

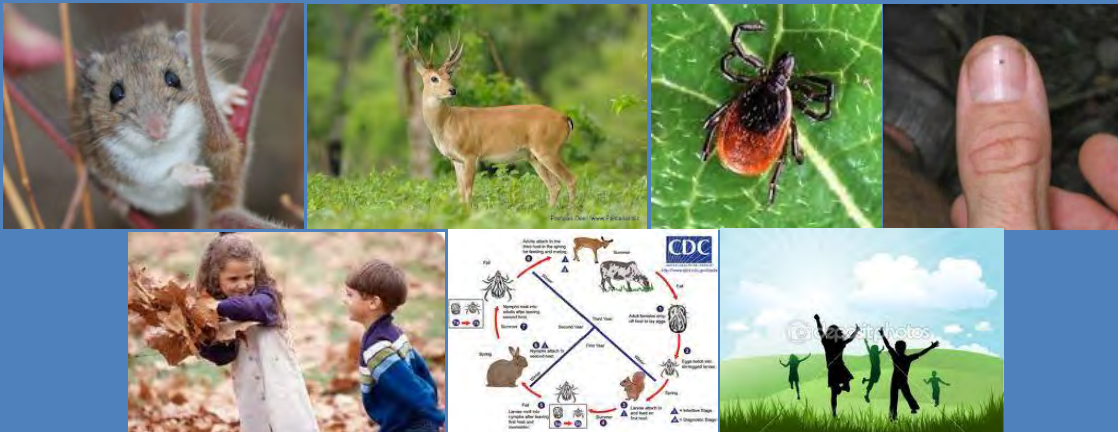
US EPA ARCHIVE DOCUMENT

Report on Tick-Borne Disease and Integrated Pest Management Conference Arlington, VA March 5-6, 2013

Sponsored by
Centers for Disease Control and Prevention and
US Environmental Protection Agency



And Participating Federal Partners



Prepared for:

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I. Introduction and Welcome

Introduction

The US Environmental Protection Agency (EPA) and the Centers for Disease Control and Prevention (CDC) co-hosted a conference on Tick-Borne Disease (TBD) Integrated Pest Management (IPM) on March 5-6, 2013, in Arlington, VA. This conference brought together representatives from numerous federal, state and local agencies, academia, and stakeholders to discuss the current state of IPM for the management of tick-borne diseases.

This conference built upon EPA's 2011 Promoting Community IPM for Preventing Tick-Borne Diseases Conference (www.epa.gov/pestwise/events/tick_meeting.html). The 2011 conference captured the research and information surrounding prevention of TBD from the perspective of government and non-government stakeholders. Key outcomes, summarized at www.epa.gov/pestwise/events/ticks/tickconferencereport.pdf, included the identification of successful strategies for community IPM programs, research priorities and knowledge gaps, and potential partnerships.

The TBD-IPM Workgroup was borne out of the conference. Formed under the auspices of the Public Health Pesticide Consortium, the TBD-IPM workgroup is an alliance of 14 federal agencies addressing the recommendations of the 2011 conference and developing a white paper that details federal sector research needs, including developing measurable IPM tools to reduce risk from tick-borne disease.

TBD-IPM Workgroup efforts have included:

- Collecting, integrating, and sharing best practices, including communications tools and resources, for IPM of ticks and TBDs,
- Identifying and prioritizing research gaps and needs,
- Sharing agency-specific strategic plans relating to the control of infected ticks and the pathogens they may transmit, and
- Developing a white paper and strategy for IPM and prevention of TBD and consensus documents that can be shared across US federal agencies for the purpose of promoting and coordinating IPM programs and activities.

The objectives of the 2013 conference were to:

- Complete the Federal Initiative: Tick-Borne Disease Integrated Pest Management White Paper,
- Identify research strategies to support community IPM programs,
- Facilitate collaboration among federal partners to support research initiatives, and
- Provide information on current tick IPM research.

This report provides discussions from each presenter according to the agenda. The presentations of the speakers who agreed to provide them publicly are attached on EPA's website:

http://www.epa.gov/pesp/events/2013_tick_meeting.html



United States Environmental Protection Agency and Centers for Disease Control and Prevention

Welcome. Keith Matthews, EPA and Ben Beard, CDC

Tick-borne diseases (TBD) are recognized as of high priority, with three novel tick-borne diseases seen in humans. The goal of this conference is to discuss what we are doing to address and prevent TBD transmission and how we can improve prevention tools.

The *Federal Initiative: Tick-Borne Disease Integrated Pest Management White Paper* was developed by the interagency Tick-borne Diseases Integrated Pest Management Workgroup (TBD IPM WG) for the purpose of enhancing communication and collaboration among US federal agencies. The Workgroup would like comment on the following questions:

- Do we have it right?
- How can we make it a document we can use to get more support?

II. Lyme Disease and Other Tick-Borne Diseases of Humans in the United States White Paper



United States Department of Agriculture

Overview of Inter-Agency White Paper. Dan Strickman, USDA (7 pp, 190k)

Daniel Strickman, National Program Leader for Veterinary, Medical, and Urban Entomology within the US Department of Agriculture's (USDA) Agricultural Research Service (ARS), and Acting Director of USDA's Overseas Biological Control Laboratories, introduced the Tick-Borne Disease (TBD) Integrated Pest Management (IPM) Workgroup White Paper, *Federal Initiative: Tick-Borne Disease Integrated Pest Management*, that highlights federal partner agency accomplishments, identifies opportunities for collaboration among stakeholders, and states the related research needs of highest strategic priority as well as potential initiatives to measure success.

III. Research Strategies to Support Community IPM Programs

SESSION 1, DAY 1: AGENCY OVERVIEWS



USDA Animal and Plant Health Inspection Service: Veterinary Services (VS) Approaches to Tackling Ticks in the US. Matthew Messenger and Angela James, APHIS, USDA (12 pp, 782k)

Tick-related activities within US Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Veterinary Services (VS) include epidemiology, surveillance and monitoring, and control. VS receives requests from industry and professional organizations and provides identification and information services pertaining to parasites of animals, often related to the distribution of ticks and their related diseases. The Veterinary Services' Centers for Epidemiology and Animal Health (CEAH), Fort Collins, CO works to answer these questions and is eager to collaborate and share information.

Tools used by VS include tick geo database, life histories, and distribution maps for various tick species. Data from tick activities are used by the Smithsonian and National Ecological Observatory Network (NEON), for mapping, predictive species modeling, and disease risk categorization. APHIS National Veterinary Services Laboratories (NVSL), in Ames, IA provides ticks identification and diagnostic testing for diseases, focusing on ticks of livestock, exotic ticks, screwworms, and hemoparasites. NVSL receives ticks from many sources, with the majority coming from the Cattle Fever Tick Eradication Program (CFT), the DHS Custom Border Protection, and the US Fish and Wildlife Service.

APHIS has been involved in tick control efforts for many years. The CFT develops and evaluates tick control products, e.g., anti-tick vaccines, control and treatment devices, and self-medicating technologies. Its principal collaborators are USDA ARS and major veterinary pharmaceutical and feed companies. VS's *One Health (OH) Strategic Direction* focuses on domestic and foreign animal health issues that have potential to affect human health and the environment. As a result, VS is building new collaborations and partnerships and sustain existing relationships in the OH community and spearheading outreach and communication to build credibility, trust, and respect in the OH community.

USDA Agricultural Research Service: Our Tick Work. Dan Strickman, ARS, USDA

The Agricultural Research Service (ARS) is an in-house research arm of USDA. Its fiscal year budget exceeds \$1 billion. ARS has over 100 labs in the US – many of which are co-located with land grant universities and 6 at overseas locations. ARS has the largest research program in Veterinary Entomology. The Veterinary, Medical, and Urban Entomology Program consists of 58 scientists, working at 10 locations, with a \$16 million annual budget.

Three ARS labs collaborated with the Yale University School of Medicine on tick-related research; however, earmarked funding for Yale was lost in FY2011. Although ARS has experienced program

loss due to budget cuts, the tick program continues at a reduced level. The ARS Natural Products Utilization Research Unit, in Oxford, Mississippi, researches natural products for uses in agriculture in order to produce more toxicologically benign pest management tools. (CDC is also doing significant work in this area.)

ARS's work related to the Cattle Fever Tick focuses on treatment of wild deer (which also controls the tick population), the application of existing vaccine based on the genome of the Cattle Fever Tick, and research related to new toxicants. Candidate antigens have been found to be highly effective against the Cattle Fever Tick.

Products produced from the ARS Program include:

- 4-poster deer treatment bait stations for self-treatment of deer,
- an automatic deer collaring device that has ability to administer vaccine,
- Ivermectin treated mineral-protein block, which works for cattle but has not been effective for deer,
- DEET and experimental repellents,
- anti-tick vaccines, and
- research of the *Borrelia miyamotoi* pathogen, which has been associated with Lyme-like illness.

National Institute of Food and Agriculture's Portfolio of Extension and Research Projects on Ticks. Herbert Bolton, NIFA, USDA (15 pp, 267k)

The mission of USDA's National Institute of Food and Agriculture (NIFA) is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education, and extension programs. While ARS is USDA's intramural research arm, NIFA coordinates extramural research, with its links to land-grant universities and others eligible to receive grant funding.

Currently, NIFA does not support a specific grant program for research on ticks or tick-borne diseases, though this research is eligible for funding under several NIFA-funded programs:

- NIFA, in collaboration with the National Science Foundation (NSF), administers the Ecology and Evolution of Infectious Diseases Program, a competitive grants program, though to date NIFA has not funded any tick related research.
- NIFA provides Capacity Building Funding to land-grant universities, which administer these funds. The recipient university decides how to use funds for research. Capacity Building Funding accounts for approximately one-half of NIFA's funding. Land-grant universities have supported many tick and tick-borne disease research and extension projects with Capacity Building Grants.
- NIFA funds 4 Regional Integrated Pest Management Centers (IPM Centers), which act as regional focal points for pest management information networks and collaborative team building to promote the development and implementation of IPM across states, disciplines, and purposes.
 - The Southern IPM Center provided funding for the *TickApp for Texas and the Southern Region*, which provides citizen consumers and professional practitioners with a convenient guide to the identification of ticks impacting humans, livestock, companion animals, and wildlife.
- NIFA contributes funding to extension, an Internet-based collaborative environment where land-grant university content providers exchange objective, research-based knowledge to solve real challenges in real time. The extension web site is organized into Communities of

Practice that foster virtual collaboration on several areas related to pest management, such as pest management in and around structures, which includes IPM for ticks in homes and schools and for pets.

- Under its Special Research Grants Program, NIFA has funded five tick research projects.



