO_3^-/NO_2^- or the frequency of occurrence of pesticide residues in organic and conventional crops or crop-based foods were reported. Only four non-peer-reviewed papers with suitable data sets were identified but subsequently rejected, as the small number minimised any potential bias[28] from using peer review as a 'quality' selection criterion.

As a result, 343 peer-reviewed publications reporting crop composition data were selected for data extraction, of which

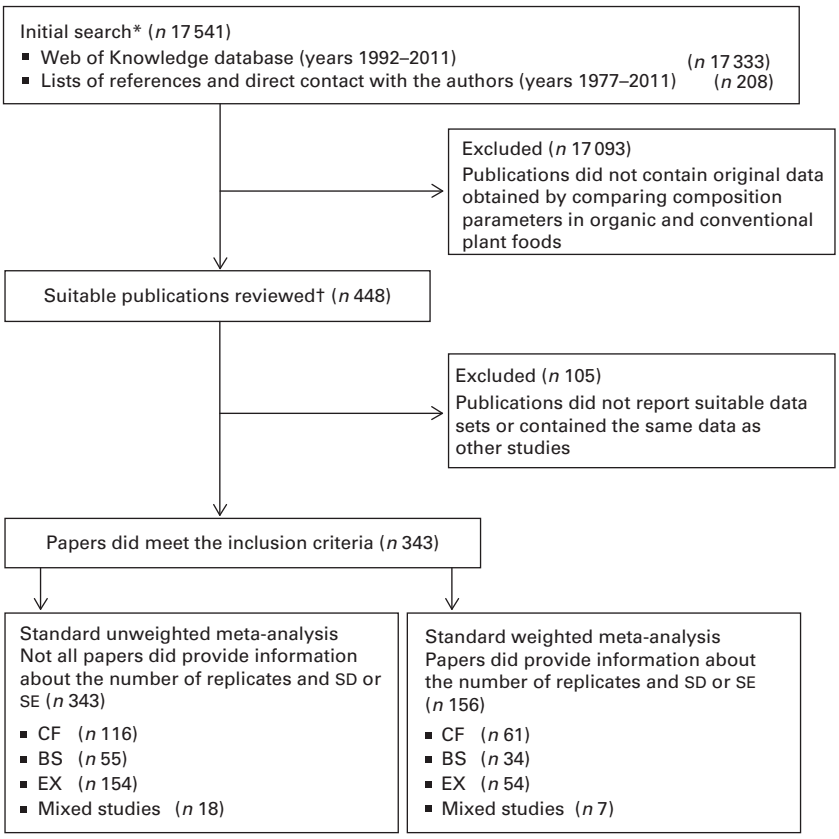

Fig. 1. Summary of the search and selection protocols used to identify papers included in the meta-analyses. *Review carried out by one reviewer; †Data extraction carried out by two reviewers. CF, comparison of matched farms; BS, basket studies; EX, controlled field experiments.

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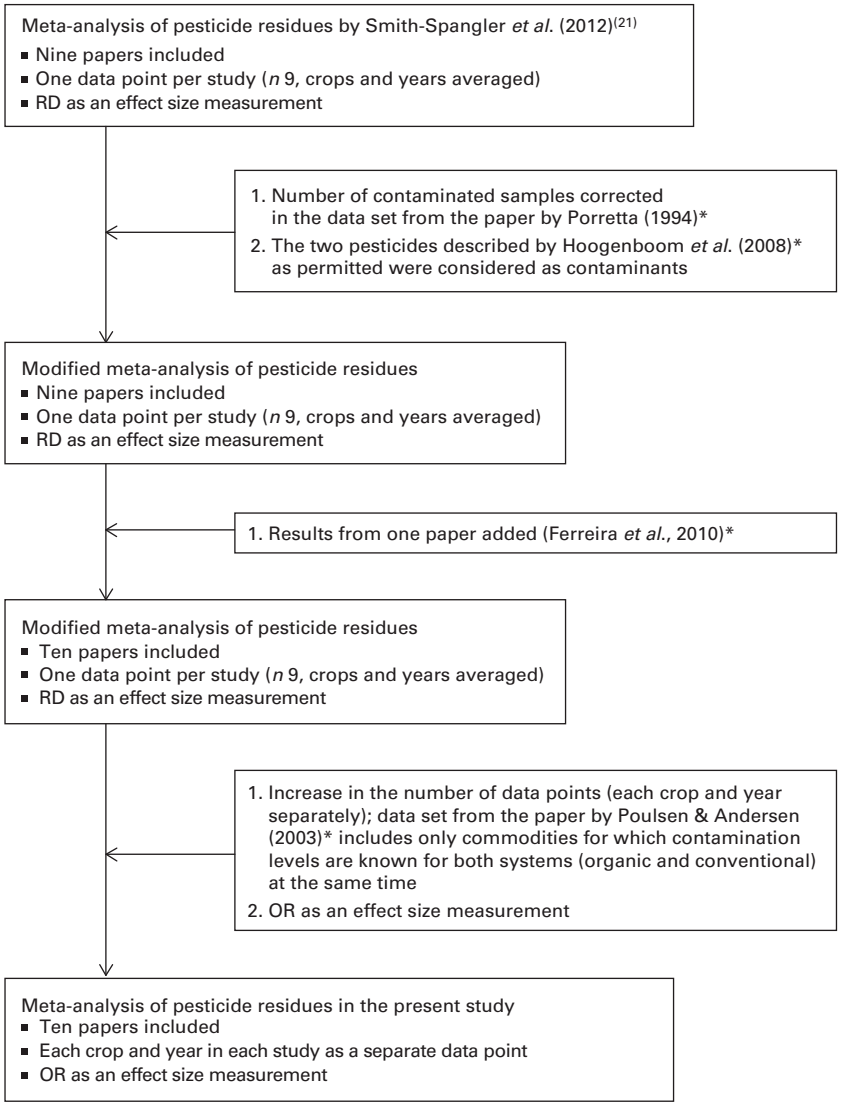

Fig. 2. Meta-analysis strategy used for the identification of data sets in the literature review. * References are summarised in Table S2 (available online). RD, risk difference.

156 references fulfilled the criteria for inclusion in the standard weighted meta-analysis and 343 fulfilled the criteria for inclusion in the standard unweighted meta-analysis. This represents a significantly greater evidence base than the three previous systematic reviews/meta-analyses of comparative crop composition data[19–21]. All publications included in these previous reviews (including studies published before 1992) were also used in the standard weighted meta-analysis carried out in the present study, except for a small number of papers that were found to report the same data as other publications that had already been included.

Data were extracted from three types of comparative studies: (1) comparisons of matched farms (CF), farm surveys in which samples were collected from organic and conventional farms in the same country or region; (2) basket studies (BS), retail product surveys in which organic and conventional products were collected in retail outlets; (3) controlled field experiments (EX) in which samples were collected from experimental plots managed according to organic or conventional farming standards/protocols. Data from all the three types of studies were deemed relevant for the meta-analyses if the authors stated that (1) organic farms included in farm surveys were using organic farming methods, (2) organic products collected in retail surveys were labelled as organic, and (3) organic plots used in EX were managed according to organic farming standards.

Several studies compared more than one organic or conventional system or treatment. For example, additional conventional systems/treatments were described as 'integrated,' 'low input,' 'low fertility' or 'extensive', and an additional organic system/treatment included in some studies was described as 'biodynamic'. Also, in some publications, organic or conventional systems with contrasting rotation designs (e.g. with or without cover crops) or fertilisation regimens (different types and levels of N inputs) were compared. In such cases, only the organic and conventional (non-organic) system identified

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by the authors as closest to the typical, contemporary organic/conventional farming system was used in the meta-analyses, as recommended by Brandt *et al.*[20]. Full references of the publications and a summary of descriptions of the studies included in the meta-analyses are given in Tables S2 and S4 (available online).

The database generated and used for the meta-analyses will be made freely available on the Newcastle University website (http://research.ncl.ac.uk/nefg/QOF) for use and scrutiny by others.

Data and information extraction and validation

Information and data were extracted from all the selected publications (see above) and compiled in a Microsoft Access database. A list of the information extracted from the publications and recorded in the database is given in Table S4 (available online).

Data reported as numerical values in the text or tables were copied directly into the database. Only data published in graphical form were enlarged, printed, measured (using a ruler) and then entered into the database as described previously[20].

Where data for multiple time points were reported, two approaches were used, depending on whether the analysed crop tissue was likely to be used as food/feed. For crops that are continuously harvested (e.g. tomato and cucumber), analytical data for mature/ripe products (e.g. fruits) collected at multiple time points during the season were averaged before being used in the standard meta-analyses; if analytical data for immature/unripe products were reported, they were not included in the mean. For crops (e.g. grape and cereals) in which products (e.g. fruits and grain) are harvested/analysed at different maturity stages, only analytical results for the mature product (that would have been used as food/feed) were used. In both the standard weighted and standard unweighted analyses, composition data reported for different cultivars/varieties and/or years/growing seasons in the same publication were averaged before being used in the meta-analyses.

Publications were assessed for eligibility and data were independently extracted from them by two reviewers. Data extracted by the two reviewers were then compared. Discrepancies were detected for approximately 2% of the data extracted, and in these cases, data extraction was repeated to correct mistakes. A list of the publications included in the meta-analyses is given in Table S2 (available online).

Study characteristics, summaries of the methods used for sensitivity analyses and ancillary information are given in Tables S2–S10 (available online). These include information on (1) the number of papers from different countries and publication years used in the meta-analyses (see online supplementary Figs. S1 and S2); (2) study type, location and crop/products assessed in different studies (see online supplementary Table S3); (3) the type of material/data extracted from the papers (see online supplementary Table S4); (4) data-handling methods/inclusion criteria and meta-analysis methods used in the sensitivity analyses (see online supplementary Table S5); (5) composition parameters included in the meta-analyses (see online supplementary Table S6); and (6) composition parameters for which meta-analyses were not possible ($n < 3$; see online supplementary Table S7).

Table S8 (available online) summarises basic statistics on the number of studies, individual comparisons, organic and conventional sample sizes, and comparisons showing statistically or numerically higher concentrations in organic or conventional crops for the composition parameters included in Figs. 3 and 4. Tables S9 and S10 (available online) summarise the numerical values for the mean percentage differences (MPD) and 95% CI calculated using the data included in the standard unweighted and weighted meta-analyses of composition parameters shown in Figs. 3 and 4, respectively (where MPD are shown as symbols).

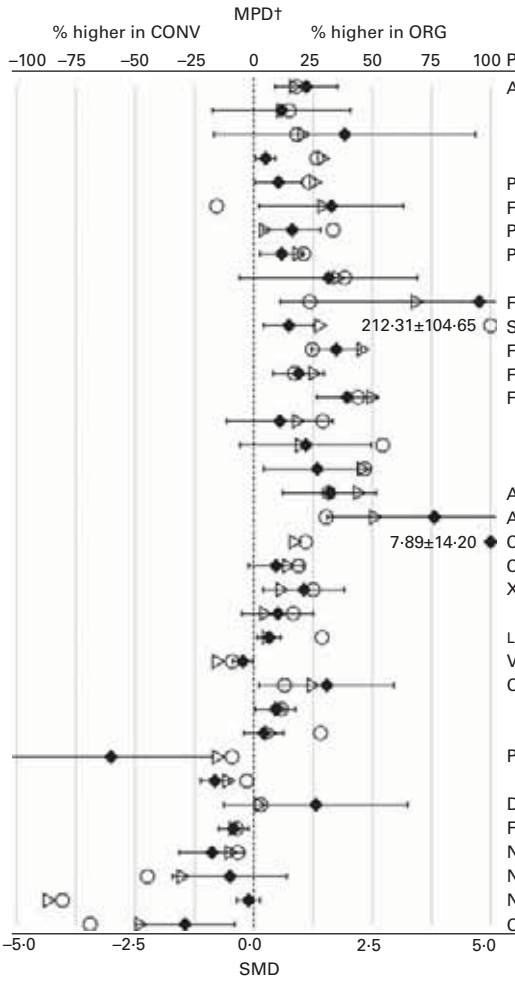
Meta-analyses

A total of eight different meta-analyses were undertaken. The protocols used for the standard weighted and unweighted meta-analyses were based on the methodologies described by Palupi *et al.*[29] and Brandt *et al.*[20], respectively. In Fig. 3, the results obtained using standard random-effects meta-analysis weighted by inverse variance and a common random-effects variance component and unweighted meta-analysis of difference in means are shown. In addition, six sensitivity analyses were undertaken. Sensitivity analyses included (1) using data reported for each cultivar or variety of crops separately and/or (2) treating data reported for different years in the same publication as separate events in the weighted or unweighted meta-analyses (see online supplementary Table S5). The results of the sensitivity analyses are available on the Newcastle University website (http://research.ncl.ac.uk/nefg/QOF).

Effect sizes for all the weighted meta-analyses were based on standardised mean differences (SMD) as recommended for studies in which data obtained by measuring the same parameters on different scales are included in meta-analyses[25,26].

Both weighted and unweighted meta-analyses were carried out using the R statistical programming environment[30]. Weighted meta-analyses, with the SMD as the basic response variable, were conducted using standard methods and the open-source 'metafor' statistical package[31–34]. A detailed description of the methods and calculations used is given in the 'Additional Methods Description' section in the online supplementary material.

A positive SMD value indicates that the mean concentrations of the observed compound are greater in the organic food samples, while a negative SMD indicates that the mean concentrations are higher in the conventional food samples. The statistical significance of a reported effect size (i.e. SMD_{tot}) and CI were estimated based on standard methods[35] using 'metafor'[31]. The influence of potential moderators, such as crop/food type (fruits, vegetables, cereals, oil seeds and pulses, herbs and spices, and crop-based compound foods), was additionally tested using mixed-effect models[36] and subgroup analyses.



Parameters	Unweighted meta-analysis *n*	Ln ratio‡	*P**	Weighted meta-analysis *n*	*P**	Heterogeneity§
Antioxidant activity	160	4·74	<0·001	66	0·001	Yes (96 %)
FRAP	14	4·73	0·013	5	0·436	Yes (90 %)
ORAC	8	4·76	0·011	4	0·176	Yes (95 %)
TEAC	22	4·80	<0·001	7	0·030	Yes (26 %)
Phenolic compounds	129	4·74	<0·001	58	0·051	Yes (93 %)
Flavonoids (total)	20	4·54	0·282	8	0·039	Yes (89 %)
Phenolic acids (total)	9	4·85	0·008	3	0·012	Yes (86 %)
Phenolic acids‖¶	153	4·72	0·002	89	0·015	Yes (97 %)
Chlorogenic acid	24	4·84	0·009	14	0·103	Yes (98 %)
Flavanones‖¶	75	4·73	0·100	54	0·027	Yes (100 %)
Stilbenes	8	5·42	0·005	4	0·008	No (1 %)
Flavones and flavonols‖	194	4·78	<0·001	134	<0·001	Yes (97 %)
Flavones‖	27	4·72	0·063	23	0·001	Yes (85 %)
Flavonols‖¶	168	4·81	<0·001	111	<0·001	Yes (98 %)
Quercetin	23	4·79	0·028	17	0·341	Yes (95 %)
Rutin	12	4·93	0·013	9	0·127	Yes (96 %)
Kaempferol	14	4·90	0·006	13	0·023	Yes (94 %)
Anthocyanins (total)	20	4·82	<0·001	10	0·002	Yes (82 %)
Anthocyanins‖	53	4·79	0·004	22	0·001	Yes (99 %)
Carotenoids (total)	15	4·78	0·005	4	0·271	Yes (100 %)
Carotenoids‖¶	163	4·71	<0·001	82	0·126	Yes (98 %)
Xanthophylls¶	66	4·78	<0·001	33	0·018	Yes (97 %)
Lutein	21	4·74	0·019	13	0·203	Yes (90 %)
L-Ascorbic acid	65	4·73	0·005	30	0·018	Yes (76 %)
Vitamin E	25	4·56	0·300	15	0·046	No (0 %)
Carbohydrates (total)	60	4·71	0·003	16	0·037	Yes (98 %)
Carbohydrates‖¶	111	4·68	0·001	53	0·049	Yes (93 %)
Sugars (reducing)	20	4·78	0·034	3	0·360	No (0 %)
Protein (total)	87	4·53	<0·001	26	0·007	Yes (99 %)
Amino acids‖¶	332	4·58	0·001	117	<0·001	Yes (91 %)
DM¶	129	4·63	0·001	24	0·191	Yes (99 %)
Fibre	19	4·54	0·010	15	0·017	Yes (42 %)
N	88	4·55	0·001	35	0·015	Yes (97 %)
Nitrate¶	79	4·33	0·001	29	0·429	Yes (99 %)
Nitrite	15	4·17	<0·001	7	0·419	No (0 %)
Cd	62	4·25	<0·001	25	0·008	Yes (98 %)

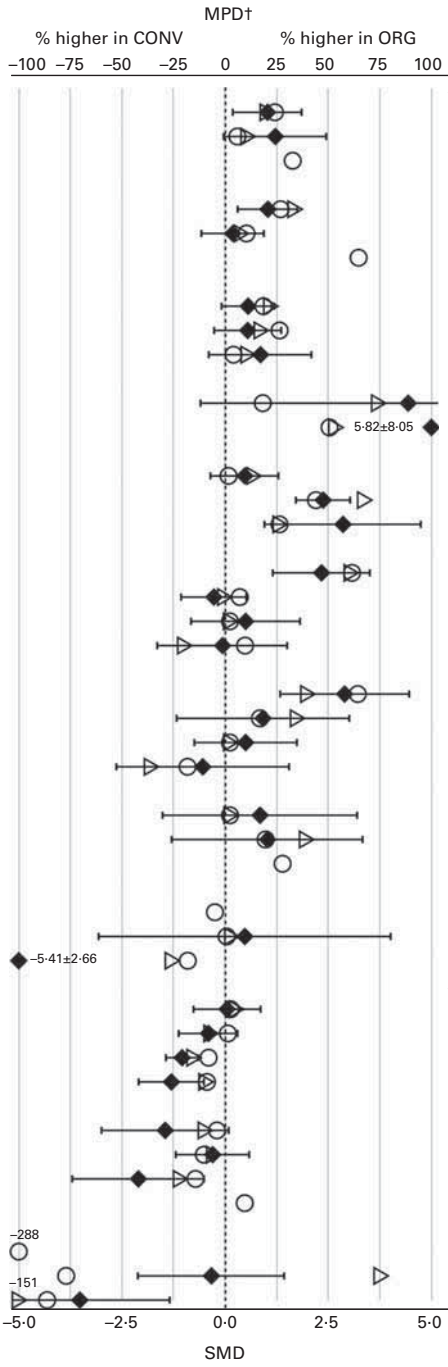
Fig. 3. Results of the standard unweighted and weighted meta-analyses for antioxidant activity, plant secondary metabolites with antioxidant activity, macronutrients, nitrogen compounds and cadmium (data reported for all crops and crop-based foods included in the same analysis). MPD, mean percentage difference; CONV, conventional food samples; ORG, organic food samples; *n*, number of data points included in the meta-analyses; FRAP, ferric reducing antioxidant potential; ORAC, oxygen radical absorbance capacity; TEAC, Trolox equivalent antioxidant capacity; SMD, standardised mean difference. Values are standardised mean differences, with 95 % confidence intervals represented by horizontal bars. * *P* value < 0·05 indicates a significant difference between ORG and CONV. † Numerical values for MPD and standard errors are given in Table S9 (available online). ‡ Ln ratio = Ln(ORG/CONV × 100 %). § Heterogeneity and the I^2 statistic. ‖ Data reported for different compounds within the same chemical group were included in the same meta-analyses. ¶ Outlying data points (where the MPD between ORG and CONV was more than fifty times greater than the mean value including the outliers) were removed. ○, MPD calculated using data included in the standard unweighted meta-analysis; ▷, MPD calculated using data included in the standard weighted meta-analysis; ◆, SMD.

We carried out tests of homogeneity (Q statistics and I^2 statistics) on all the summary effect sizes. Homogeneity was indicated if I^2 was less than 25 % and the P value for the Q statistics was greater than 0·010. Funnel plots, Egger tests of funnel plot asymmetry and fail-safe number tests were used to assess publication bias[37] (see online supplementary Table S13 for further information).

For the unweighted meta-analysis, the ratio of organic means:conventional means ($\bar{X}_O/\bar{X}_C$) expressed as a percentage was ln-transformed, and the values were used to determine whether the arithmetic average of the ln-transformed ratios was significantly greater than ln(100), using resampling[38]. The reported P values were derived from Fisher's one-sample randomisation test[39], and a $P<0{\cdot}05$ was considered statistically significant. For all composition parameters for which a statistically significant difference between organic and conventional food samples was detected in the standard weighted analysis (analysis 1), forest plots were constructed to show SMD and corresponding 95 % CI for individual studies and types of foods (see Fig. 4 and online supplementary Figs. S5–S41). In addition, the results of the standard unweighted analyses are shown in Figs. 3 and 4.

Table S12 (available online) summarises the results of the standard weighted and unweighted meta-analyses for all the composition parameters for which no analyses detected significant differences between organic and conventional products.