Department of Defense

Department of Defense Efforts in Tick Surveillance and Preventing Tick-Borne Disease in the US. Ellen Stromdahl, DoD (41 pp, 3.6MB)

Tick-borne disease is considered an occupational health risk for the military personnel in the field and their dependents. The US Army Public Health Command (USAPHC) conducts tick and tick-borne disease surveillance, tick taxonomy and imaging, and tick repellents.

- USAPHC has created tick threat maps using GIS to map pest populations and geospatially communicate areas of varying tick risk.
- In support of its tick and tick-borne disease surveillance, USAPHC collects ticks by a variety of methods. USAPHC manages the Human Tick Test Kit Program, a free tick identification and pathogen testing service for DoD health care facilities. USAPHC analyses the resulting data.
- The Entomological Sciences Program at the US Army Institute of Public Health developed the Macropod, a field-portable macro imaging device for ultra-high resolution photography for arthropod identification. It allows for high-resolution imaging of insect vectors with rapid posting to the Internet for species identification and dissemination to deployed soldiers.
- USAPHC publishes the Army Vector-borne Disease Report weekly through the summer months in the US. By describing cases of key vector-borne diseases among Army beneficiaries as well as vector surveillance results across Army installations, the report provides a picture of disease threat and occurrence.
- The Walter Reed Biosystematics Unit (based in the Smithsonian Institution) has created TickMap, a geospatially referenced online clearinghouse for tick disease vector species collection records and distribution models. Users can pan and zoom to anywhere in the world to view the locations of past tick collections and the results of modeling that predicts the geographic extent of individual species. This new, interactive tool contains approximately 56,000 records.
- The Armed Forces Health Surveillance Center (AFHSC) publishes the Medical Surveillance Monthly Reports, an online journal that includes case reports of tick-borne disease in military patients.
- The Defense Medical Epidemiology Database is an AFHSC tool that provides remote access to a subset of data contained within the Defense Medical Surveillance System (DMSS), the central repository of medical surveillance data for the US Armed Forces. Users can query and get up-to-date and historical data on diseases and medical events and longitudinal data relevant to personnel characteristics and deployments experience for all active duty and reserve component service members.
- The Naval Medical Research Center (NMRC) has developed a quantitative real-time polymerase chain reaction (qPCR) assay for identification and detection of tick-borne pathogens, i.e., various rickettsial pathogens, in clinical specimens and various pathogen vectors.

- NMRC personnel are researching *Rickettsia parkeri* in adults and children to determine the incidence of *R. parkeri* and diagnose fevers and rashes of unknown origin.
- NMRC is developing a new paper swabbing procedure for testing of Rickettsial disease. This technique may be incorporated into the Human Tick Test Kit Program.
- The Armed Forces Pest Management Board (AFPMB) meets two times/year to make policy recommendations, provide guidance, and coordinate the exchange of information on all matters related to DoD pest management. Its website includes obscure and newly published papers, and a DVD on tick identification, available at no cost.
- The DoD Insect Repellent System, adopted by AFPMB, is used against arthropods of military significance and is required for all military personnel. It consists of permethrin treated uniforms (either factory-treated or field applied), properly worn, and the application of DEET on exposed skin. The use of the DoD Insect Repellent System and other personal protective measures (PPMs) by service personnel are required by military policy when they are in situations where insect exposure is likely.
- The Deployed War-Fighter Protection (DWFP) is a DoD-sponsored research program administered by the AFPMB to develop and validate novel methods to protect US military personnel deployed abroad from threats posed by disease-carrying insects.
- The USDA ARS's Center for Medical, Agricultural, and Veterinary Entomology (CMAVE) – located in Gainesville, FL – conducts research on insects of agricultural, medical, and veterinary importance, with the goal of achieving control of pest species through the development of environmentally acceptable approaches. CMAVE conducts biological monitoring. CMAVE developed test procedure to ensure military uniforms are correctly treated to protect troops from arthropod bites. The US Army Natick Soldier Research, Development, and Engineering Center monitor for permethrin applications applied to military clothing.



Centers for Disease Control and Prevention

Centers for Disease Control and Prevention Activities on Lyme and Other Tick-Borne Diseases. C. Ben Beard, CDC (11 pp, 2.4MB)

Within the U.S. Centers for Disease Control and Prevention (CDC), responsibility for activities related to Lyme and other tick-borne diseases is shared between several different organizational groups. The Division of Vector-Borne Diseases (DVBD), within the CDC's National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), is responsible for national surveillance, reference diagnostics, prevention, control, research, and outbreak response for Lyme disease, tularemia, tick-borne relapsing fever, Heartland virus, Powassan virus, *Rickettsia*, and anaplasmosis. The Division of Parasitic Diseases and Malaria (DPDM) in CDC's Center for Global Health (CGH) coordinates nationwide human surveillance and other activities related to babesiosis. Responsibilities related to the safe use of pesticides and integrated pest management reside within CDC's National Center for Environmental Health (NCEH). Activities that address the protection of workers from tick-borne diseases reside in the National Institute of Occupational Safety and Health (NIOSH). CDC's Lyme disease strategic prevention priorities are aimed at the goal of building a national prevention plan based on validated prevention methods and approaches, on which to establish a Department of Health and Human Services' (DHHS) Healthy People 2020 goal for Lyme disease prevention. CDC's four-part prevention strategy includes strengthening surveillance, identifying and validating prevention methods, improving early and accurate diagnosis, and

leveraging collaboration with external partners and stakeholders. Public health products and services in the developmental pipeline include new diagnostics, novel vaccines, natural product insecticides, and educational resources.

Recent IPM highlights and CDC accomplishments include:

- Initiation of the TickNet program – a collaborative public health effort that fosters coordinated surveillance, research, education, and prevention of tickborne diseases with local and state departments – in 19 states and field trials using acaricide in residential yards.
- Launch of a communication plan and prevention toolkit to improve public awareness and knowledge.
- Creation of a course on the importance of IPM to the control of public health pests, including ticks.
- Demonstration of the field efficacy of rodent target bait boxes.
- Partnering with industry to develop a host-targeted Lyme disease vaccine and evaluate in lab animals.
- Partnering with universities and industry on field trials of a host-targeted vaccine for rodent reservoirs of *Borrelia burgdorferi*.
- Identification of the brown dog tick as the primary vector of *Rickettsia rickettsii* in recent RMSF outbreaks in Arizona.
- Collaboration with state, federal, local, and tribal partners on a pilot study and coordinated IPM program to control *R. sanguineus* using a newly developed tick collar.
- Development of educational material for outdoor employers and workers.
- Funding of field evaluation of novel tick control IPM methods by university partners.



National Institutes of Health

National Institutes of Health–National Institute of Allergy and Infectious Diseases Lyme Disease and Other TBDs: A Focus on Prevention Research Projects. Joseph Breen, NIAID, NIH (11pp, 555k)

Research on Lyme disease and other TBDs at the NIH focuses on prevention research projects conducted by multiple institutes and centers, with the majority of research – both intramural and extramural – supported by the National Institute for Allergy and Infectious Diseases (NIAID).

The major goals of the NIAID Lyme Disease Research Program are to develop better means of diagnosing, treating, and preventing Lyme disease. Its activities in relation to TBDs include:

- Development of a reservoir targeted vaccine using VV-OspA – through a public-private partnership with a biopharmaceutical company and CDC-DVBD – which is undergoing testing.
- Funding of development of a reservoir targeted vaccine using e-OspA – small business award to a medical research company with university collaborators; completed phase I proof of principle with NIAID support; and now undergoing further development with CDC support.
- The NIAID Genomic Sequencing Centers for Infectious Diseases have completed projects on *Borrelia burgdorferi* (11 strains) and *Ixodes scapularis* and is pursuing ongoing projects on *Ehrlichia chaffeensis* (8+ strains), *Babesia microti* (multiple strains), Rickettsiales species

(approximately 25 strains planned), and Anaplasmataceae species (approximately 16 strains planned).

- Report released by the Institute of Medicine of the National Academies, April 20, 2011: *Critical Needs and Gaps in Understanding Prevention, Amelioration, and Resolution of Lyme and Other Tick-Borne Diseases: The Short-Term and Long-Term Outcomes – Workshop Report.*



National Science Foundation

Tick-borne Disease Research at the NSF. Samuel Scheiner, NSF (12 pp, 887k)

The National Science Foundation (NSF) is an extramural funding agency, making grants primarily to academia and through partnerships with academia. Core programs relating to TBD include:

- Population and Community Ecology – in particular, the effect of biological diversity on disease transmission, i.e., examining how community structure affects vector-borne diseases.
- Symbiosis, Defense and Self-Recognition – the interaction between hosts and vectors.
- Evolutionary Ecology – evolutionary dynamics.
- Mathematical Biology – disease dynamics from theoretical standpoint or modeling.

NSF (Directorates for Biological Science; Social, Behavior and Economic Sciences; and Geosciences) also funds and administers – in collaboration with the NIH Fogarty International Center, USDA NIFA, and the UK Research Councils – special competitions for grants in the Ecology and Evolution of Infectious Diseases (EEID), with the mission of developing predictive principles to enable the prevention of infectious disease transmission. This program has funded 109 interdisciplinary research projects since it began in 2000, some of them focusing on TBDs.

EEID research projects:

- Look at all factors – ecological context, pathogen dynamics, environmental change, socio-economic context, transmittal agent(s), host(s) biology – as one system.
- Apply a multivariate approach toward risk assessment.
- Emphasize the prevention of infectious disease through forwarding a more comprehensive and rigorous science.
- Consider a diversity of diseases and hosts.



Department of Interior

US Department of the Interior. Howard Ginsberg, USGS

Within the Department of the Interior (DOI), the National Park Service (NPS), US Fish and Wildlife Service (FWS), and Bureau Land Management (BLM) are the primary agencies that work to protect wildlife – as well as their staff, visitors, and local human populations – from tick-borne diseases issues. The US Geological Survey (USGS), as a research agency of DOI, supports these efforts through research.

The focus of NPS is the protection of natural systems. Its efforts directed toward preventing tick-borne disease can be challenging, as some technologies used to protect wildlife may have negative impact on humans. NPS uses IPM methods to prevent vector-borne diseases. Within NPS, the Wildlife Health Branch is most closely associated with vector-borne diseases.

Several USGS program areas – i.e., land use change, environmental health (Geohealth newsletter), natural hazards, water, and ecosystems – link to TBD. Its National Wildlife Health Center – which includes a program for wildlife disease research – has conducted a modest level work on tick-borne diseases. The USGS web site, diseasemaps.usgs.gov, provides disease mapping by country, based on data provided by state health departments to CDC, using CDC's ArboNet surveillance system. Although its primary focus is mosquito transmitted diseases, it recently added tick-borne diseases. FWS' function is to protect land, wildlife, plants, and fish. It maintains over 500 refuges; consequently ticks are a regular occurrence. FWS addresses TBD prevention through planning and preparedness and the use of IPM. Further, FWS has experimented with permethrin treated clothing and limiting the number of vehicles in the field as means to prevent tick bites and TBD transmission. FWS uses the DOI illness tracking system for monitoring occurrence of certain diseases, such as Lyme disease and *babesiosis*. It also maintains a log of tick bites received by personnel, though not all bites result in disease.