MPD were calculated for all parameters for which significant effects were detected by the standard unweighted and/or weighted meta-analysis protocols. This was done to facilitate value judgements regarding the biological importance of the relative effect magnitudes. A detailed description of the



Products‡	Unweighted meta-analysis *n*	Ln ratio§	Unweighted meta-analysis *P**	Weighted meta-analysis *n*	Weighted meta-analysis *P**
Antioxidant activity					
Fruits	93	4·79	<0·001	39	0·019
Vegetables	58	4·65	0·166	25	0·061
Other	5	4·89	0·030	–	–
Phenolic compounds (total)					
Fruits	58	4·74	0·006	30	0·008
Vegetables	61	4·69	0·003	25	0·638
Cereals	6	4·93	0·079	–	–
Phenolic acids‖¶					
Fruits	83	4·72	0·038	47	0·106
Vegetables	48	4·75	0·018	30	0·200
Cereals	21	4·63	0·266	12	0·189
Flavanones‖¶					
Fruits	59	4·68	0·257	40	0·086
Vegetables	16	4·90	0·017	14	0·156
Flavones and flavonols‖					
Fruits	87	4·69	0·108	47	0·272
Vegetables	98	4·85	<0·001	78	<0·001
Cereals	9	4·83	0·002	9	0·004
Carotenoids‖¶					
Fruits	36	4·97	<0·001	19	<0·001
Vegetables	101	4·64	0·149	39	0·523
Cereals	14	4·63	0·165	14	0·467
Compound food	12	4·65	0·410	10	0·938
Xanthophylls¶					
Fruits	20	5·04	<0·001	9	<0·001
Vegetables	26	4·73	0·056	5	0·394
Cereals	14	4·63	0·162	14	0·436
Compound food	6	4·48	0·171	5	0·615
Carbohydrates (total)					
Fruits	24	4·63	0·189	6	0·484
Vegetables	31	4·76	0·008	6	0·391
Cereals	4	4·79	0·319	–	–
Protein (total)					
Fruits	7	4·57	0·344	–	–
Vegetables	34	4·61	0·426	8	0·793
Cereals	43	4·45	<0·001	15	<0·001
Amino acids‖¶					
Fruits	38	4·61	0·478	18	0·907
Vegetables	152	4·61	0·234	18	0·295
Cereals	121	4·54	<0·001	63	<0·001
Compound food	21	4·52	<0·001	18	0·002
N					
Fruits	19	4·57	0·214	7	0·071
Vegetables	42	4·52	0·001	20	0·523
Cereals	14	4·48	0·001	7	0·011
Herbs and spices	12	4·69	0·005	–	–
Cd					
Fruits	4	3·78	0·066	–	–
Vegetables	34	4·36	0·045	10	0·719
Cereals	17	4·13	<0·001	8	0·002

Fig. 4. Results of the standard unweighted and weighted meta-analyses for different crop types/products for antioxidant activity, plant secondary metabolites with antioxidant activity, macronutrients, nitrogen and cadmium. MPD, mean percentage difference; CONV, conventional food samples; ORG, organic food samples; *n*, number of data points included in the meta-analyses; SMD, standardised mean difference. Values are standardised mean differences, with 95 % confidence intervals represented by horizontal bars. * *P* value $<0{\cdot}05$ indicates a significant difference between ORG and CONV. † Numerical values for MPD and standard errors are given in Table S10 (available online). ‡ For parameters for which $n \leq 3$ for specific crops/products, results obtained in the weighted meta-analyses are not shown. § Ln ratio = Ln(ORG/CONV × 100 %). ‖ Data reported for different compounds within the same chemical group were included in the same meta-analyses. ¶ Outlying data points (where the MPD between ORG and CONV was more than fifty times greater than the mean value including the outliers) were removed. ○, MPD calculated using data included in the standard unweighted meta-analysis; ▷, MPD calculated using data included in the standard weighted meta-analysis; ◆, SMD.

calculations is given in the 'Additional Methods Description' section in the online supplementary material.

We also calculated MPD using only data pairs included in the weighted meta-analyses to estimate the impact of excluding data for which no measures of variance were reported on the magnitude of difference. As the MPD can be expressed as '% higher' in conventional or organic crops, they provide estimates for the magnitude of composition differences that are easier to correlate with existing information on the potential health impacts of changing dietary intake levels for

individual or groups of compounds than the SMD values. The 95 % CI for MPD were estimated using a standard method[35].

For some composition parameters, individual effect sizes were more than fifty times greater than the pooled effect. This applied to one effect size each for phenolic acids, flavanones, flavones, flavonols, carbohydrates, DM and NO_3^-; four effect sizes for carotenoids and xanthophylls; eight effect sizes for amino acids; and forty-one effect sizes for volatile compounds. Such large differences can be considered biologically implausible, and these 'outlier' data pairs were therefore omitted from the final standard meta-analyses as shown in Figs. 3 and 4 and Tables S10 and S11 (available online).

Data reported for the frequency of occurrence of detectable pesticide residues (percentage of samples with detectable pesticide residues) in organic and conventional crops were compared using a weighted meta-analysis protocol based on the ln-transformed OR[40]. The formula used to calculate OR is given in the 'Additional Methods Description' section in the online supplementary material.

An overall assessment of the strength of evidence was made using an adaptation of the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) system[41].

Results

Analyses were based on data from publications reporting results from EX (154 papers), CF (116 papers), and BS (fifty-five papers) or results from more than one type of study (EX, CF and/or BS; eighteen papers) (see online supplementary Table S3).

Approximately 70 % of all the studies included in the meta-analyses were carried out in Europe, mainly in Italy, Spain, Poland, Sweden, the Czech Republic, Switzerland, Turkey, Denmark, Finland and Germany, with most of the remaining studies being carried out in the USA, Brazil, Canada and Japan (see online supplementary Table S3 and Fig. S2). Among the papers included in the meta-analyses, 174 reported comparison data for vegetables and a smaller number reported data for fruits and cereals (112 and sixty-one, respectively), while only thirty-seven reported data for other crops/crop-based food products (e.g. oil seeds and pulses, herbs and spices, and compound foods) (see online supplementary Table S3). Publications reported data for 907 different composition parameters, of which 182 were included in the meta-analyses (see online supplementary Tables S6 and S7).

Antioxidant activity

A large number of comparisons were available for antioxidant activity in organic and conventional crops (160 for the unweighted meta-analysis and sixty-six for the weighted meta-analysis), but the authors used a wide range of different methodologies. Both weighted and unweighted meta-analyses detected a significantly higher antioxidant activity in organic crops (Fig. 3) and the MPD was 17 (95 % CI 3, 32) % (Fig. 3).

When data reported for fruits and vegetables were analysed separately, a significant difference was detected for fruits, while only a trend towards a significant difference ($P=0{\cdot}06$) was observed for vegetables (Fig. 4), although there was no evidence of an interaction.

When data available for specific antioxidant activity assays were analysed, similar results were obtained for the Trolox equivalent antioxidant capacity assay with both the standard weighted and unweighted meta-analyses and for the ferric reducing antioxidant power and oxygen radical absorbance capacity assays with only the standard unweighted meta-analysis (Fig. 3).

Antioxidants/(poly)phenolics

The concentrations of secondary metabolites with antioxidant activity, including a wide range of nutritionally desirable (poly)phenolics, were also studied in a relatively large number of studies (see online supplementary Table S8).

For (poly)phenolics, the standard weighted meta-analysis detected significantly and substantially higher concentrations of total flavonoids, total phenolic acids, phenolic acids (where data reported for all individual phenolic acid compounds were included in the same analysis), flavanones, stilbenes, flavones, flavonols, kaempferol, total anthocyanins and anthocyanins in organic crops and/or processed foods made from organic crops. The unweighted meta-analysis yielded similar results, except for (1) total flavonoids, for which no significant difference was detected, and (2) flavanones and flavones, for which only trends towards higher concentrations in organic crops were detected (Fig. 3). The unweighted meta-analysis also detected significantly higher concentrations of chlorogenic acid (5-*O*-caffeoylquinic acid) in organic crops (Fig. 3). The MPD for most of the compounds were between 18 and 69 % for most of the above-mentioned antioxidant compounds (Fig. 3). Inclusion of data for which no measures of variance were reported in the calculation of MPD yielded similar values for phenolic compounds, phenolic acids, chlorogenic acid, flavones, quercetin, kaempferol and anthocyanins; higher values for phenolic acids (total), stilbenes and quercetin-3-rutinoside; and lower values for flavonoids, flavanones and flavonols (see Fig. 4 and online supplementary Table S9).

When data reported for phenolic compounds, phenolic acids and flavanones in fruits, vegetables, cereals and/or processed crop-based foods were analysed separately, significant differences were detected only for the concentrations of phenolic compounds and phenolic acids in fruits and a trend towards a significant difference ($P=0{\cdot}09$) was detected for the concentrations of flavanones in fruits (Fig. 4), although there was no evidence of an interaction. In contrast, when differences in the concentrations of flavones and flavonols were analysed separately for fruits, vegetables and cereals, significant differences were detected for vegetables and cereals, but not for fruits, with evidence of interactions (Fig. 4). For all other antioxidant/(poly)phenolic compounds, separate analyses for different crop types were not possible due to the unavailability of sufficient data.

Smaller, but statistically significant and biologically meaningful composition differences were also detected for a small number of carotenoids and vitamins. Both unweighted and

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weighted meta-analyses detected significantly higher concentrations of xanthophylls and L-ascorbic acid and significantly lower concentrations of vitamin E in organic crops. Higher concentrations of total carotenoids, carotenoids (where data reported for all individual phenolic acid compounds were included in the same analysis) and lutein were also detected by the unweighted meta-analysis (Fig. 3). The MPD were 17 (95% CI 0, 34)% for total carotenoids, 15 (95% CI −3, 32)% for carotenoids (where data reported for all individual carotenoid compounds were included in the same analysis), 12 (95% CI −4, 28)% for xanthophylls, 5 (95% CI −3, 13)% for lutein, 6 (95% CI −3, 15)% for vitamin C and −15 (95% CI −49, 19)% for vitamin E. Inclusion of data for which no measures of variance were reported in the calculation of MPD resulted in slightly higher values (see Fig. 4 and online supplementary Table S9).

When data reported for total carotenoids and xanthophylls in fruits, vegetables, cereals and processed crop-based compound foods were analysed separately, significantly higher concentrations in organic samples were detected only for fruits (Fig. 4), with evidence of interactions being detected for carotenoids, but not for xanthophylls.

The meta-analyses did not detect significant differences for a range of other secondary metabolites with antioxidant activity. These included some individual carotenoids (α-carotene, lycopene, β-cryptoxanthin and zeaxanthin), vitamins (α-tocopherol, γ-tocopherol, vitamin B and vitamin B_1), some specific phenolic acids (total hydroxycinnamic acids, caffeic acid, *p*-coumaric acid, ferulic acid, sinapic acid, 5-*O*-caffeoylquinic acid, ellagic acid, gallic acid and salicylic acid), some specific flavones and flavonols (apigenin, luteolin, myricetin 3-*O*-glucoside, quercetin 3-*O*-galactoside, quercetin-3-*O*-glucoside and quercetin-3-*O*-malonyl glucoside) and some specific flavanones (naringenin and naringenin (*R*-enantiomer)).

Macronutrients, fibre and DM content

Both unweighted and weighted meta-analyses detected significantly higher concentrations of total carbohydrates and significantly lower concentrations of proteins, amino acids and fibre in organic crops/crop-based compound foods (Fig. 3). The unweighted meta-analysis also detected significantly higher concentrations of reducing sugars and DM in organic crops (Fig. 4). The MPD were 25 (95% CI 5, 45)% for total carbohydrates, 11 (95% CI 2, 20)% for carbohydrates (where data reported for all individual phenolic acid compounds were included in the same analysis), 7 (95% CI 4, 11)% for reducing sugars, −15 (95% CI −27, −3)% for proteins, −11 (95% CI −14, −8)% for amino acids, 2 (95% CI −1, 6)% for DM and −8 (95% CI −14, −2)% for fibre. Inclusion of data for which no measures of variance were reported in the calculation of MPD resulted in similar values for carbohydrates, proteins, DM and fibre; higher values for reducing sugars; and lower values for carbohydrates (total) and amino acids (see Fig. 4 and online supplementary Table S9).

When data reported for proteins and amino acids in vegetables, cereals and/or processed crop-based foods were analysed separately, significant differences were detected for cereals and processed crop-based foods, but not for vegetables (Fig. 4), although there was no evidence of an interaction. Also, when data reported for carbohydrates in vegetables, fruits and cereals were analysed separately, no significant effects could be detected in their concentrations (Fig. 4).

Toxic metals, nitrogen, nitrate, nitrite and pesticides

Both weighted and unweighted meta-analyses detected significantly lower concentrations of the toxic metal Cd and total N in organic crops, while lower concentrations of NO_3^- and NO_2^- in organic crops were detected only by the unweighted meta-analysis (Fig. 3). The MPD were −48 (95% CI −112, 16)% for Cd, −10 (95% CI −15, −4)% for N, −30 (95% CI −144, 84)% for NO_3^- and −87 (95% CI −225, 52)% for NO_2^- (Fig. 3).

Inclusion of data for which no measures of variance were reported in the calculation of MPD resulted in similar values for N, NO_3^-, NO_2^- and Cd (see Fig. 4 and online supplementary Table S9).

When data reported for N and Cd concentrations in fruits, vegetables and cereals were analysed separately, significant differences were detected for cereals, but not for vegetables and/or fruits (Fig. 4), although there was no evidence of an interaction.

For the toxic metals As and Pb, no significant differences could be detected in their concentrations between organic and conventional crops in the meta-analyses (see online supplementary Table S12).

The standard meta-analyses showed that the frequency of occurrence of detectable pesticide residues was four times higher in conventional crops (46 (95% CI 38, 55)%) than in organic crops (11 (95% CI 7, 14)%) (Fig. 5). Significantly higher frequencies of occurrence of pesticide residues in conventional crops were also detected when data reported for fruits, vegetables and processed crop-based foods were analysed separately (Fig. 5). Conventional fruits had a higher frequency (75 (95% CI 65, 85)%) of occurrence of pesticide residues than vegetables (32 (95% CI 22, 43)%) and crop-based compound foods (45 (95% CI 25, 65)%), while contamination rates were very similar in the different organic crop types. This resulted in significant differences in the OR for different crop types (Fig. 5).

Other minerals

For most of the minerals (including many plant marco- and micronutrients), the meta-analyses could not detect significant composition differences between organic and conventional crops (see online supplementary Table S12). However, for a small number of minerals, differences in composition were identified by both weighted and unweighted meta-analyses, which detected significantly lower concentrations of Cr and Sr (−59 (95% CI −147, 30)% and −26 (95% CI −45,

Products†	*n*	*P**	Percentage of positive samples: ORG Mean	ORG 95 % CI	CONV Mean	CONV 95 % CI
All	66	<0·001	10·55	6·74, 14·36	46·35	37·96, 54·75
Fruits	22	<0·001	11·45	4·92, 17·99	74·60	64·65, 84·55
Vegetables	36	<0·001	10·25	4·77, 15·73	31·95	21·72, 42·18
Compound foods‡	6	<0·001	12·59	1·52, 23·65	44·64	24·81, 64·48

Fig. 5. Results of the standard weighted meta-analysis comparing ln OR for the frequency of occurrence of pesticide residues (percentage of positive samples) in organic and conventional crops. A mixed-effect model with crop/product group as a moderator was used. OR, ln OR for each product group (◆); ORG, organic food samples; CONV, conventional food samples; *n*, number of data points included in the meta-analyses. Values are odds ratios, with 95 % confidence intervals represented by horizontal bars. * *P* value $< 0{\cdot}05$ indicates a significant difference between ORG and CONV. † Crops/product groups for which $n \leq 3$ were removed from the plots. ‡ Compound foods.

−6) %, respectively), but significantly higher concentrations of Mo and Rb (65 (95 % CI 26, 105) % and 82 (95 % CI 6, 157) %, respectively) in organic crops. Also, lower concentrations of Mn (−8 (95 % CI −13, −3) %) and higher concentrations of Ga and Mg in organic crops (57 (95 % CI −122, 8) % and 4 (95 % CI −5, 13) %, respectively) were detected only by the weighted meta-analysis, while slightly higher concentrations of Zn (5 (95 % CI −6, 15) %) in organic crops were only detected by the unweighted meta-analysis (see online supplementary Table S11). As differences for Zn and Mg were relatively small and as there is limited information about potential health impacts associated with changing intake levels of either mineral (Cr, Ga, Mo, Sr and Mo), more detailed results are provided only in the online supplementary material.

Effects of crop type/species/variety, study type and other sources of variation

Heterogeneity was extremely high ($I^2 > 75$ %) for most of the composition parameters, with I^2 ranging from 76 % for ascorbic acid to 100 % for carotenoids and DM (Fig. 3). The only exceptions were vitamin E, reducing sugars, fibre and NO_2^-, for which the small number of studies and/or high within-study variability limited the ability to distinguish heterogeneity between the effects.

Strong or moderate funnel plot asymmetry consistent with a publication bias was detected for approximately half of the parameters. However, it is not possible to definitively attribute discrepancies between large precise studies and small imprecise studies to publication bias, which remains strongly suspected rather than detected where asymmetry is severe (see Table 1 and online supplementary Table S13).

When meta-analysis results obtained from different study types (BS, CF and EX) were compared, similar results were obtained for most of the composition parameters included in Fig. 3 (see online supplementary Figs. S3 and S4). However, there was considerable variation between results obtained for different crop types, crop species, and/or studies carried out in countries with contrasting pedo-climatic and agronomic background conditions (see Fig. 4 and online supplementary Figs. S5–S41).

Non-weighted MPD were calculated to aid in the biological interpretation of effect size magnitude where either the weighted or unweighted meta-analysis had identified statistically significant results. For many parameters, MPD based on all the available data produced values very similar to those calculated using only data for which measures of variance were reported (= those used for the weighted meta-analysis; Fig. 3). However, for other parameters (flavonoids, total phenolic acids, flavanones, rutin, L-ascorbic acid, reducing sugars and Cd), inclusion criteria had a large effect on the MPD.

Also, when the calculated MPD were superimposed onto SMD (with 95 % CI) results at an appropriate scale (−100 to +100 for MPD and −5 to +5 for SMD), a reasonable match was observed, with MPD for most of the compounds being present within the 95 % CI for SMD (Fig. 3). However, for some parameters (Trolox equivalent antioxidant capacity, total phenolic acids, stilbenes, rutin, total carotenoids, L-ascorbic acid, vitamin E, reducing sugars, proteins, NO_3^-, NO_2^- and Cd), MPD were outside the 95 % CI of SMD, and therefore these should be seen as less reliable.

For the composition parameters included in Fig. 3, sensitivity analyses, which were based on different inclusion criteria and data-handling methods, yielded results broadly similar to those yielded by the standard weighted and unweighted meta-analyses.

The overall assessment of the strength of evidence using an adapted GRADE[41] approach highlighted uncertainties in the evidence base, but the overall strength of evidence was moderate or high for the majority of parameters for which significant differences were detected (see Table 1 and online supplementary Table S13).

Discussion

The results of meta-analyses of the extensive data set of 343 peer-reviewed publications indicated that organic crops and processed crop-based foods have a higher antioxidant activity and contain higher concentrations of a wide range of nutritionally desirable antioxidants/(poly)phenolics, but lower concentrations of the potentially harmful, toxic metal Cd. For plant secondary metabolites, this confirms the results of the meta-analyses carried out by Brandt *et al.*[20], which indicated that there are significant composition differences between organic and conventional crops for a range of nutritionally relevant compounds. However, it contradicts the results of the systematic reviews/meta-analyses by Dangour *et al.*[19] and Smith-Spangler *et al.*[21], which indicated that there are no significant composition differences between organic and conventional crops. The main reason for the inability of previous studies to detect composition differences was probably the

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Table 1. GRADE (Grading of Recommendations, Assessments, Development and Evaluation) assessment of the strength of evidence for standard weighted meta-analysis for parameters included in Fig. 3

(Standardised mean difference values (SMD) and 95 % confidence intervals)

Parameters	SMD	95 % CI	Effect magnitude*	Inconsistency†	Precision‡	Publication bias§	Overall reliability
Antioxidant activity	1·11	0·43, 1·79	Moderate	Medium	Poor	None	Moderate
FRAP	0·59	−0·89, 2·06	Moderate	Low	Poor	Medium	Moderate
ORAC	1·92	−0·86, 4·71	Large	Low	Poor	Strong	Low
TEAC	0·25	0·02, 0·48	Small	Medium	High	Medium	Good
Phenolic compounds (total)	0·52	0·00, 1·05	Small	Medium	Moderate	None	Moderate
Flavonoids (total)	1·64	0·09, 3·19	Large	Medium	Poor	Medium	Moderate
Phenolic acids (total)	0·81	0·18, 1·44	Small	Low	Moderate	Strong	Low
Phenolic acids‖	0·59	0·11, 1·07	Small	Medium	Moderate	None	Moderate
Chlorogenic acid	1·58	−0·32, 3·49	Large	High	Poor	Medium	Low
Flavanones‖	4·76	0·54, 8·98	Large	Medium	Moderate	None	Moderate
Stilbenes	0·74	0·19, 1·28	Small	Low	Moderate	Medium	Moderate
Flavones and flavonols	1·74	1·21, 2·28	Large	Medium	High	None	Good
Flavones	0·95	0·39, 1·51	Moderate	Medium	Moderate	None	Moderate
Flavonols‖	1·97	1·31, 2·64	Large	Medium	High	None	Good
Quercetin	0·55	−0·58, 1·69	Small	Low	Poor	Medium	Low
Rutin	1·10	−0·31, 2·50	Moderate	Medium	Poor	None	Low
Kaempferol	1·34	0·19, 2·50	Moderate	Low	Poor	None	Low
Anthocyanins (total)	1·60	0·59, 2·62	Large	Low	Moderate	Medium	Moderate
Anthocyanins	3·81	1·53, 6·09	Large	Medium	High	Medium	Moderate
Carotenoids (total)	7·98	−6·22, 22·18	Large	Medium	Poor	Strong	Low
Carotenoids‖	0·47	−0·13, 1·07	Small	Medium	Poor	None	Low
Xanthophylls‖	1·06	0·18, 1·94	Moderate	Medium	Poor	Medium	Low
Lutein	0·51	−0·27, 1·29	Small	Medium	Poor	Medium	Low
Ascorbic acid	0·33	0·06, 0·60	Small	Medium	Moderate	None	Moderate
Vitamin E	−0·23	−0·46, 0·00	Small	Low	Moderate	None	Moderate
Carbohydrates (total)	1·54	0·10, 2·99	Large	Low	Poor	Medium	Low
Carbohydrates‖	0·46	0·00, 0·91	Small	Medium	Moderate	None	Moderate
Sugars (reducing)	0·21	−0·23, 0·65	Small	Low	Moderate	None	Moderate
Protein (total)	−3·01	−5·18, −0·84	Large	Medium	Moderate	Medium	Moderate
Amino acids‖	−0·82	−1·14, −0·50	Small	Medium	High	Medium	Moderate
DM‖	1·31	−0·65, 3·28	Moderate	Medium	Poor	Medium	Low
Fibre	−0·42	−0·76, −0·07	Small	Low	Moderate	None	Moderate
N	−0·88	−1·59, −0·17	Moderate	Low	Moderate	Medium	Low
NO_3^-‖	−0·50	−1·73, 0·73	Small	Medium	Poor	Medium	Low
NO_2^-	−0·11	−0·38, 0·16	Small	Low	High	None	Moderate
Cd	−1·45	−2·52, −0·39	Moderate	Medium	Moderate	Medium	Moderate

FRAP, ferric reducing antioxidant potential; ORAC, oxygen radical absorbance capacity; TEAC, Trolox equivalent antioxidant capacity.