United States Environmental Protection Agency

US Environmental Protection Agency Activities Related to Lyme Disease, EPA Overview and New England Regional Research. Bart Hoskins, EPA (35 pp, 5MB)

EPA's legislative mandate under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), is to: register pesticides (including requirements for: pesticides (e.g., pesticide-treated clothing and acaricides – conventional, biochemical, and microbial); products for controlling ticks in the environment and on pets; and testing of repellents); certify and train pesticide applicators; and support IPM and its implementation. In particular, FIFRA's mandate to EPA regarding IMP is:

- To conduct research on IPM;
- To develop IPM approaches to pest control, in cooperation with the Secretary of Agriculture; and
- To identify pests with significant public health importance, in coordination with the Secretaries of Agriculture and Health and Human Services, and implement programs to improve and – in coordination with the Public Health Services – facilitate the safe necessary use of chemical, biological, and other methods to combat and control these pests of public health importance.

These responsibilities are primarily managed by the EPA Office of Pesticide Programs (OPP), with research assistance from EPA Office of Research and Development (ORD) programs and the EPA Region 1 New England Regional Laboratory. OPP's tick control efforts include: providing IPM grant opportunities; managing a voluntary, public-private partnership, the Environmental Stewardship Program; collaborating with local, state, federal, academia, and non-profit organization on IPM; and co-leading the federal TBD-IPM work group.

OPP is also developing a voluntary labeling program for insect repellents to include skin-applied insect repellents; and a standardized graphic that clearly informs consumers of pests repelled (e.g., mosquitoes and ticks) and duration.

Through its Ecosystems, Biodiversity, and Infectious Disease Program, ORD – EPA's scientific research arm – is conducting research on ticks, anthropogenic stressors, and zoonotic disease risk.

ORD continues to initiate and support research related to Lyme disease through interagency agreements and grants and support and facilitation of collaborations. EPA recently completed a seven year study of the effectiveness of permethrin-treated deer feeding stations for control of *Ixodes scapularis* on Cape Cod and the Islands.

The preliminary findings of this study included:

- A statistically significant reduction in tick populations in the control versus study areas.
- Some areas appear to have greater incidence of co-infection (i.e., Lyme + *Anaplasma* or *Babesia*) in collected ticks.

EPA has funded a co-infection host study in small mammals. Results are expected in late 2013.

IV. Collaboration Among Federal Partners to Support Research Initiatives

SESSION 2, DAY 1: FEDERAL COLLABORATION ON RESEARCH TOOLS



US Environmental Protection Agency

Research Initiatives from EPA's 2011 Tick IPM Conference. Candy Brassard, EPA (12 pp, 411k)

The research priorities and knowledge gaps identified at the March 30-31, 2011 conference, Promoting Community IPM for Preventing Tick-Borne Diseases, were:

- Reliable surveillance data on vector distribution
- Alternatives to area wide acaricides
- Efficacy of alternative control strategies and repellents
- Linking entomological and epidemiological data
- Measuring impact of the IPM on tick-borne disease incidence
- Inventory of outreach materials
- Creation of evidence-based policies

Advances in reliable surveillance data since the 2011 conference include: TickMap, TickEncounter, APHIS Efforts, and local and state surveillance data. The remaining challenges are the needs to:

- Inventory (i.e., develop bibliography while working with federal partners and international organizations) other tick surveillance data (federal, state, local, academicians, and other stakeholders) and identify potential IPM tools.
- Establish common criteria for data collection (e.g., an American Society for Testing and Materials (ASTM) protocol) to allow for sound interpretation.

In regard to development of alternatives to area-wide acaricides (i.e., biopesticides), it has been observed that the cost of pesticide product registration may be an obstacle to more wide-spread registration of alternative pesticide products. Linking entomological and epidemiological data (e.g., the number ticks in area to the probability that a tick population will make you sick) can be problematic, making it difficult to measure the success of proposed tick IPM strategies. Spatial complexities related the association of human disease reporting to the diagnosis and not the location of where the TBD was acquired can confound establishing this linkage.

EPA supports the following programs to address the need to inventory outreach materials related to tick TBD:

- The Pesticide Environmental Stewardship Program (PESP)
- The National Pesticide Information Center – website
- TickLES (Tick Learning and Education for Schools), school education program – a fun video for children created by the Lyme Disease Association and the University of Medicine & Dentistry of NJ -- New Jersey Medical School, with funding from EPA

However, there is a continuing need to evaluate the cost-effectiveness of various outreach methods and to better identify the information the public wants. Although IPM strategies may be effective in reducing the incidence of TBD, measuring the impact of the IPM on tick-borne disease incidence is challenging because of the difficulty in establishing causal links. EPA has funded several tick IPM research grants that can assist in measuring these impacts.

2013 goals for EPA PESP related to tick IPM include:

- Continue collaboration with federal IPM partners on the White Paper and in identifying next steps for collaboration,
- Initiate Tick Monitoring Bibliography to include potential IPM tools,
- Continue partnership with USDA under the EPA-USDA Memorandum of Understanding,
- Incorporate tick IPM into EPA's School IPM program,
- Recruit groups related to tick IPM into PESP and stimulate educational outreach to current PESP partners,
- Participate in the 2013 Tick-Borne Disease IPM Conference, and
- Continue to participate in conferences for TBD-IPM.



Department of Interior

Federal Research on Tick-borne Diseases: Identification of Gaps and Strategic Priorities.
Howard Ginsberg, USGS (20 pp, 398k)

Of the large diversity in vector-borne diseases in North America, the great majority of the human cases are of Lyme disease. In Europe, however, the high prevalence is of tick-borne encephalitis. The goal of federal interagency TBD-IPM Workgroup effort is to develop a framework to: foster collaboration among agencies; avoid duplication of effort; and identify areas that require additional federal attention.

There are a variety of agencies with missions that include tick-borne diseases, from basic research to applications, each with its own particular area(s) of emphasis and perspectives. These are, principally:

- USDA – domestic animal health
- DoD and DHHS – human health
- NSF – ecology and evolution of infectious disease
- DOI – wildlife health, and
- EPA – environmental health

While DHHS (in particular, NIH and CDC) primarily addresses the medical research aspects of the federal efforts, disease prevention functions are spread across a larger set of agencies. Disease prevention includes coordination of efforts on environmental management of pathogens affecting wild and domestic animals and humans, and also the recognition of the importance of interdisciplinary collaborations to promote human health (i.e., One Health).

Many of the knowledge gaps were defined by Rebecca Eisen et al. in the 2012 paper, *What Do We Need to Know About Disease Ecology to Prevent Lyme disease in the Northeastern United States?* (J. Medical Entomology. Vol 49(1) 11-22). These include:

- 1) Identifying critical host infestation rates required to maintain enzootic transmission
- 2) Understanding how habitat diversity and forest fragmentation affect acarological risk and effectiveness of interventions
- 3) Quantifying epidemiological outcomes of interventions focused on ticks or reservoir hosts
- 4) Refining knowledge of how human behavior affects disease risk and how to foster adoption of personal protection measures and environmental management

In addition to the concerns stated by Eisen et al., there is a need to address the changing dynamics related to environmental changes, such as human demographic patterns, climate change, host distributions, habitat modification. These include: changing tick distributions; changing host distributions; and changing active seasons. An example of the increased interagency collaboration in data collection and dissemination required to meet these challenges is TickMap, which began as a DOD activity and is now a collaboration of DoD, Smithsonian, USDA, USGS, CDC, NSF, and others, as part of VectorMap program.

Examples of areas in which interagency collaboration related to TBD prevention and response are needed are:

- Sharing of expertise in response to tick-borne disease outbreaks – CDC would be the lead but would need to rely on the use of the animal expertise of USDA and USGS. Currently, however, there is no formal relationship between these agencies to foster the needed collaboration.
- Development of decision making tools for management of tick-borne diseases – USDA developed the IPM approach, which is used as a standard in many agencies. However, it is not linked to other tools, such as cost-effectiveness models used by CDC, the adaptive management and structured decision making approaches used by USGS, and the testing of management approaches on federal lands used by DoD, DOI, and USDA. It seems that each area does not know about the “workings” of the other area programs.

To avoid duplication of effort the following is needed:

- Support for federal collaborations and maintenance of the consortium to continue communication among federal agencies.
- Guidance to integrate federal research programs.

The related areas that need addition federal attention are:

- Improved surveillance measures
- Effects of habitat parameters on pathogen transmission dynamics and implications for effectiveness of interventions
- Epidemiological outcomes of management interventions – how much do they lower the number of human cases?
- The effect of human behavior on disease risk
- The effect of changing environmental conditions on epidemiology and distribution of tick-borne diseases



Current Areas of Collaboration Among Federal Partners. Dan Strickman, USDA (8 pp, 221k)

Multiple US federal agencies currently share responsibility in addressing various aspects of TBD problems in the US. Through the coordination of efforts across these agencies, the US government has the opportunity to improve efficacy of control and reduce the burden of risk from TBD. The Tick-borne Diseases Integrated Pest Management Workgroup (TBD IPM WG) was created for the purpose of enhancing communication and collaboration among US federal agencies involved in tick control as they relate to human health and to companion animals and wildlife that may serve as potential zoonotic reservoirs of human disease. The TBD IPM WG, created in 2011, is an inter-agency subgroup of the Public Health Pesticide Consortium, consisting of representatives from multiple US federal agencies; these are:

- US Department of Agriculture (USDA) – Agricultural Research Service (ARS); National Institutes of Food and Agriculture (NIFA); Animal Plant and Health Inspection Service (APHIS); and The IR-4 Project Minor Use Pesticide Registration (Rutgers University, funded by USDA)
- US Department of Defense (DOD) – US Army (Walter Reed Army Institute of Research) and Armed Forces Pest Management Board (AFPMB)
- US Department of Health and Human Services (DHHS) – Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH)
- National Science Foundation (NSF)
- US Department of Interior (DOI) – US Geological Survey (USGS); US Fish and Wildlife Service (USFWS); and National Park Service (NPS)
- US Environmental Protection Agency (EPA) – Office of Research and Development (ORD); Office of Pesticide Programs (OPP); and Office of Science Advisor (OSA)

The function of the TBD IPM WG is to:

- Collect, share, organize, and integrate information on best practices, including communications tools and resources, related to IPM of ticks and TBDs.
- Identify and prioritize research gaps and needs.
- Share agency-specific strategic plans relating to the control of ticks and the pathogens they may transmit.
- Develop white papers and strategy for IPM and prevention of TBD and consensus documents that can be shared across US federal agencies for the purposes of improving and coordinating IPM programs and activities.

The White Paper is organized in a similar manner to the IPM process: Risk Assessment/Biology, Pest Surveillance, Control, and Monitoring/Sustainability.

Activities for Risk Assessment/Biology include:

- Research on biology of pathogens and ticks
 - Grants programs (USDA, NSF, NIH, CDC, EPA)
 - Support to land grant universities (USDA)
 - In-house efforts (NIH, USGS, USDA)
- Distribution and modeling
 - Disease (CDC, USDA, EPA, USGS, DoD)
 - Ticks (CDC, USDA, DoD)

- Aids to risk assessment
 - Web sites (CDC, USGS, USDA, DoD)
 - Virus and reagents (NIH, DoD)
 - Databases (CDC, USDA, DoD)
 - Tick genome (NIH)
 - Formal risk assessments (USDA: APHIS, CEAH)

Activities for Pest Surveillance include:

- Disease (CDC, USDA, USGS, DoD)
- Ticks (CDC, USDA, DoD)
- Identification (CDC, USDA, DoD)

Activities for Control consist of:

- Information
 - Public (CDC, EPA, USDA)
 - Occupational (DOI, CDC, EPA, DoD)
- New acaricides (CDC, USDA)
- Strategies (CDC, USDA, EPA, DoD)
- Demonstration projects (USDA, EPA, CDC)
- Operational (USDA, DoD)

Activities for Monitoring/Sustainability consist of:

- Cattle fever tick and bovine babesiosis (USDA)
- Exotic tick surveillance and control (USDA)
- Tick vectors of human disease (DoD)
- Monitoring (USDA, DoD, CDC, USGS)

The White Paper recommendations include:

- Development and implementation of a set of common goals that would contribute to a reduction of the disease burden from pathogens transmitted by ticks through coordination and development of a formal inter-agency workgroup to reduce resource burden and increase knowledge base for all federal partners and promoting consistent policies between all agencies where appropriate.
- Establishment of collaborative research directions dedicated to studying tick vectors and the pathogens they transmit, conducting tick surveillance, identifying and confirming human health exposure, and developing tools for preventing or reducing exposure to ticks that transmit disease pathogens.
- Continuation of community outreach, education, and collaboration efforts regarding on ticks and associated pathogens.

Milestones for this effort include:

- Complete White Paper that identifies needs and outlines strategic priorities.
- Hold two-day conference with federal partners to discuss white paper and strategic plan, hosted by EPA and CDC.
- Systematic collection of public information on local needs.
- Conduct outreach to other stakeholders through the federal workgroup.
- Develop information clearinghouse on tick IPM.



Discussion: Achievable Goals and Deadlines for Initiatives, Graphic Illustrating Collaborations. Adriana Costero, NIH

The discussion centered on the Strategic Priorities outlined in the white paper. These encompass:

- Epidemiology – surveillance (that generates data to support predictive models)
- Ecology – habitat analysis
- Research – tick biology
 - Repellents/acaricides
 - See IOM Eisen et al 2012 publication
- Modeling – decision support
- Control
- Outreach – clearing house
 - Education

These priorities provided the framework for a broader discussion of the role of research and surveillance to manage, prevent, and control tick-borne diseases. Surveillance provides data to inform models of predictability and distribution. The data generated by surveillance can be captured and stored in databases that can then be utilized by modelers. Surveillance data can be enhanced by the output of research on tick ecology, tick/pathogen interactions, and tick/vertebrate host interactions. The heterogeneity of tick geography, species, and life cycles contributes to the complexity of the ecology/epidemiology of TBD. Data from surveillance and ecological studies of ticks informs policy, public health, and education of the public with regard to ticks and tick-borne diseases. Managing public expectations of what science and policy can do was considered very important by the participants. Finally, education and predictive models can be used for prevention and control of ticks and tick-borne diseases, including vertebrate host control, personal protection (repellents), and managing expectations regarding the level of risk and how it may decrease by using control/preventive strategies.

Conference participants then tried to develop a list of priorities based on the discussion of the strategic priorities. It was agreed that the development of working groups that have multidisciplinary participation from different federal agencies will ensure a broad perspective.

- a) Surveillance – TickMap, vector base, Arbonet are established databases/systems that collect information and are readily accessible.
- b) Outreach to counties and health care providers needs to be enhanced in order to target prevention and control strategies and mitigate disease risk.
- c) The impact of interventions must be monitored in order to assess whether an intervention is working.
- d) Aspects such as research (basic and translational), operations, implementation, extension, and education should all be coordinated.
- e) A National Survey of Tick Distribution needs to be established to help in these efforts.



United States Environmental Protection Agency

Establishment of Funding for Research Initiatives. Chris Zarba, EPA

We need to tease out areas that have potentially fundable activities. While there will be financial challenges, this is still a good time to move forward with research efforts. The agencies should divide the activities, based on those that are of interest to them. Determine what can be done in-house and what can be contracted out. If responsibility is shared among agencies, it is easier to sell to upper management. A well thought out plan makes it easier to support.

V. Conclusions and Next Steps – Day 1



Department of Defense

Next Steps and Day 1 Conclusions. Maj. Robert Lowen, DoD

The 2011 conference resulted in the identification of 7 gaps. The conclusions and priorities from today's discussion are:

- Tick collection/surveillance
- Pathogen detection
- Tick control
- Personal protection
- Risk assessment

The proposed approach entails dividing into smaller groups by topics, taking part in discussions throughout the year, and then meeting again.

Participants identified the following subgroups:

- Vector Surveillance – Determine the optimal graphical interface. Use CDC ELC (Epidemiology and Laboratory Capacity for Infectious Diseases) grant money applied to key states that have Lyme disease. This funding will allow states to collect data on Lyme disease and enable the purchase of data needed for the tick-borne disease mapping system.
- Intervention Strategies – Provide recommendations on best practices and find opportunities for interagency collaboration to pool resources.
- Modeling – Undertake risk modeling to project where diseases are expanding.

Additional suggested priorities include:

- Development of methods to measure the success of an IPM strategy; this will enable intervention from assessment of whether we are using the correct IPM strategy.
- Defining the appropriate marketing and audiences. Marketing to the wrong people can keep a good IPM out of the consumer's hands.
- Identify what people are willing to pay.
- Establishing an IPM clearinghouse of best practices, with a web interface through which existing studies can be made accessible. Investigate whether an agency currently has the infrastructure to start this site.

VI. Keynote Address: Clinical Manifestations and Pathogenesis of Obligately Intracellular Bacterial Tick-borne Diseases in the US (49 pp, 6.5MB)



Key Note Speaker: David H. Walker, M.D., Committee on Lyme Disease and Other Tick-Borne Diseases: The State of the Science; Institute of Medicine, National Academy of Sciences; The Carmage and Martha Walls Distinguished University Chair in Tropical Diseases; University of Texas Medical Branch, Professor and Chairman, Department of Pathology; Executive Director, Center for Biodefense and Emerging Infectious Diseases. Dr. Walker addressed the clinical manifestations and pathogenesis of obligately intracellular bacterial tick-borne diseases in the US. The presentation elaborated on the agents and vectors of tick-borne obligately intracellular bacterial disease in the US, especially on *Rickettsia ehrlichia*, and *Anaplasma* agents. Dr. Walker described the pathogenic sequence of events in Rickettsial infections, followed by the pathophysiology of Rickettsial disease, which begins with vascular permeability, edema (life threatening in brain and lungs), low blood volume, hypotension, and decreased perfusion of organs, ultimately leading to organ dysfunction (e.g., acute renal failure). Recent evidence of *Ehrlichia chaffeensis* seroprevalence among children was found in the South East and South Central regions of US. Other incidents of causative agents such as *Anaplasma phagocytophilum* were observed in Connecticut and Northwestern Wisconsin.

VII. Invited Guest: Willy Burgdorfer, Ph.D. National Institute Allergy and Infectious Diseases, National Institutes of Health, Emeritus



Dr. Willy Burgdorfer, the world renown researcher who discovered *Borrelia burgdorferi*, the pathogen causing Lyme disease, attended the conference as an invited guest. Discussions of the past, current, and future needs of Tick IPM were held amongst federal, state, and local government officials and all other attending stakeholders. The need for biannual and international conferences for Tick IPM was highlighted to keep abreast of current research to prevent tick borne diseases and promote collaborative research efforts.

VIII. Information on Current Tick IPM Research

Described below are the abstracts of the presentations discussed in Session 1, on targeted management of ticks, and Session 2, on tools for predicting and communicating potential risks.

SESSION 1, DAY 2: TARGETED MANAGEMENT OF TICKS

Discussed below are the presentations pertaining to the targeted management of ticks for preventing and controlling tick-related diseases.



Research on Tick Bite Prevention and Control (22 pp, 924k)

Dr. William Nicholson of CDC, on behalf of Dr. Charles S. Apperson, Department of Entomology & Center for Comparative Medicine and Translational Research, North Carolina State University, discussed a study to evaluate the effectiveness of permethrin impregnated uniforms for the prevention of tick bites and tick-borne illness among North Carolina outdoor workers. The Tick-borne Illness and Clothing Study (TICS) in North Carolina was a double-blind, 2 year long, randomized intervention study. The treatment group wore uniforms impregnated with permethrin and control group wore the non-treated uniforms. The study results showed *Amblyomma americanum* was the most prevalent tick. The *Amblyomma americanum* was tested for *Ehrlichia* species. Among *Erlichia* species, the *Erlichia ewingii* was most prevalent. There was no evidence of *Anaplasma* species in this tick.



Intervention at the Host/Parasite Interface: Overview and Perspective (38 pp, 1.7MB)

Durland Fish, Ph.D., Yale School of Public Health and Yale School of Forestry and Environmental Studies, presented a few intervention strategies at the Host/Parasite Interface and provided an overview of potential challenges associated with its implementation. Dr. Fish suggested multiple ways for preventing and controlling tick-borne diseases, such as off host and on host treatments. The off host treatment included the area application of acaricides and environmental alterations. The on host treatment included host reduction, host targeted acaricides, and host targeted vaccines. Dr. Fish stated that, in principle, either decreasing the deer population or ticks on deer will reduce the rate of disease. As an example, the Block Island – located between New York and Rhode Island and has an abundant deer population – study was presented. The ticks were more predominantly infected with *Borrelia burgdorferi* than *Babesia microti*. But the rate of infection for both *Borrelia burgdorferi* and *Babesia microti* were similar. Several control strategies including the tick tubes that containing permethrin, acaricide treatment of *Peromyscus leucopus*, OspA vaccine (that destroys *Borrelia* exiting and entering ticks), and a field study with mice, USDA 4-poster device were described.