* Study quality was considered low because of high risks of bias and potential for confounding. However, we considered large effects to mitigate this *sensu* GRADE; large effects were defined as >20 %, moderate effects as 10–20 % and small as <10 %.

† Inconsistency was based on the measure of heterogeneity and the consistency of effect direction *sensu* GRADE.

‡ Precision was based on the width of the pooled effect CI and the extent of overlap in the substantive interpretation of effect magnitude *sensu* GRADE.

§ Publication bias was assessed using visual inspection of funnel plots, Egger tests, two fail-safe number tests, and trim and fill (see online supplementary Table S13). Overall publication bias was considered high when indicated by two or more methods, moderate when indicated by one method, and low when indicated by none of the methods. The overall quality of evidence was then assessed across domains as in standard GRADE appraisal.

‖ Outlying data pairs (where the mean percentage difference between the organic and conventional food samples was over fifty times higher than the mean value including outliers) were removed.

highly limited number of studies/data sets available or included in analyses by these authors, which would have decreased the statistical power of the meta-analyses.

In addition, most of the previous studies did not use weighted meta-analyses based on SMD. This approach is recommended when combining data from studies that measure the same parameter (e.g. the major phenolic compounds found in different crops), but use different scales[25,26,29]. In the study carried out by Dangour *et al.*[19], published data from (1) surveys in which the organic samples were produced to 'biodynamic-organic' standards and (2) field experiments investigating associations between organic and conventional production protocols and crop composition were not included in the meta-analyses. This would have further reduced the number of data sets and sensitivity of meta-analyses and contributed to the lack of significant composition differences being detected. In the meta-analyses carried out in the present study, 'biodynamic-organic' data sets were treated as organic, as biodynamic standards comply with the legal European Union organic farming standards. Data from comparative field experiments were also included, as controlled experimental studies are less affected by confounding factors (e.g. contrasting soil and climatic and agronomic background conditions between farms that supplied organic and conventional samples) than farm and retail surveys. The reason for excluding field experiments carried out in the study of Dangour *et al.*[19] is that in the field experiments the organic plots were not certified according to organic farming standards. In the meta-analyses carried out in the present study, field experiments investigating associations between organic and

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conventional agronomic practices/protocols and crop composition were included, as the crop management practices rather than the certification process were assumed to affect crop performance and composition.

The finding of a four times higher frequency of occurrence of pesticide residues in conventional crops confirms the results of the study of Smith-Spangler *et al.*[21], in which a very similar set of studies (nine of the ten publications used in the present study) were used for analysis.

The potential (1) nutritional benefits of higher concentrations of antioxidant/(poly)phenolics in organic crops, (2) risks associated with potentially harmful pesticide residues, Cd, NO_3^- and NO_2^-, and (3) agronomic factors responsible for composition differences are discussed in more detail below.

Antioxidants/(poly)phenolics

Among the composition differences detected by the meta-analyses carried out in the present study, the higher antioxidant activity and higher concentrations of a wide range of antioxidants/(poly)phenolics found in organic crops/crop-based foods may indicate the greatest potential nutritional benefits. Based on the differences reported, results indicate that a switch from conventional to organic crop consumption would result in a 20–40 % (and for some compounds more than 60 %) increase in crop-based antioxidant/(poly)phenolic intake levels without a simultaneous increase in energy, which would be in line with the dietary recommendations[16,17]. This estimated magnitude of difference would be equivalent to the amount of antioxidants/(poly)phenolics present in one to two of the five portions of fruits and vegetables recommended to be consumed daily and would therefore be significant/meaningful in terms of human nutrition, if information linking these plant secondary metabolites to the health benefits associated with increased fruit, vegetable and whole grain consumption is confirmed[16–18].

However, it is important to point out that there is still a lack of knowledge about the potential human health impacts of increasing antioxidant/(poly)phenolic intake levels and switching to organic food consumption. For example, there are still gaps in the understanding of the (1) uptake, bioavailability and metabolism of (poly)phenolics after ingestion and (2) exact compounds/molecules and modes of action responsible for health benefits[16]. Also, it is important to consider that most of the human dietary intervention studies on associations between antioxidant/(poly)phenolic intake and health indicators were based on the comparison of standard diets with diets in which the amount of specific (poly)phenolic-rich foods (e.g. cocoa, red wine, tea/coffee, berries, citrus and nuts) was high[16,17].

There are, to our knowledge, only two human dietary intervention studies in which contrasting antioxidant/(poly)phenolic intake levels were generated by providing diets based on conventional and organic crops; both studies focused on assessing antioxidant status in humans and were inconclusive with respect to the identification of potential health impacts of organic food consumption[21,42,43]. However, there are several animal dietary intervention studies that have identified significant associations between organic feed consumption and animal growth and physiological (including immune and endocrine) parameters and/or biomarkers of health when compared with conventional feed consumption[44,45]. Among these studies, one recent factorial animal study has gone one step further and assessed associations between contrasting crop fertilisation and crop protection protocols used in conventional and organic farming systems and (1) the composition (including (poly)phenolic content) of crops/compound feeds made from crops and (2) the growth, physiological, immunological and hormonal parameters of rats that consumed these feeds[46]. With respect to composition differences, the study yielded results similar to those of the meta-analyses carried out in the present study. For example, rat feeds produced from organic crops had lower concentrations of proteins and Cd, but higher concentrations of polyphenols and the carotenoid lutein. The study also demonstrated that composition differences were mainly linked to contrasting fertilisation regimens (green and animal manures *v.* mineral fertiliser inputs). The consumption of feeds made from organic crops by the rats resulted in higher levels of body protein, body ash, leucocyte count, plasma glucose, leptin, insulin-like growth factor 1, corticosterone, and IgM, and spontaneous lymphocyte proliferation, but lower levels of plasma IgG, testosterone and mitogen-stimulated proliferation of lymphocytes[46]. Redundancy analysis identified total polyphenol concentrations in feeds as the strongest driver for the physiological/endocrinological parameters assessed in rats. This suggests that a switch from conventional to organic crop consumption may have impacts similar to those of an increase in the intake of foods with high antioxidant/(poly)phenolic contents. This hypothesis would merit further exploration in animal and human dietary intervention studies.

Many of the antioxidants, including (poly)phenolics, found in higher concentrations in organic crops are known to be produced by plants in response to abiotic (e.g. wounding and heat, water and nutrient stress) and biotic (pest attacks and disease) stress and form part of the plants' constitutive and inducible resistance mechanisms to pests and diseases[47–49]. Therefore, higher concentrations of (poly)phenolics in organic crops may be due to higher incidence/severity of pest and disease damage, causing enhanced (poly)phenolic production as part of the inducible plant resistance response. The differences in antioxidant concentrations between organic and conventional crops may therefore have been due to contrasting pest and disease damage and/or fertilisation intensity. However, there are, to our knowledge, no sound published data/evidence for a causal link between higher pest/disease incidence/severity and antioxidant/(poly)phenolic concentrations in organic crops. In contrast, there is increasing evidence that differences in fertilisation regimens between organic and conventional production systems (and, in particular, the non-use of high mineral N fertiliser inputs) are significant drivers for higher (poly)phenolic concentrations in organic crops[20,49–52]. For example, Sander & Heitefuss[50] reported that increasing mineral N fertilisation resulted in reduced concentrations of phenolic resistance compounds in wheat leaves and increased severity of foliar

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disease (powdery mildew). Similarly, a review by Rühmann *et al.*[51] describes the negative correlations between N fertilisation/supply-driven shoot growth and concentrations of phenylpropanoids and apple scab resistance in young leaves in apple trees[51]. In tomato, deficiency of both N and P was found to be linked to flavonol accumulation in plant tissues[52]. More recently, Almuayrifi[49] has demonstrated that the non-use of synthetic pesticides and fungicides has no effect on phenolic acid and flavonoid concentrations and profiles in wheat, but that the use of standard, conventional mineral (NPK) fertiliser regimens is associated with significantly lower phenolic acid and flavonoid concentrations in wheat leaves compared with organic wheat crops fertilised with green and animal manures only. The variability in relative differences in antioxidant/(poly)phenolic concentrations found between studies and crops may therefore at least partially be explained by variability in the fertilisation protocols in both the organic and non-organic systems compared. The finding in the present study that organic crops have significantly lower N, NO_3^- and NO_2^- concentrations would support the theory that differences in antioxidant/(poly)phenolic concentrations between organic and conventional crops are driven by contrasting N supply patterns. This view is supported by previous studies that have suggested that under high N availability, plants allocate carbohydrates from photosynthesis to primary metabolism and rapid growth while producing less amounts of secondary metabolites involved in defence[51].

However, additional research is required to gain a more detailed understanding of the relative contribution of fertilisation and crop protection regimens and disease and pest prevalence/severity to the expression of constitutive and inducible resistance mechanisms in different organically managed crop plants[50].

Cadmium and pesticide residues

Cd is a highly toxic metal and one of the only three toxic metal contaminants (the other two being Pb and Hg) for which the European Commission has set maximum residue levels (MRL) in foods[53]. Cd accumulates in the human body (especially in the liver and kidneys) and therefore dietary Cd intake levels should be kept as low as possible[53]. The on average 48% lower Cd concentrations found in organic crops/crop-based foods in the meta-analyses carried out in the present study are therefore desirable, although the exact health benefits associated with reducing Cd intake levels via a switch to organic food consumption are difficult to estimate. Similar to the results of the present study, a recent literature review by Smith-Spangler *et al.*[21] has also reported that of the seventy-seven comparative data sets (extracted from fifteen publications), twenty-one indicated significantly lower and only one significantly higher Cd concentrations in organic foods. Differences in Cd contamination levels between organic and conventional winter wheat have recently been shown to be mainly linked to differences in fertilisation regimens (especially the high mineral P inputs used in conventional farming systems), although contrasting rotation designs also contributed to differences in Cd concentrations between organic and conventional wheat[7]. A range of other soil (e.g. pH) and agronomic (e.g. liming) factors are known to affect Cd concentrations in crops[54], and these may explain the variability in results between individual comparative studies, crop species and crop types (see Fig. 4 and online supplementary Figs. S4 and S22).