Most Effective Tick-borne Disease IPM Tools Reported at State Level (25 pp, 2MB)

Kirby Stafford, Ph.D., Connecticut Agricultural Experimental Station stated that despite the over 30 years of work on Lyme disease, incidents of Lyme disease still occur. Dr. Stafford mentioned that the most effective strategy for preventing Lyme disease would be to declare war on the ticks to reduce their population. But which strategies will work to decrease tick abundance remains a question. Dr. Stafford discussed the results of the 2008 study on effectiveness of personal protective measures to prevent Lyme disease. The results indicated that the use of personal protective clothing and tick repellent were more effective than checking the body for ticks and spraying acaricides. In another 2008 study on knowledge, attitudes, and behaviors regarding Lyme disease prevention among Connecticut residents showed that most respondents were willing to remove leaf litter rather than installing fencing, as it was considered to be an inexpensive intervention strategy. Similarly, other studies and strategies for controlling tick populations, such as the Japanese Barberry control and ticks, field application of *Beauveria bassiana* or *Metarhizium anisopliae*, and considering the use of garlic as a repellent were discussed.



TickNET Intervention Trial (47 pp, 1.6MB)

Katherine Feldman, DVM, MPH, State Public Health Veterinarian; Chief, Center for Zoonotic and Vector-borne Disease Prevention and Health Promotion Administration, at the Maryland Department of Health and Mental Hygiene, discussed that in 2010, of the top 10 notifiable diseases in Maryland, Lyme disease was the third most common. Dr. Feldman provided a brief introduction on the TickNet Intervention Trial established by CDC in 2007, which is a collaborative health effort between state and local departments. The TickNET extramural efforts included the CDC's Emerging Infections Program (EIP) that adapted the EIP model for tick-borne disease. The TickNET applied research was aimed at determining the degree of underreporting of disease, and conducting intervention trials. The intervention trials included the Lyme and Other Tick-borne Disease Prevention Study (LTDPS) and a Bait Box study. The 2009 TickNET laboratory survey was a multistate effort to understand the burden of testing for tick-borne disease and increase the understanding of laboratory practices. In 2011 and 2012, the EIPs of the Connecticut, Maryland, and New York Departments of Health and the CDC conducted the LTDPS to determine if a single, targeted pesticide application to yards could prevent tick-borne diseases.



Beneficial Uses of Pheromone-assisted Strategies for Control of Ticks and Tick-borne Diseases (23 pp, 1.2MB)

Daniel Sonenshine, Ph.D., Professor (Emeritus), Old Dominion University, Norfolk, Virginia, described that pheromones regulate beneficial behavior within species that could be valuable to the control of ticks and tick-borne diseases. Dr. Sonenshine stated that all female ticks, except *Ixodes sp.* produce an attractant sex pheromone (ASP) to attract males for mating. He suggested the implementation of pheromone assisted tick control strategies. The pheromone tick control strategies discussed were: 1. confusants – to confuse male ticks by the ubiquitous presence of pheromone, prevent mating, and increase the killing of ticks; 2. attract and kill – the pheromone decoy is applied to the host animals; and 3. assembly in natural environment, where the deer ticks aggregate around gummy droplets dispersed in vegetation, imbibe acaricide, and die.



Toward Diminishing the Lyme *Borrelia* Threat from Nature: a Comprehensive Prospective Five-year Field Study Report

Maria Gomes-Solecki, DVM, University of Tennessee, discussed results from an NIH/CDC-funded 5-year field study. The study suggested the use of an oral reservoir targeted vaccine against Lyme *borreliosis*, which was tested in the field to determine its effect in reducing the prevalence of *B. burgdorferi* infection of questing nymphal *I. scapularis* ticks. No presentation slides are available for this study.



Host Targeted Technologies as Components of Community-based IPM for Blacklegged and Lone Star Ticks (25 pp, 2.6MB)

Kimberly Lohmeyer, Ph.D., USDA, explained briefly about the cattle fever tick eradication campaign in the US which ran from 1907 to 1943. The campaign relied heavily on surveillance, but concern exists of an outbreak of cattle fever tick in the outer zones of Mexico. Dr. Lohmeyer provided several host-targeted methods for preventing ticks from feeding to repletion on deer, especially EPA approved topical application of 4-Poster Deer Treatment Bait Stations and 2-Poster Deer Feeder Treatment Adapters. Other deer treatment technologies currently under development, such as the Automatic Deer Collaring Device and Automatic RFID Tag Implantation Device, were discussed.

SESSION 2, DAY 2: TOOLS FOR PREDICTING AND COMMUNICATING POTENTIAL RISK

This section provides the abstracts of presentation discussed during the second session of conference Day 2 on tools for predicting and communicating potential risks. This second session was further divided into two sub-topics: 1. Mapping and risk-based modeling for decision support for IPM, and 2. Transmission of tick-borne diseases and prevention management.

MAPPING AND RISK-BASED MODELING FOR DECISION SUPPORT FOR IPM

Discussed below centers on the presentations pertaining to mapping and risk-based modeling for decision support for IPM.



Effects of Forest Fragmentation on Lyme Disease Risks (19 pp, 1.9MB)

Laura Jackson, Ph.D., EPA, explored two modeling approaches using large landscapes across Maryland and Pennsylvania. The modeling approaches were based on human reported case rates, natural environment, and human behavior. The Percent Forest-Herbaceous edge is the most critical variable in Maryland landscape model of Lyme disease incidence rate. The percent forest is the second key variable. The model showed highest incidence rate of Lyme disease occurred at 53.5% forest cover. Several strategies such as habitat fragmentation and adopting a collective strategy to manage fragmentation were described to reduce the rate of Lyme disease. This Maryland case study was extended into Pennsylvania. Two category threshold probability model and Interactive Risk Visualization Tool were described for predicting the risks.



Emergence of Lyme in Canada: Environmental Drivers and Public Health Responses (30 pp, 3.7MB)

Nicholas Ogden, Ph.D., Public Health Agency of Canada, presented data on increase in Lyme disease in Canada and stated that the diversity in ticks is similar to that observed in the US. The tick *Ixodes scapularis* is found in Canada. Dr. Ogden stated that the drivers of Lyme Risk Emergence are abiotic factors, such as temperature. Thus, they developed simulation models to determine the effect of temperature, which is an empirical operation that supports the hypothesis. Migratory passerines were suggested as the probable source of Lyme vector, *Ixodes scapularis* into and through Canada. In addition, there is increasing evidence of presence of *Borrelia burgdorferi* in areas abundant in *Peromyscus leucopus* (white footed mouse). Several public health programs tailored toward prevention and control, early diagnosis and treatment, and capacity building were described.



TickEncounter: Strategies for Engaging and Empowering People to Adopt “Best” Tick Bite Protection and Disease Prevention Actions

Tom Mather, Ph.D., University of Rhode Island, elaborated on the features of the TickEncounter web site (www.tickencounter.org), which is a web-based tool for identifying ticks in an area and empowering the public to adopt protection and prevention strategies. Dr. Mather observed that the website was mostly visited on Monday and Tuesday (probably after a potential encounter with a tick on the weekend). The Get TickSmart Process and 5 TickSmart Actions described on the website inform and educate the public on tick prevention and control. In addition, the website provided a tick risk calculator to obtain risk scores and receive customized action plans.

TRANSMISSION OF TICK-BORNE DISEASES AND PREVENTION MANAGEMENT

Discussed below are the presentations pertaining to transmission of tick-borne diseases and prevention management.



Effectiveness of Peridomestic Prevention Measures against Lyme Disease (35 pp, 3.5MB)

Neeta Connally, Ph.D., Western Connecticut State University, stated that “peridomestic risk” – i.e., an assumption that highest risk to contract the disease – is from one’s own backyard. The presentation elaborated on the Connecticut Emerging Infections Program to assess public health impact of emerging infectious diseases and evaluate methods for prevention. Dr. Connally, described a case control study to evaluate the effectiveness of peridomestic control measures on the prevention of Lyme disease by landscape modifications, personal protection, or chemical control.



Potential Effective Tick Control and IPM Research (31 pp, 421k)

Karl Malamud-Roam, Ph.D., IR-4, Rutgers University, provided details on the IR-4 Public Health Pesticides (PHP) Program (ir4.rutgers.edu/publichealth.html) to register pesticides (including repellants, attractants, and toxicants) for public health and veterinary use. Dr. Malamund-Roam stated that the IR-4 PHP inventory database will soon be electronically available for accessing information on new uses for registered products, product retention, new materials and products,

and development process improvements. In addition, other specific information on registration status, mode of action, use patterns, and exempt materials can be obtained from PHP website.



Identification and Promotion of Effective IPM Tools to Reduce Tick-borne Diseases (27 pp, 2.8MB)

Joe Piesman, Ph.D., CDC, presented approaches to prevent Lyme disease by personal protection, tick control, and medical tools. Dr. Piesman stated that in Europe there is a different approach and regulatory environment than in the US. The area-wide acaricides survey in Connecticut, Massachusetts, New Jersey, and New York showed that US homeowners are not willing to use them. Alternatives to area-wide acaricides suggested were: host removal, host targeted treatments, least toxic materials such as tree extracts, fungal agents, and landscape management. In addition, the application of an insecticidal constituent from Alaska Yellow Cedar (*Chamaecyparis nootkatensis*) was observed to control nymph ticks in the field trial at Naval Weapons Station Earle in New Jersey. Another Integrated Tick Management (ITM) study in Millstone, New Jersey, used deltamethrin barrier spray, applied 4-poster acaricide to deer, and applied Bait box acaricide to rodents, achieved a high level control of ticks. Other antibiotic baits included in lab trials with doxycycline-hyclate impregnated baits provided 100% prophylaxis and cure of mice and cleared *Borrelia burgdoferi* in feeding ticks. The future of ITM would be to use area-wide acaricides, host targeted acaricides, vaccines, antibiotics, natural products, and biological control agents.



Best Tools for IPM Risk Communication (22 pp, 2.4MB)

Tom Green, Ph.D., IPM Institute of North America, Inc., described working with CISCO in 1998 to develop a schools IPM program for schools needing help with pest management. In 2006, a coordinated action was developed to integrate pest management into the school infrastructure to reduce pests and pesticide risks. Several IPM initiatives were implemented, such as the USDA-funded Pest Management Strategic Plan (PMSP), with an IPM PMSP workshop in schools, co-hosted by EPA. Additionally, national steering and advisory committees, and national and regional workgroups were formed, and other collaborations were considered. Logic models and Green Shield certification were developed to facilitate implementation of IPM programs in schools.

IX. Summary

The major TBDs of humans in the U.S. include Lyme disease, Rocky Mountain spotted fever, ehrlichiosis, and anaplasmosis. While concentrated in specific geographic regions, they are increasing each year in both case numbers and distribution. The observed increases in numbers and distribution have most likely resulted from ecological changes that have led to greater contact between people and ticks.