The present study demonstrated that the prohibition of synthetic chemical pesticide use under organic farming standards results in a more than 4-fold reduction in the number of crop samples with detectable pesticide residues. This supports previous studies that have concluded that organic food consumption can reduce exposure to pesticide residues[21–23]. The considerably higher frequency of occurrence of detectable residues in conventional fruits (75%) than in vegetables (32%) may indicate higher levels of crop protection inputs being used in fruit crops, but could also have been due to the use of more persistent chemicals, different sprayer technologies used and/or pesticide applications being made closer to harvest. The finding of detectable pesticide residues in a proportion (about 11%) of organic crop samples may have been due to cross-contamination from neighbouring conventional fields, the continued presence of very persistent pesticides (e.g. organochlorine compounds) in fields or perennial crop tissues from past conventional management, and/or accidental or fraudulent use of prohibited pesticides in organic farms.

Pesticide residues that are below the MRL set by the European Commission[55,56] are considered by regulators not to pose risk to consumers or the environment, as they are significantly lower than concentrations for which negative health or environmental impacts can be detected in the regulatory pesticide safety testing carried out as part of the pesticide approval process[55]. However, a significant number of crop samples included in the regulatory European Food Safety Authority pesticide residue monitoring in Europe are still found to contain pesticide residues above the MRL[57]. For example, in recent European Food Safety Authority surveys, pesticide residues above the MRL have been found in 6·2% of spinach, 3·8% of oat, 3·4% of peach, 3·0% of orange, 2·9% of strawberry and lettuce, 2·8% of table grape and 2·7% of apple samples analysed[57]. There is still scientific controversy about the safety of some currently permitted pesticides (e.g. organophosphorus compounds) even at levels below the MRL and complex mixtures of pesticides, as additive/synergistic effects of pesticide mixtures have been documented and safety testing of pesticide mixtures is currently not required as part of the regulatory pesticide approval process[58–60]. Similar to Cd, the lower risk of exposure to pesticide residues can be considered desirable, but potential health benefits associated with reducing pesticide exposure via a switch to organic food consumption are impossible to estimate.

It should be pointed out that (1) there are only eleven studies in which the frequencies of occurrence of pesticide residues were compared, (2) eight of these studies focused on only one crop species, (3) no comparative studies for cereals, oilseeds and pulses were identified in the literature review, and (4) the data available did not allow scientifically

robust comparisons of the concentrations of pesticides. Therefore, it is important to carry out further studies to improve our understanding of differences in the frequency of occurrence and concentrations of pesticide residues between organic and conventional crops.

Proteins, amino acids, nitrogen and nitrate/nitrite

The concentrations of proteins, amino acids and N (which are known to be positively correlated in plants) were found to be lower in organic crops, and this is consistent with the results of previous studies that have linked lower protein concentrations to lower N inputs and N availability in organic crop production systems[61,62]. The nutritional significance/relevance of slightly lower protein and amino acid concentrations in organic crops to human health is likely to be low, as European and North American diets typically provide sufficient or even excessive amounts of proteins and essential amino acids. Also, while some studies concluded that protein content in most European and North American diets is too high and that this contributes to the increasing incidence of diabetes and obesity[63], other studies reported that increasing protein intake levels may be a strategy to prevent obesity[64]. Therefore, the lower protein and amino acid concentrations found in organic foods are unlikely to have a significant nutritional or health impact.

The higher NO_3^- and NO_2^- concentrations in conventional crops are also thought to be linked to high mineral N inputs, as both NO_3^- and NO_2^- are known to accumulate in plants under high-mineral N input regimens[65]. The higher NO_2^- concentrations in conventional crops/crop-based foods are nutritionally undesirable, as they have been described to be risk factors for stomach cancer and methaemoglobinaemia in humans[65]. However, while increasing dietary NO_2^- intake levels is widely considered to be potentially harmful for human health, there is still controversy about the potential health impacts of crop-based dietary NO_3^- intake[65–67].

Effects of crop type/species/variety, study type and other sources of variation

One of the main challenges to interpreting comparisons of organic and inorganic food production systems is the high heterogeneity arising from combinations of (1) crops, crop types and/or crop-based foods, (2) countries, and/or (3) pedo-climatic and agronomic background conditions. As has been mentioned in previous reviews[19–21], pooling diverse information was necessary, because for most of the composition parameters, the number of published studies available was not sufficient to carry out separate meta-analyses for specific countries/regions and crop types and species. Consequently, heterogeneity was extremely high ($I^2 > 75\%$) for most of the composition parameters for which significant differences were detected.

For many composition parameters, the method of synthesis did not have large effects on results, in terms of both statistical significance and the magnitude of relative difference between organic and conventional crops. This indicates that there is now a sufficiently large body of published information to identify differences that are relatively consistent across study types, crops, and pedo-climatic and agronomic environments. Therefore, for these parameters, future studies should focus on increasing our understanding of the underlying agronomic, pedo-climatic and crop genetic factors responsible for composition differences between organic and conventional crops.

For other composition parameters (e.g. ferric reducing antioxidant power, oxygen radical absorbance capacity, Trolox equivalent antioxidant capacity, and levels of flavonoids, stilbenes, total carotenoids, L-ascorbic acid, proteins, NO_2^- and Cd), differences in methods had a large impact in terms of both significant effects being detected and/or estimates of the magnitude of difference based on MPD and SMD. For these compounds, additional high-quality studies (that report measures of variance) are required to increase the power of weighted meta-analyses.

Overall assessment of the strength of evidence for antioxidant/(poly)phenolic parameters indicated high or moderate reliability for thirteen of the nineteen parameters and moderate reliability for Cd. This supports the conclusion that future research would likely be confirmatory.

In contrast to previous literature reviews[19–21], the larger number of studies now available allowed separate meta-analyses to be carried out for different crop types (e.g. fruits, vegetables and cereals), but only for a limited number of composition parameters. This demonstrates that there is variation between crop types with respect to (1) whether the production system has a significant effect and/or (2) the magnitude of difference between organic and conventional crops, although sample sizes remain insufficient to detect interactions between crop types in many cases.

The present study also identified variation between studies (1) carried out in countries with different pedo-climatic conditions and agronomic protocols (e.g. rotation designs, irrigated or non-irrigated crop production, and level and type of animal manures used) and/or (2) focused on different crop species. This is not surprising as both genetic and environmental/agronomic factors are known to affect the concentrations of N, NO_3^-, NO_2^-, proteins, sugars, antioxidants/(poly)phenolics, Cd and pesticides in crops[7,9–12,20,47–52,62]. However, due to the lack of detailed information on agronomic and pedo-climatic background conditions in most of the available literature, it is currently not possible to quantify the relative contribution of genetic and environmental/agronomic sources of variation.

The unweighted MPD were calculated to provide an estimate of the magnitude of difference that is meaningful when considering nutritional/health impacts of changes in crop composition. However, care should be taken when interpreting MPD values, as they do not take variability in the precision of individual studies into account[25] and provide less precise estimates of effect than weighted estimates.

However, there is now evidence from a large number of quality studies that consistently show that organic production systems result in crops/crop-based compound foods with higher concentrations of antioxidants/(poly)phenolics and lower concentrations of Cd and pesticide residues compared

with conventional production systems. There is little uncertainty surrounding this overall result, but further research is required to quantify more accurately the relative impacts of (1) crop types, species, and varieties/cultivars/hybrids and (2) agronomic and pedo-climatic background conditions on the relative difference between organic and conventional crop composition.

The need for use of standardised protocols for comparative food composition studies

The present study identified deficiencies in a large proportion of the published studies. These included a lack of standardised measurements and a lack of reporting (and, in particular, the non-reporting of measures of variability and/or replication) for many composition parameters, and there was evidence of duplicate or selective reporting of data collected in experiments, which may lead to publication bias. Particularly, there is a lack of studies comparing pesticide residue levels in organic and conventional crops, and there has been very little effort taken to re-analyse and then publish available comparative data from food surveillance surveys (e.g. the regular pesticide residue and food composition surveys carried out by the European Food Safety Authority and national agencies in Europe and elsewhere). Also, in many studies, there was a lack of detailed information on (1) the geographical origin of samples in retail surveys and (2) agronomic (e.g. rotation, fertilisation, tillage and irrigation regimens), pedo-climatic and crop genetic backgrounds (in farm surveys and field experiments), which would allow potential sources of variation to be investigated.

Not all studies included in the meta-analyses used certified reference materials as a quality assurance measure for the accuracy of estimates of concentrations of compounds in crops. This is unlikely to have affected the estimates of relative differences between organic and conventional crops, as the same extraction and analytical methods were used for organic and conventional samples in all the studies included in the meta-analyses in the present study. However, data from studies that did not use reference materials are less reliable when used to estimate the concentrations of nutritionally relevant compounds in crops and total dietary intake levels of such compounds in crop-based foods.

Therefore, it is important to develop guidelines for studies comparing the impacts of agronomic practices on crop/food composition to minimise heterogeneity and/or allow agronomic, environmental and crop genetic drivers to be used as covariates in analyses.

The need for dietary intervention/cohort studies to identify health impacts

A recent review by Smith-Spangler *et al.*[21] has analysed the results of fourteen studies in which the effects of organic and conventional food (both crop and livestock product) consumption on clinical outcomes (e.g. allergic symptoms and *Campylobacter* infections) and health markers (e.g. serum lipid and vitamin concentrations) were studied. However, they concluded that the currently available data do not allow clear trends with respect to health markers and outcomes to be identified. Therefore, there is an urgent need for well-controlled human intervention and/or cohort studies to identify/quantify potential human health impacts of organic *v.* conventional food consumption.

Diet composition may have an effect on the relative impact of switching from conventional to organic food consumption, and this should be considered in the design of such studies. For example, the relative impact of switching from conventional to organic food consumption could be expected to be smaller for diets with high amounts of (poly)phenolic-rich foods.

Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S0007114514001366

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The authors' contributions are as follows: M. B. (an animal and food scientist) designed the database, carried out many of the meta-analyses and contributed to the writing of the manuscript; D. S.-T. (a nutritionist) carried out a major part of the literature search and extraction and contributed to the writing of the manuscript; N. V. (a crop scientist) contributed to the literature search (especially for perennial and Mediterranean crops) and the preparation of the manuscript; C. S. (a human nutritionist) contributed to the design of the study, the discussion of potential health impacts of composition differences and the critical review of the manuscript;

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R. S. (an environmental modeller and data analyser) helped to design the literature search and database storage and helped to design and provided guidance for the meta-analyses used; G. B. S. (a research synthesis methodologist specialising in meta-analytical approaches) contributed to and provided advice on the additional analyses carried out in response to referees' recommendations; C. B. (an agronomist specialising on organic production systems) helped with the literature review (especially with respect to studies carried out in North and South America) and the preparation/review of the manuscript; B. B. (an agricultural microbiologist) contributed to the literature search, the critical review of the manuscript and the discussion related to the mechanisms for higher antioxidant concentrations in organic crops; E. M. (a plant pathologist) helped with the literature search and the critical review of the manuscript, in particular, with respect to interactions between antioxidant concentrations and crop resistance; C. G. (a plant pathologist/crop agronomist) helped with the literature search (especially with respect to Mediterranean crops) and the critical review of the manuscript; J. G.-O. (a human nutritionist) contributed to the literature review and the discussion of potential health impacts of composition differences identified in the meta-analyses; E. R. (a human nutritionist) helped with the literature review and the critical revision of the manuscript, especially with respect to human intervention studies focused on the health impacts of organic food consumption; K. S.-S. (an animal nutritionist/physiologists) contributed to the literature review and the critical revision of the manuscript, especially with respect to animal dietary intervention studies focused on the physiological and health impacts of organic feed consumption; R. T. (a human nutritionist) helped with the literature review and the critical revision of the manuscript, especially with respect to studies carried out in Scandinavian countries; D. J. (an agronomist specialising on organic production systems) contributed to the literature review (especially with respect to studies carried out in Eastern and Central European countries) and the preparation/review of the manuscript; U. N. (head of Europe's largest organic farming institutes) helped with the literature review (especially with respect to studies linking mineral nutrient supply and antioxidant concentrations in crops) and the critical review of the manuscript; P. N. (a plant pathologist/crop agronomist) contributed to the interpretation of data and the critical review of the manuscript; C. L. (an agronomist specialising on agricultural production system design and the study of interactions between agronomic practices, and food quality and safety) had primary responsibility for the design of the study, the management of the research project and the preparation of the manuscript.

Conflict of interest: the senior author of the paper, C. L., owns farm land in Germany that is managed according to conventional farming standards and a smallholding in Greece that is managed according to organic farming standards.

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Rebecca Rupp

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Killer Fungus Could Threaten World Food Supply

by **Rebecca Rupp**

In John Christopher's sci-fi tale *No Blade of Grass* (http://www.amazon.com/No-Blade-Grass-John-Christopher/dp/0380003198), a virus wipes out all the world's grasses—the entire family Poaceae, which includes some 10,000 different species, among them wheat, barley, oats, rye, millet, rice, sorghum, and sugarcane.

The result, of course, was disastrous. There was worldwide famine (presumably also obliterating grazing animals and the pandas; bamboo is a grass). Starving people formed bands of marauders. In England—where the story is set—farms savvy enough to have concentrated on such non-grass crops as cabbages and potatoes turned themselves into armed fortresses and shot desperate people who tried to breach their stockades.

'Let Them Eat Cake'

It's not all that outlandish a scenario. Wheat, the staple crop that provides 20 percent of the world's calories, is the major component of the staff of life: bread. For much of history, the bulk of the human diet has consisted of bread—and when people are deprived of it, all hell breaks loose. The French and Russian Revolutions both began with bread riots. The Romans attempted to placate an unhappy populace with "bread and circuses." And the Bolsheviks won a lot of popular support by promising "peace, land, and bread." Marie Antoinette's famously insensitive "Let them eat cake" (http://www.nytimes.com/2001/09/04/books/a-resolute-biographer-and-a-kinder-gentler-antoinette.html) in the face of France's crippling bread shortages is generally said to have set the monarchy on the road to the guillotine.

To be fair, she almost certainly never said it—the story has been attributed to any number of rich and reputedly clueless figures, among them a Chinese emperor whom, upon being told his starving subjects lacked rice, supposedly replied "Let them eat meat!" However, no matter who said what, it's clear that lousy wheat harvests and lack of available bread played no small part in the French crown's demise.

(http://theplate.nationalgeographic.com/files/2014/07/7993639861_a85c7d3e60_z.jpg)

Photograph by Lina Nagano

Cultural Implications of Bread

An indication of the importance of bread is its widespread cultural significance. Almost every region has its characteristic bread—among them New England anadama bread, Irish soda bread, Indian naan and chapatis, Middle Eastern pita bread, French baguettes and croissants, and German pumpernickel. (This last is possibly the world's best-named bread; the word translates as "devil's fart.")

The sharing of bread traditionally signals hospitality (an act performed continually and duplicitously in *Game of Thrones* (http://insidetv.ew.com/2013/12/01/game-of-thrones-red-wedding-2/)). The medieval designations of "lord" and "lady" derive from the Old English for, respectively, "bread eater" and "loaf kneader," reflecting the central role of bread in the European household. Downton Abbey's aristocratic Lord and Lady Grantham—nibblers of cucumber sandwiches—have their roots in bread. Special breads play a role in any number of holidays and celebrations, from Passover's matzo to Good Friday's hot cross buns.

To supply the demand for bread (http://www.washingtonpost.com/wp-dyn/content/article/2008/04/04/AR2008040403937.html)—and buns, crackers, cookies, cupcakes, muffins, ice cream cones, and dozens of different kinds of pasta—the world produces nearly 700 million tons of wheat a year. In the United States, we've got over 60 million acres planted in wheat.

So what if something goes wrong?

(http://theplate.nationalgeographic.com/files/2014/07/5843671196_cf4de5091e_b.jpg)
A healthy wheat field in Kenya was affected by Ug99 fungus. Photograph by Petr Kosina/CIMMYT

SciFi Thriller Could be a Real-Life Nightmare

Wheat's nemesis is a fungus commonly known as wheat stem rust, the latest permutation of which is known as Ug99, first identified in Uganda and formally named in 1999. If Ug99 turns into a pandemic, we're in trouble. Just 10 percent of wheat is resistant to it; the other 90 percent of the world crop, a sitting duck, would flop over and rot within weeks of infection. Ug99 has the potential to make the horrific Irish Potato Famine look like a Sunday School picnic.

Nobelist Norman Borlaug (http://www.nobelprize.org/nobel_prizes/peace/laureates/1970/borlaug-bio.html), the father of the 20th-century Green Revolution, was able to fend off wheat stem rust beginning in the 1940s by crossing commercial rust-sensitive wheat varieties with rust-resistant strains. The problem with rust resistance, though, is that it's inevitably short-lived. On average, a single rust-resistant gene lasts only three to four years before rust finds a way to weasel around it.

Rust is a resilient organism with a large and relentlessly evolving genome. Balked of one means of nabbing its victim, rust will cunningly bide its time and come up with another mode of attack. In this sense, it's much like influenza virus, which killed 50 million people in the pandemic of 1918 and whose constantly shifting genetic makeup forces us to get new flu shots year after year. When it comes to persistence, there's nothing like a microorganism.

(http://theplate.nationalgeographic.com/files/2014/07/5242099029_1513a715a6_b.jpg)
Agustín Aguilar, CIMMYT greenhouse and laboratory assistant, at work in the greenhouse that houses transgenic wheat at CIMMYT's El Batán, Mexico headquarters. Photograph by Xochiquetzal Fonseca/CIMMYT

GMOs Could Offer a Fix

More effective rust resistance comes from a technique called "pyramiding" in which multiple resistance genes are loaded onto a single strain of wheat. As was true of the Three Musketeers, there's strength in numbers: multiply-resistant wheat strains can sometimes fight off rust for decades. Traditional breeding strategies are effective here, but are painfully slow, sometimes taking fifteen years or more to produce a rust-resistant variety. Better and faster is genetic engineering in which an entire string of rust-resistant genes—many plucked from tough wild grasses—is pieced together and inserted as a block into a wheat chromosome. Public opposition to GMOs, however, has slowed or blocked the development of such rust-resistant wheats—and that could come back to bite us. If Ug99 gets off the ground, we're going to need a lot of help, and fast.

Rust isn't a problem that's going to go away—and even the best and brightest of rust-resistant strains won't remain so forever. As Norman Borlaug presciently said: "Rust never sleeps." It's something to think long and hard about.

Especially if we hope to keep on eating our daily bread.

This story is part of* National Geographic*'s special eight-month Future of Food (http://food.nationalgeographic.com/)series.

Grens, Kerry. “Putting Up Resistance.” *The Scientist*, June 2014, pp 34-39.
See Stem rust of wheat (http://www.apsnet.org/edcenter/intropp/lessons/fungi/Basidiomycetes/Pages/StemRust.aspx) from the American Phytopathological Society.
Oppenneer, Betsy. *Celebration Breads: Recipes, Tales, and Traditions*. Simon & Schuster, 2010.

Trackbacks

1. *Killer Fungus Could Threaten World Food Supply | The Inquisitive Eater (http://inquisitiveeater.com/2014/07/10/killer-fungus-could-threaten-world-food-supply/)* says:
   July 10, 2014 at 3:02 pm
   (http://theplate.nationalgeographic.com/2014/07/10/killer-fungus-could-threaten-world-food-supply/#comment-547)

   […] To read the full article please visit The Plate. […]

   (/2014/07/10/killer-fungus-could-threaten-world-food-supply/?replytocom=547#respond)
2. *Morsels For The Mind – 18/07/2014 › Six Incredible Things Before Breakfast (http://www.scilogs.com/six_incredible_things_before_breakfast/morsels-for-the-mind-18072014/)* says:
   July 19, 2014 at 10:09 pm
   (http://theplate.nationalgeographic.com/2014/07/10/killer-fungus-could-threaten-world-food-supply/#comment-565)

   […] Rust never sleeps. Rebecca Rupp on the rust fungus that threatens our food supply. […]

   (/2014/07/10/killer-fungus-could-threaten-world-food-supply/?replytocom=565#respond)

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In our rapidly changing, globalized world, we all need to understand how food has made us who we are today and how it shapes our future. Starting with the May issue of *National Geographic* magazine and continuing on through 2014, National Geographic explores our complex relationship with what we eat and where our food comes from.

About Rebecca Rupp

Rebecca Rupp has a Ph.D. in cell biology and biochemistry, and is the author of more than 200 articles for national magazines and nearly two dozen books, both for children and adults. Her most recent book, *How Carrots Won the Trojan War*—an overview of the history and science of garden vegetables—won the GWA Gold Award as Best Garden Book of 2012. She lives in northern Vermont and attempts to be open-minded about everything except centipedes and lima beans.

Food by the Numbers


(http://www.nationalgeographic.com/foodbynumbers/)

Interested in food? Check out our "Food by the Numbers" (http://www.nationalgeographic.com/foodbynumbers/) video infographics.

From: Nancy Oden [mailto:cleanearth@tds.net]
Sent: Monday, July 21, 2014 12:50 PM
To: Jennings, Henry
Subject: The EPA Dithers While a Popular Pesticide Threatens Ecosystems | Mother Jones

Henry - Please print out this article (link below) and put it in the Board's packets for next meeting. Thank you. I don't know how much more actual, genuine (non-industry) science it will take to get the Board to ban Neonicotinoid pesticides.

We and the world know they're killing bees (and other helpful insects, too, of course) while the Board fiddles with what new pesticides they're going to approve this month. There is much that can be said about their inaction on pesticides toxic not only to bees, but us, too - - but I will not do so at this time.

Please just see that they get this article. I hope you've given them the others I've sent from time to time. Do any Board members even comment on any of them, ever? You can include this email, too, if you think it might help them come to some good decisions!