Integrated Pest Management (IPM) of ticks is an important line of defense against transmission of TBDs. The goal of IPM is to employ various combinations of control techniques intelligently and safely in an effort to maximize effectiveness. Multiple federal agencies of the U.S. government perform research, surveillance, prevention, control, education, and regulation in an effort to reduce the impact of TBDs on humans.

To identify tick-borne disease integrated pest management research opportunities, and support collaboration amongst the research community, the Environmental Protection Agency and the Centers for Disease Control and Prevention co-hosted the Tick-Borne Disease (TBD) Integrated Pest Management (IPM) on March 5-6, 2013, in Arlington, VA. TBD-IPM WG participating federal partners included: USDA ARS, USDA NIFA, USDA APHIS, USDA FS, NIH, DOI USGS, DOI NPS, DOI FWS, NSF, DoD USAPB, DoD AFPMB, DoD WARIAR, USEPA OPP, USEPA ORD and USEPA Region 1. The conference brought together representatives from over 16 federal agencies and state agencies, 7 academicians (universities and non-profit organizations), who presented their research findings the current state of IPM for the management of tick-borne diseases.

The outcomes of this conference include:

The *Federal Initiative: Tick-Borne Disease Integrated Pest Management White Paper* is expected to be complete in 2013 by the TBD-IPM WG federal partners. During this process a federal collaboration effort of over 14 agencies over the past two years has been formed. The expertise of these federal partners largely consists of senior research entomologists responsible for developing and/or implementing tick-borne disease integrative pest management programs. In addition, the communication during meetings and monthly conference calls, have identified areas where existing research programs can be coordinated to conserve on resources.

This conference provided an opportunity for world renowned entomologists who were federal, state and local government officials as well as expert academicians and stakeholders to identify research coordination needs and future guidance. The discussions identified Tick IPM research initiatives which have great promise for further investigation.

As a result of this conference, development of a national survey for tick monitoring (i.e., bibliography) and integrative pest management to support vector surveillance has been initiated. This is expected to identify effective intervention strategies, habitat evaluation, and support modeling initiatives for predicting risk in the future. This will support establishing an IPM clearinghouse of best practices, with a web interface through which existing studies can be made accessible.

Participants of this conference confirmed the need to develop an information clearinghouse to support education, outreach and communication efforts” while identifying stakeholders who can fund initiatives. Development of a decision support model for cost-effectiveness of prevention was recommended once the clearinghouse is established.

This conference successfully identified future research needs, for collaborations amongst all stakeholders to use Tick-Borne Disease Integrated Pest Management as a tool to reduce the risk of tick-borne disease. The presentations of the speakers who agreed to provide them publicly are attached on EPA’s website: http://www.epa.gov/peps/events/2013_tick_meeting.html

X. Tick-Borne Disease Integrated Pest Management Conference Agenda

US ENVIRONMENTAL PROTECTION AGENCY AND DISEASE CONTROL AND PREVENTION

ARLINGTON, VA -- MARCH 5-6, 2013

The Environmental Protection Agency and the Centers for Disease Control and Prevention will co-host a conference on Tick-Borne Disease (TBD) Integrated Pest Management (IPM) on March 5-6, 2013, in Arlington, VA. The conference will bring together representatives from numerous federal, state and local agencies, academia, and stakeholders to discuss the current state of IPM for the management of tick-borne diseases.

BACKGROUND

This conference builds upon EPA's 2011 *Promoting Community IPM for Preventing Tick-Borne Diseases Conference* (epa.gov/pestwise/events/tick_meeting.html). The 2011 conference captured the research and information surrounding prevention of TBD from the perspective of government and non-government stakeholders. Key outcomes, summarized at epa.gov/pestwise/events/ticks/tickconferencereport.pdf, included the identification of successful strategies for community IPM programs, research priorities and knowledge gaps, and potential partnerships.

The TBD-IPM Workgroup was borne out of the conference. Formed under the auspices of the Public Health Pesticide Consortium, the TBD-IPM workgroup is an alliance of 14 federal agencies addressing the recommendations of the 2011 conference and developing a white paper that details federal sector research needs, including developing measurable IPM tools to reduce risk from tick-borne disease.

TBD-IPM Workgroup efforts include:

- Collecting, integrating, and sharing best practices, including communications tools and resources, for IPM of ticks and TBDs,
- Identifying and prioritizing research gaps and needs,
- Sharing agency-specific strategic plans relating to the control of infected ticks and the pathogens they may transmit, and
- Developing a white paper and strategy for IPM and prevention of TBD and consensus documents that can be shared across U.S. federal agencies for the purpose of promoting and coordinating IPM programs and activities.

The 2013 conference will:

- Complete the *Federal Initiative: Tick-Borne Disease Integrated Pest Management White Paper*
- Identify research strategies to support community IPM programs
- Facilitate collaboration among federal partners to support research initiatives
- Provide information on current tick IPM research

**LOCATION: U.S. EPA
2777 S. CRYSTAL DRIVE, POTOMAC YARD SOUTH, ROOM 4370/4380**

MARCH 5TH (FEDERAL PARTNERS ONLY)

WELCOME

8:30 AM Keith Matthews, Director, Biopesticides and Pollution Prevention Division
U.S. Environmental Protection Agency
Ben Beard, Ph.D., Centers for Disease Control and Prevention

MEETING OVERVIEW

8:45 AM Inter-Agency White Paper, *Federal Initiative: Tick-Borne Disease Integrated Pest Management*, Dan Strickman, Ph.D. (USDA)

SESSION 1: AGENCY OVERVIEWS – JOHN CARROLL, PH.D. USDA

9:00 AM **U.S. Department of Agriculture** – Herbert Bolton, Ph.D.

9:30 AM **U.S. Department of Defense** – Ellen Stromdahl, Ph.D.

10:00 AM **U.S. Department of Health and Human Services** – Adriana Costero, Ph.D.

10:30 AM Break

10:45 AM **National Science Foundation** - Sam Scheiner, Ph.D.

11:10 AM **U.S. Department of Interior** – Carol DiSalvo, Ph.D.

11:35 AM **U.S. Environmental Protection Agency** – Bart Hoskins, M.Sc.

NOON LUNCH

SESSION 2 – FEDERAL COLLABORATION ON RESEARCH TOOLS – MATTHEW MESSENGER, PH.D., USDA

1:00 PM **Research Initiatives from EPA's 2011 Tick IPM Conference** – Candace Brassard, M.S., EPA

1:15 PM **Identification of Gaps and Strategic Priorities** –Howard Ginsberg, Ph.D., USGS

1:45 PM **Review of Current Areas of Collaboration Among Federal Partners** - Dan Strickman, Ph.D.,

USDA

2:15 PM **Break** (*Refreshments in Honor of John Carroll's Retirement*)

2:45 PM **Discussion: Achievable Goals and Deadlines For Initiatives, Graphic Illustrating**

Collaboration- Moderator: Adriana Costero, Ph.D., NIH

4:00 PM **Establishment of Funding for Research Initiatives** –Chris Zarba, Ph.D., EPA

4:30 PM **Next Steps and Day 1 Conclusions** – Major Robert G. Lowen, Ph.D., DoD

Additional Participating TBD-IPM Workgroup Members: Federal Partners: David Brassard, M.S. (EPA), Clara Fuentes, Ph. D. (EPA), Robert Hillger, M.S. (EPA), Robert Massung, Ph.D. (CDC), William Nicholson, Ph.D. (CDC), Sam Perdue, Ph.D. (NIH), Joe Breen, Ph.D. (NIH), Lyle Peterson (CDC), Harold Harlan (DoD)

5:00 PM Adjourn

6:00 PM Optional Informal Dinner

SOCCI (2800 S. Potomac Ave., Arlington, VA), located in Renaissance Hotel adjacent to EPA

LOCATION: U.S. EPA
2777 S. CRYSTAL DRIVE, POTOMAC YARD SOUTH, 1ST FLOOR CONFERENCE ROOM 1204/1206

MARCH 6TH (RESEARCHERS, PARTNERS, STAKEHOLDERS, AND PUBLIC)

WELCOME

8:30 AM **BEN BEARD, PH.D.** (CENTERS FOR DISEASE CONTROL AND PREVENTION)

KEY NOTE ADDRESS: Clinical Manifestations and Pathogenesis of Obligately Intracellular Bacterial Tick-borne Diseases in the US

DAVID WALKER, M.D., Committee on Lyme Disease and Other Tick-Borne Diseases: The State of the Science; Institute of Medicine, National Academy of Sciences; University of Texas Medical Branch - Carmage and Martha Walls Distinguished Chair in Tropical Diseases, Professor and Chair of the Department of Pathology, Executive Director of the Center for Biodefense and Emerging Infectious Diseases

INVITED GUEST: WILLY BURGENDORFER, PH.D., NATIONAL INSTITUTE ALLERGY AND INFECTIOUS DISEASES, NATIONAL INSTITUTES OF HEALTH, EMERITUS

SESSION 1: TARGETED MANAGEMENT OF TICKS – ELLEN STROMDAHL (DoD) AND JOE BREEN (NIH)

9:15 AM **Research on Tick Bite Prevention and Control** - Charles Apperson, Ph.D., North Carolina State University

9:35 AM **Intervention at the Host/Parasite Interface: Overview and Perspective** - Durland Fish, Ph.D., Yale University

9:55 AM **Most Effective Tick Borne Disease IPM Tools Reported at the State Level**- Kirby Stafford, Ph.D., Connecticut Agricultural Experimental Station

10:15 AM Break

10:30 AM **Permethrin Treated Uniforms Program for DOD to Promote IPM** - Thomas Harkins, M.S., US Army Public Health Command

10:50 AM **TickNET Intervention Trial** - Katherine Feldman, DVM, MPH, Maryland Department of Health and Hygiene

11:10 AM **Beneficial uses of pheromone-assisted strategies for control of ticks and tick-borne diseases** - Daniel Sonenshine, Ph.D., Emeritus, Old Dominion University

11:30 AM **Toward diminishing the Lyme borrelia threat from nature: a comprehensive prospective five-year field study report** - Maria Gomes-Solecki, DVM, University of Tennessee

11:50 AM **Host-targeted technologies as components of community-based IPM for blacklegged and lone star ticks** - Kim Lohmeyer, Ph.D., US Department of Agriculture

12:10 PM Lunch

**SESSION 2: TOOLS FOR PREDICTING AND COMMUNICATING POTENTIAL RISK –
MAPPING AND RISK-BASED MODELING FOR DECISION SUPPORT FOR IPM- HERB BOLTON (USDA) AND
WILLIAM NICHOLSON (CDC)**

- 1:10 PM **Effects of Forest Fragmentation on Lyme Disease Risks** - Laura Jackson, Ph.D., US Environmental Protection Agency
- 1:30 PM **Emergence of Lyme in Canada: Environmental Drivers and Public Health Responses** - Nicholas Ogden, Ph.D., Public Health Agency of Canada
- 1:50 PM **Tick Map Development and Future Research Strategies** - Major Scotty Long, Ph.D., Walter Reed Army Institute of Research
- 2:10 PM **TickEncounter: Strategies for Engaging, Educating and Empowering People to Adopt “Best” Tick Bite Protection and Disease Prevention Actions** - Tom Mather, Ph.D., University of Rhode Island

TRANSMISSION OF TICK-BORNE DISEASES AND PREVENTION MANAGEMENT

- 2:30 PM **Effectiveness of Peridomestic Prevention Measures Against Lyme Disease** - Neeta Connally, Ph.D., Western Connecticut State University
- 2:50 PM **Potential Effective Tick Control and IPM Research** - Karl Malamud-Roam, Ph.D., IR-4, Rutgers University
- 3:10 PM Break**
- 3:30 PM **Identification and Promotion of Effective IPM Tools to Reduce Tick Borne Diseases** - Joe Piesman, Ph.D., Centers for Disease Control and Prevention
- 2: 50 PM **Best Tools for IPM Risk Communication** - Tom Green, Ph.D., IPM Institute of North America, Inc.

SESSION 3: MEASURING THE SUCCESS OF TICK IPM

- 4:10 PM **Open Discussion for All Participants** - Moderator: Howard Ginsberg, Ph.D., US Geological Survey
- 4:55 PM **Closing Remarks**
Candace Brassard, M.S., US Environmental Protection Agency
- 5:00 PM Adjourn**

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Conference Code: 703-308-8107

Keynote Speaker: David H. Walker M.D.

Dr. Walker is Chair of the Department of Pathology and Executive Director of the Center for Biodefense and Emerging Infectious Diseases where he and his faculty are developing vaccines against arboviral infections, emerging viral hemorrhagic fevers, and rickettsiosis in state-of-the-art BSL-3 and BSL-4 facilities. His research has elucidated mechanisms of immunity to Rickettsia and Ehrlichia, developed animal models for investigating rickettsiosis and ehrlichiosis, and contributed to elucidating the pathology and pathophysiology of Lassa fever, Rocky Mountain spotted fever, Mediterranean spotted fever, and human monocytotropic ehrlichiosis. Among emerging infections, he contributed to the discovery, characterization, and/or epidemiology of *Anaplasma phagocytophilum* (human granulocytotropic anaplasmosis), *Rickettsia japonica* (Japanese spotted fever), *R. felis* (flea-borne spotted fever), and *E. chaffeensis* (human monocytotropic ehrlichiosis). His efforts have enhanced the science of rickettsiology in China, Sicily, Mexico, Brazil, Peru and Cameroon. His commitment to high quality dissemination of up-to-date knowledge of tropical medicine is exemplified in third edition of *Tropical Infectious Diseases: Principles, Pathogens, and Practice*. He has served on the Armed Forces Epidemiology Board, the Defense Health Board, and the National Research Council Standing Committee on Biodefense and is Associate Editor of *Emerging Infectious Diseases* and *PLoS Neglected Tropical Diseases*. He is President of the American Society of Tropical Medicine and Hygiene.

Willy Burgdorfer, Ph.D.

Dr. Burgdorfer gained world-wide recognition for his 1981 discovery of a tick-borne spirochete as the long-sought cause of Lyme disease and related disorders in the U.S. and Europe. The agent was named after him—*Borrelia burgdorferi*. Dr. Burgdorfer is currently a NIAID emeritus. Dr. Burgdorfer's most relevant research concerned the interactions between animal and human disease agents and their transmitting photo of *Borrelia burgdorferi*, the agent of Lyme disease arthropod vectors, particularly ticks, fleas and mosquitoes. He earned his Ph.D. in Zoology, Parasitology, and Bacteriology from the University of Basel and the Swiss Tropical Institute.

PARTICIPANTS

Charles Apperson, Ph.D.

Charles Apperson is William Neal Reynolds Distinguished Professor Emeritus in the Department of Entomology at North Carolina State University in Raleigh, North Carolina. Dr. Apperson is a vector biologist with 40 years of experience in researching the ecology, behavior and control of arthropod vectors of public health pathogens.

Ben Beard, Ph.D.

Ben Beard is Chief of the Bacterial Diseases Branch in CDC's Division of Vector-Borne Diseases, and the Associate Director for Climate Change at CDC's National Center for Emerging and Zoonotic Infectious Diseases where he coordinates CDC's effort to understand and mitigate the impact of climate variability and disruption on infectious disease ecology. Dr. Beard is co-lead for the TBD-IPM federal workgroup. He is also an Associate Editor for the journal *Emerging Infectious Diseases* and past President of the Society for Vector Ecology. Dr. Beard earned a B.S. in 1980 at Auburn University, an M.S. in 1983 at the Louisiana State University School of Medicine, and a Ph.D. in 1987 at the University of Florida. He served as a post-doctoral fellow and associate research scientist at Yale University School of Medicine.

Herb Bolton, Ph.D.

Herb Bolton is the National Program Leader for Entomology at the USDA's National Institute of Food and Agriculture, Institute of Food Protection and Sustainability, in Washington, DC. His grant portfolio at the Institute includes the Regional Integrated Pest Management Centers, Hatch and Hatch Multistate projects, extension Communities of Practice, and IPM in Affordable Housing through an interagency agreement with HUD. He is a Board Certified Entomologist in the areas of medical/veterinary and urban/structural entomology. Dr. Bolton earned his Ph.D. in Entomology from the University of Florida.

[Candace Brassard, M.S.](#)

Candace Brassard is Senior Biologist in the Biopesticides and Pollution Prevention Division with the U.S. EPA's Office of Pesticide Programs . Her work includes responsibility for the Tick Integrated Pest Management Initiative. Ms. Brassard is co-lead for the TBD-IPM federal workgroup. She holds a B.S. from the University of Massachusetts, Amherst, and an M.S. in Environmental Policy from George Washington University.

[David W. Brassard, M.S.](#)

David Brassard is a Senior Scientist within the Biological and Economic Analysis Division with the U.S. EPA's Office of Pesticide Programs. He leads interdisciplinary teams of entomologists and economists to conduct complex analyses comparing the performance of insecticides and acaricides with alternative chemical and non-chemical controls. Mr. Brassard holds a B.S. in Entomology from the University of Massachusetts (1974), and an M.S. in Entomology from North Dakota State University (1976).

[Joe Breen, Ph.D.](#)

Joe Breen is the program officer for the Lyme disease and anthrax extramural research programs at the National Institute of Allergy and Infectious Disease (NIAID), a position he has held since 2007. Dr. Breen joined NIAID in 2003 as a genomics program officer where he oversaw a portfolio of grants and contracts applying genomic and proteomic approaches to the diagnosis, treatment and prevention of infectious diseases. He received his Ph.D. in biochemistry from Temple University School of Medicine, and conducted postdoctoral research at the National Institutes of Health in the area of developmental biology using protein-protein interaction techniques.

[John F. Carroll, Ph.D.](#)

John Carroll has 36 years at the USDA's Beltsville Agricultural Research Center within several laboratories, including the Animal Parasitic Diseases Laboratory and the Livestock Insects Laboratory. He has conducted research on pests including the control of ticks and responses of ticks to repellents. Dr. Carroll received his B.A. from Siena College, with M.S. and Ph.D. degrees in entomology from University of Florida.

[Neeta Connally, Ph.D.](#)

Neeta Connally is an Assistant Professor in the Department of Biological & Environmental Sciences at Western Connecticut State University. Her main research interest is the peridomestic prevention of Lyme and other tick-borne diseases in the northeastern U.S. She collaborates with colleagues at the Connecticut Emerging Infections Program, Yale School of Public Health, CDC, and other state partners, on current TickNET projects. She also works with the Center for Vector Borne Disease at the University of Rhode Island, helping to develop decision-support tools for tick-borne disease prevention. She holds a Ph.D. from University of Rhode Island, and an M.S. from Tulane University.

[Adriana Costero, Ph.D.](#)

Adriana Costero is currently the Vector Biology Program Officer at NIAID. In that role, she manages over 100 grants and cooperative agreements including parasite-vector interactions to ecological/behavioral studies of disease transmission and risk. Dr. Costero received her B.S. from National University of Mexico, an M.S. from The Ohio State University and a Ph.D. in Entomology from McGill University. She was a Postdoctoral Fellow at the Medical Entomology Section of the Laboratory of Parasitic Diseases at NIAID where she studied parasite/vector interactions before progressing into a career in science administration.

[Carol DiSalvo, M.S.](#)

Carol DiSalvo is the National Park Service IPM Coordinator, where she provides oversight on IPM Program activities. She also serves as liaison between national parks and Federal agencies on IPM efforts involving vector borne disease, developed landscapes, and wild land. Ms. DiSalvo earned her A.S. degree in Biological Technology from SUNY Agricultural and Technical College, her B.S. in Forestry/Environmental Science from SUNY College of Environmental Science and Forestry, and an M.S. in Natural Resources from Virginia Institute of Technology.

[Katherine A. Feldman, DVM, MPH](#)

Katherine Feldman is the State Public Health Veterinarian and Chief of the Center for Zoonotic and Vector-borne Diseases with the Maryland Department of Health and Mental Hygiene. Her responsibilities include the surveillance, investigation, and control of zoonoses and vector-borne diseases in Maryland. She is a Diplomate in the American College of Veterinary Preventive Medicine, through which she obtained a certification in Epidemiology Specialty. Dr. Feldman earned her veterinary degree from Cornell University, and her MPH from University of California, Berkeley.

[Durland Fish, Ph.D.](#)

Durland Fish is Professor of Epidemiology and Microbiology at Yale School of Public Health and Yale School of Forestry and Environmental Studies. He has devoted most of his career to the study of tick ecology and tick borne diseases. Dr. Fish is currently Director of the Yale Center for EcoEpidemiology, an interdisciplinary center that seeks to integrate environmental science and ecology with medical epidemiology. His laboratory continues to study the ecology of vector-borne disease with an emphasis on tick-borne pathogens causing Lyme disease, human anaplasmosis and babesiosis. His research interests include environmental causes of disease emergence, interactions among pathogens in vectors and hosts, and the development of novel methods for vector-borne disease prevention.

[Bart Hoskins, M.S.](#)

Bart Hoskins is a Biologist with the U.S. Environmental Protection Agency. Based within the Agency's New England Regional Laboratory, Mr. Hoskins focuses primarily on ecological risk assessments for Superfund sites. He also works on two studies involving tick-borne diseases: one is an on-going study of the effectiveness of pesticide application using 4-poster deer feeding stations, with the second study focusing on identifying mammalian host species for Lyme, Anaplasma, and Babesia. Both studies are based in Cape Cod, Martha's Vineyard, and Nantucket.