Thank you..... - Nancy Oden, Clean Earth Farms, Jonesboro, Maine

http://www.motherjones.com/tom-philpott/2014/07/silent-spring-eternal-epa-dithers-while-popular-pesticide-threatens-ecosystems

The EPA Dithers While a Popular Pesticide Threatens Ecosystems

—By ***Tom Philpott*** *(/authors/tom-philpott)* | Fri Jul. 18, 2014 4:18 PM EDT

Ah, summer—the season when trillions of corn and soybean plants tower horizon-to-horizon in the Midwest. All told, US farmers planted more than 170 million acres (http://www.nass.usda.gov/Newsroom/2014/06_30_2014.asp) in these two crops this year—a combined landmass roughly equal in size to the state of Texas (http://www.statemaster.com/graph/geo_lan_acr_tot-geography-land-acreage-total). That's great news for the companies that turn corn and soy into livestock feed, sweeteners, and food additives; but not so great for honeybees, wild pollinating insects like bumblebees, and birds.

That's because these crops—along with other major ones like alfalfa and sunflower—are widely treated with pesticides called neonicotinoids. Made by European chemical giants Bayer and Syngenta, these chemicals generate a staggering $2.6 billion in annual revenue (http://www.rollcall.com/news/pesticide_ban_is_just_one_piece_of_honeybee_puzzle-233624-1.html) worldwide—and have come under heavy suspicion as a trigger of colony collapse disorder and other, less visible, ecological calamities.

Last year, the European Union imposed a two-year ban on the chemicals (http://www.motherjones.com/tom-philpott/2013/05/eu-ban-bee-harming-pesticides-puts-pressure-us-epa), pending more study of their effects on pollinators. The US Environmental Protection Agency—which originally approved the products through a highly dubious process I laid out here—has stood by (http://www.epa.gov/pesticides/about/intheworks/ccd-european-ban.html) these ubiquitous pesticides.

Meanwhile, damning research piles up.

• In a study (http://onlinelibrary.wiley.com/doi/10.1111/1365-2435.12292/full) (press release here (http://www.sciencedaily.com/releases/2014/07/140709140308.htm)) that came out in early July and was published in the peer-reviewed journal *Functional Ecology*, UK researchers outfitted bumblebees with radio-frequency identification tags, dosed some of them with levels of neonics equal to what they might find in a treated field, and set them outside to observe their foraging behavior. The results suggest that the pesticides impair bees' learning ability: Bees from untreated colonies improved their pollen-collecting ability as they learned to forage, while their neonic-exposed counterparts saw their pollen collection dwindle with time. The takeaway is similar to that of another bumblebee study (http://www.nature.com/nature/journal/v491/n7422/full/nature11585.html#affil-auth) (my summary here (http://www.motherjones.com/tom-philpott/2012/10/yet-another-study-links-bayer-pesticide-bee)), this one by a different set of UK researchers and published by *Nature* in 2012. Bad foraging makes bee colonies more vulnerable to a host of threats that confront them: loss of habitat, parasitic mites, and viruses.

• Another study (http://www.nature.com/nature/journal/vaop/ncurrent/full/nature13531.html#affil-auth), also released in July, adds weight to the concern that neonics aren't just harming insects, but also birds (http://www.motherjones.com/tom-philpott/2013/03/not-just-bees-bayers-pesticide-may-harm-birds-too). In this one, published in *Nature* and well-summarized by *National Geographic* (http://news.nationalgeographic.com/news/2014/07/140709-birds-insects-pesticides-insecticides-neonicotinoids-silent-spring/), scientists looked at neonic concentrations in water and bird populations over time on Dutch farmland. They found that in the areas with relatively high concentrations of a common neonic called imidacloprid, bird populations "tended to decline by 3.5 per cent on average annually." The evidence is circumstantial—they proved that neonics are correlated with, but not the cause of, bird declines. But the case is pretty damning: The declines began in the mid-'90s, when neonics were introduced; and the correlation with neonic concentrations held up when the researchers controlled for other factors that could cause bird decline, like changes in crop type and amount of fertilizer used. The authors conclude that neonics may have "cascading effects" on ecosystems—by poisoning insects en masse, they harm the other species that feed on them, including birds. In that way, neonics are reminiscent of the "persistent insecticides in the past"—a reference to the harsh, now-banned chemicals like DDT that Rachel Carson thundered against in her seminal 1962 book *Silent Spring.*

> In the areas with relatively high concentrations of a common neonic, bird populations "tended to decline by 3.5 per cent on average annually."

• *The Silent* Spring analogy got a depressing boost earlier in the summer when a group of European scientists called the Task Force on Systemic Pesticides released a comprehensive analysis of the recent science on neonics' ecosystem effects. Their conclusion, published in the peer-reviewed *Environmental Science and Pollution Research (https://www.motherjones.com/files/iucnneonics.pdf)*: "Population-level impacts have been demonstrated to be likely at observed environmental concentrations in the field for insect pollinators, soil invertebrates and aquatic invertebrates." Translation: the stuff is likely not just killing bees, but also earthworms and water bugs like dragonflies. "The evidence is very clear. We are witnessing a threat to the productivity of our natural and farmed environment equivalent to that posed by organophosphates or DDT," Jean-Marc Bonmatin, of the National Center for Scientific Research (CNRS) in France and one of the 29 international researchers who conducted the four-year assessment, told *The Guardian* (http://www.theguardian.com/environment/2014/jun/24/insecticides-world-food-supplies-risk). "Far from protecting food production, the use of neonicotinoid insecticides is threatening the very infrastructure which enables it."

I asked the Environmental Protection Agency for comment on its neonic stance amid such withering criticism. "The EPA will continue monitoring the open literature and other data sources for further developments on this issue," the agency replied in a statement. Meanwhile, it is painstakingly reviewing its approval (http://www2.epa.gov/pollinator-protection/schedule-review-neonicotinoid-pesticides) of each of the major neonicitinoid products, the first of which won't be completed until 2016-'17.

Lay Off the Almond Milk, You Ignorant Hipsters (/tom-philpott/2014/07/lay-off-almond-milk-ignorant-hipsters)

That Antioxidant You're Taking Is Snake Oil (/tom-philpott/2014/07/everything-we-know-about-antioxidants-and-vitamins-wrong)

WRP#EKIDSRWW (/authors/tom-philpott) *Food and Ag Correspondent*

Tom Philpott is the food and ag correspondent for *Mother Jones*. For more of his stories, click here (http://www.motherjones.com/authors/tom-philpott). To follow him on Twitter, click here (http://twitter.com/#!/tomphilpott). RSS (/RSS/AUTHORS/116126) | TWITTER (HTTP://TWITTER.COM/TOMPHILPOTT)

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Are Your Delicious, Healthy Almonds Killing Bees? (/tom-philpott/2014/04/california-almond-farms-blamed-honeybee-die)
Sixty percent of the nation's managed honeybees pollinate California's almond harvest. And they're getting doused with some gnarly chemicals.

Did Scientists Just Solve the Bee Collapse Mystery? (/tom-philpott/2014/05/smoking-gun-bee-collapse)
The environment is full of stuff that harms bees—but a new Harvard study fingers a Bayer pesticide as the main culprit.

The Mystery of Bee Colony Collapse (/tom-philpott/2013/07/bee-colony-collapse-disorder-fungicides)
Scientists have blamed insecticides for years, but new research suggests another deadly killer...

Feds Will Take Their Sweet Time Evaluating Pesticide Linked to Bee Deaths (/blue-marble/2013/04/epa-honeybees-drop-dead)
The EPA will allow use of neonic pesticides at least through 2018. That's good news for Syngenta and Bayer; bad news for the birds and the bees.

3 New Studies Link Bee Decline to Bayer Pesticide (/tom-philpott/2012/03/bayer-pesticide-bees-studies)
And pressure mounts for the EPA to do something about it.

Boston deploys goats against poison ivy in Hyde Park

By Faiz Siddiqui | GLOBE CORRESPONDENT JULY 23, 2014

The leader, Cole, ambled up to the metal fence, and with a wide stare and what looked like a grin, began to survey his new domain.

One by one, the others followed Cole through the gate: Chester, a fellow LaMancha goat with a paintbrush-like black tail; Dalia, an Alpine with perky white ears; and Christopher, another Alpine with a long gray beard that conjured up the image of a wise man.

CONTINUE READING BELOW ▼

It was not long before all of Boston's newest contract employees had disappeared among the

tall trees and brush in Hyde Park's West Street urban wild. Their task: Help to clear 2 acres overrun with poison ivy, buckthorn, Asiatic bittersweet, Japanese knotweed, and other invasive species growing on Parks and Recreation Department property.

Best of all for the cloven-hoofed friends, these menaces are lip-smacking delicacies.

"It's not only cute, but it makes really good sense," said 27-year-old Jessica Muscaro, the project coordinator for the Hyde Park Green Team.

Department officials said it was the first time Boston has sought the help of goats for a city project. Officials say the hairy, four-legged weed whackers represent a fast, clean, and efficient way to clear the area for green space without using herbicides or loud and polluting machinery.

The four goats will live in the urban wild for eight weeks, protected by a solar-powered electric fence. People are encouraged to look, but not touch, as the poison ivy oils may stick to the goats' coats, even though it does not harm their digestive tracts.

CONTINUE READING BELOW ▼

Teenagers from the Hyde Park Green Team will provide water and food to supplement the goats' diet , then begin pruning trees and building trails once the area cleared.

"Goats are an ecofriendly way to regulate overgrowth and manage pests and weeds, while giving nutrients back to the earth," Mayor Martin J. Walsh said in a statement.

Tony Barrows, who has lived in Hyde Park for 27 years, remembered taking his young daughter to the site, alongside the Neponset River, in the 1990s. That was before the trees had been choked by the Asiatic bittersweet and the trails covered by other invasive plants.

"I'd like to see some development along the river bank where people can jog, or just sit down, read a book," he said.

DAVID L RYAN/GLOBE STAFF

The goats will live on site at the West Street Urban Wild for eight weeks.

The $2,800 to rent the goats is being covered by grants provided to the Southwest Boston Community Development Corporation. James Cormier, owner of the Goatscaping Co. in Plympton, is providing the animals, which range from 120 to 170 pounds.

“It would be way more time-consuming for the city to come in and start chop, chop, chopping away,” he said.

The community development corporation’s assistant director, Pat Alvarez, said she came up with the idea to use goats after hearing about other cities using animals to make way for urban greenspace. Goats, sheep, llamas, and wild burros have cleared brush at O’Hare International Airport in Chicago. In Washington, D.C., goats helped clear the Congressional Cemetery in 2013.

Alvarez fondly remembered being chased around her yard by a “mean” billy goat as a child.

The four goats deployed in Boston were similarly mischievous Wednesday.

One began to chew on a Goatscaping sign dug into the dirt, prompting Cormier to yell, “Hey, don’t eat the sign!” Another, Dalia, attempted to climb a tree before giving up.

But they soon got down to business. Christopher's beard flapped against his chin as he chomped on a leafy bush. Dalia's long ears wiggled as she chewed a dense shrub to the stem. Within an hour, small sections of foliage had been cleared.

"They're quiet, unlike machinery," Alvarez said. "We also think they're going to be great ambassadors for the urban wild. Plus, they're just fun."

Faiz Siddiqui can be reached at faiz.siddiqui@globe.com.