[Howard S. Ginsberg, Ph.D.](#)

Howard Ginsberg is a Research Ecologist with the U.S. Geological Survey at Patuxent Wildlife Research Center. He is Unit Leader of Patuxent's Coastal Field Station, and Professor in Residence at the University of Rhode Island. Dr. Ginsberg has published widely on the ecology of vector-borne diseases, especially tick-transmitted infections such as Lyme disease. His emphasis is on understanding transmission dynamics and factors that influence human exposure to vector-borne zoonotic pathogens. This knowledge is used to develop efficient approaches to surveillance and management of vector-borne diseases that protect public health while minimizing negative effects on sensitive natural systems. He received his Ph.D. in Entomology from Cornell University.

[Thomas Green, Ph.D.](#)

Thomas Green is president and co-founder of the IPM Institute of North America, a non-profit organization whose mission is to leverage marketplace power to improve health, environment and economics in agriculture and communities. The Institute co-leads the National School IPM Working Group, and created IPM STAR Certification for schools, which has impacted more than 2 million children. Dr. Green is a Certified Crop Advisor, a Natural Resources Conservation Service-certified Technical Service Provider, and serves as president of the Entomological Foundation. He holds a Ph.D. in Entomology from the University of Massachusetts.

[Laura Jackson, Ph.D.](#)

Laura Jackson is a Research Biologist with the U.S. EPA's Office of Research and Development, in Research Triangle Park, North Carolina. She is a Principal Investigator in the Sustainable and Healthy Communities Research Program. Her current work focuses on the role of ecosystem services and the built environment in public health. She received her B.S. from Bryn Mawr College, her M.S. from Duke University's School of Forestry and Environmental Studies, and a Ph.D. in Ecology at the University of North Carolina-Chapel Hill.

[Angela M. James, Ph.D.](#)

Angela James is on staff at USDA's Centers for Epidemiology and Animal Health, where she studies the spatial epidemiology of animal diseases particularly related to ticks. Her research interests include the landscape

ecology of vectors and vector-borne pathogens. Dr. James received a Ph.D. in Entomology from the University of Georgia with an emphasis in vector-borne disease agents and tick physiology. Her post-doctoral studies were conducted at the Centers for Disease Control and Prevention and the Arthropod-borne and Infectious Diseases Laboratory at Colorado State University.

[Kim Lohmeyer, Ph.D.](#)

Kim Lohmeyer is a Research Entomologist with the USDA's Agricultural Research Service where he is based within the Knippling-Bushland U.S. Livestock Insects Research Laboratory in Kerrville, TX. Dr. Lohmeyer's current research is directed at developing and evaluating new compounds and delivery technologies to control ticks on cattle and white-tailed deer. She is also evaluating novel chemicals for tick control as well a cooperative project to train dogs to detect cattle fever ticks infesting cattle at U.S. ports of entry. She earned a B.S. from King University, an M.S. from University of Tennessee, and a Ph.D. in Entomology from the University of Georgia.

[MAJ Robert Lowen, Ph.D.](#)

MAJ Robert Lowen is a U.S. Army Entomologist currently serving as Chief of the Vector Control Department at the Walter Reed Army Institute of Research, Entomology Division, and Chair of the Vector Control & Surveillance Products Integrated Product Team for MRM. His awards include the Bronze Star, the Meritorious Service Medal (1 oak leaf cluster), the Army Commendation Medal (4 oak leaf clusters), and the Army Achievement Medal. MAJ Lowen received his B.S. and M.S., University of Manitoba. He earned his Ph.D. from the University of Florida's Department of Entomology & Nematology.

[Thomas N. Mather, Ph.D.](#)

Thomas Mather is professor of public health entomology and zoonotic diseases at the University of Rhode Island (URI). He is director of URI's Center for Vector-Borne Disease and its TickEncounter Resource Center. His focus has been on developing a genes-to-vaccines strategy for blocking tick feeding, preventing tick-borne disease transmission and developing on-line platforms for health promotion programs to prevent tick-borne diseases. Dr. Mather earned his B.S. from Muhlenberg College, M.S. from University of Delaware, Ph.D. from University of Wisconsin and Post-Doc from Harvard University School of Public Health, Boston, MA.

[Keith Matthews, J.D.](#)

Keith Matthews is the Director of the Biopesticides and Pollution Prevention Division (BPPD) in the Office of Pesticide Programs, U.S. EPA. Mr. Matthews served as the acting Director of BPPD between August 3, 2009, and March 30, 2010, and was appointed the Director of BPPD in November, 2010. Prior to coming to BPPD, Mr. Matthews was a staff attorney and then Assistant General Counsel in EPA's Office of General Counsel (OGC), where he provided legal counsel to a number of Agency clients, including BPPD, OAR, OEI, and ORD. In addition to his legal training at the Georgetown University Law Center, Mr. Matthews earned an M.S. in Biology from the California Institute of Technology, where he conducted graduate work in molecular developmental neurobiology.

[Matthew Messenger, Ph.D.](#)

Matt Messenger is a Staff Entomologist with APHIS Veterinary Services, Ruminant Health Programs, and the Program Manager for the Cattle Fever Tick Eradication Program. Dr. Messenger is based at APHIS headquarters in Riverdale, MD. He holds a B.S. from Oklahoma State University, an M.S. from Kansas State University, and a Ph.D. in Entomology from the University of Florida.

[William L. Nicholson, Ph.D.](#)

William Nicholson is Chief of the Pathogen Biology and Disease Ecology Activity in the Rickettsial Zoonoses Branch, Division of Vector-Borne Diseases, at the Centers for Disease Control and Prevention. His current position focuses on research of various ecological aspects of rickettsial diseases domestically and internationally. Dr. Nicholson's primary research interests and efforts cover ecology, epidemiology, microbiology, acarology, and control of tick-borne diseases.

[Nick Ogden, Ph.D.](#)

Nick Ogden is a UK-trained veterinarian who is currently a senior research scientist within the Zoonoses Division of the Public Health Agency of Canada. His work focuses on the ecology and epidemiology of zoonoses. He also served as interim Director of the Environmental Issues Division of the Public Health Agency of Canada where he directed a program involving climate change impact on vector and water-borne disease risks. Dr. Ogden received his veterinary training at University of Liverpool. After 10 years of mixed clinical practice, in 1996 he completed a doctorate in Lyme disease ecology at the University of Oxford's Department of Zoology.

[Joe F. Piesman, Ph.D.](#)

Joseph Piesman is the Chief of Tick-Borne Disease Activity of the Bacterial Division Branch of the CDC's Division of Vector-Borne Diseases. Dr. Piesman has 37 years of research focused on tick biology, ecology, and control. His research interests include Prevention of Tick-Borne Diseases, with a primary interest in tick-spirochete interactions. He led intramural and extramural efforts to develop integrated tick management techniques for community projects to prevent Lyme disease and other tick-borne diseases in 4 states in the northeastern US. He has over 180 peer reviewed publications principally on ticks and tick-borne disease prevention.

[Karl Malamud-Roam, Ph.D.](#)

Karl Malamud-Roam is the Public Health Pesticides Program Manager for the IR-4 Project, and a Senior Research Scientist at Rutgers University in Princeton, New Jersey. Dr. Malamud-Roam provides technical and regulatory support for the development of public health pesticides, including toxicants, repellents, and other chemical tools useful in the prevention of vector-borne disease. He holds a B.A. from Princeton University and a Ph.D. from University of California, Berkeley.

[Sam Scheiner, Ph.D.](#)

Sam Scheiner currently serves as Director for Ecology and Evolution of Infectious Diseases at the National Science Foundation. Previously he was an Associate Professor at Arizona State University West, Assistant and Associate Professor at Northern Illinois University, and Adjunct Faculty at the University of Arizona. In ecology, he works on macroecological patterns of diversity, species richness relationships, and diversity metrics. In general biology, he is developing a set of general theories encompassing all of biology. He received his B.A., M.S. and Ph.D. from the University of Chicago.

[Daniel E. Sonenshine, Ph.D.](#)

Daniel Sonenshine is Professor Emeritus and Eminent Scholar in the Department of Biological Sciences at Old Dominion University. Dr. Sonenshine evaluates the practical application of pheromone-assisted tick control strategies to increase tick kill and disrupt tick reproduction leading to total eradication. He also studies the role of antimicrobial peptides on the transmission of *Borrelia burgdorferi*, *Rickettsia parkeri*, etc. His specialty is the study of the role of pheromones and other semiochemicals in the biology of ticks. Dr. Sonenshine earned his Ph.D. in Entomology from the University of Maryland.

[Kirby C. Stafford, III, Ph.D.](#)

Kirby Stafford is Vice Director of The Connecticut Agricultural Experiment Station and Chief Entomologist within the Experiment Stations' Department of Entomology. His research area is the ecology and control of *Ixodes scapularis* (blacklegged tick) with a recent focus on natural, biological, and integrated tick control. Dr. Stafford has authored or co-authored 60 articles in peer-reviewed scientific journals and produced handbooks on both tick and fly management. Dr. Stafford earned his B.S. from Colorado State University, his M.S. from Kansas State University, and his Ph.D. in Entomology from Texas A&M University.

[Daniel Strickman, Ph.D.](#)

Daniel Strickman is the National Program Leader for Veterinary, Medical, and Urban Entomology within the U.S. Department of Agriculture's Agricultural Research Service, as well as Acting Director of USDA's Overseas Biological Control Laboratories. Key career accomplishments include eradicating *Aedes aegypti* from a Thai village without the use of insecticides, and eradicating an infestation of *Aedes albopictus* from Santa Clara County, California. He is also the co-inventor of RNAi insecticide for mosquito control, and has authored 104

peer reviewed publications. Dr. Strickman earned his M.S. and Ph.D. in Entomology from the University of Illinois.

[Ellen Stromdahl, M.S.](#)

Ellen Stromdahl is an entomologist for the Tick-Borne Disease Program of the U.S. Army Public Health Command (formerly U.S. Army Center for Health Promotion and Preventive Medicine). Ms. Stromdahl's research has focused on emerging human pathogens associated with the ticks found in the United States, especially the lone star tick, *Amblyomma americanum*, which is the tick most frequently received by the Human Tick Test Kit Program.

[Christopher Zarba, Ph.D.](#)

Chris Zarba is the Director for the Science Advisory Board, within the U.S. EPA's Office of the Administrator. Before this transition, Mr. Zarba functioned as the Office Director for National Center for Environmental Research (NCER) in the Office of Research and Development. NCER is responsible for providing extramural funds to researchers on subjects selected by the Agency to be of greatest concern. Mr. Zarba is well recognized for the "Beaches Action Plan," a report developed to identify healthy beaches criteria. This report was used to seek congressional support for the initiative.