

## Summary

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<b>Meeting dates:</b>	August 8-9, 2013
<b>Agenda item:</b>	Elk Hoof Disease Diagnostic and Management Update – <b>Briefing</b>
<b>Presenter(s):</b>	Dr. Sandra Jonker, WDFW Region 5 Wildlife Program Manager Dr. Kristin Mansfield DVM, MPVM, WDFW Wildlife Veterinarian

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### **Background summary:**

The Department is working with specialists, here and abroad, to understand what is causing hoof disease in southwest Washington elk. The Department and cooperating researchers and veterinarians have extensively analyzed samples from 43 elk of different ages from areas with elk affected by hoof disease and from areas that are not affected by hoof disease. So far, we have ruled out several potential causes and have narrowed the list of possibilities. Evidence suggests the involvement of an infectious bacterium associated with elk hoof disease.

The Department has established a Technical Advisory Group (HDTAG) composed of veterinarians and researchers to guide the diagnostic effort and a Public Working Group (HDPWG) to discuss research and management questions and options, share information, and communicate with the public. The Department has compiled all the input from the HDPWG, HDTAG, and WDFW staff to develop a management approach in response to hoof disease and address the top 3 research needs that have developed from the ongoing analyses and discussion: 1) What is the prevalence of hoof disease in elk?, 2) What is the distribution of hoof disease on the landscape?, and 3) What is the effect of hoof disease on the population (i.e., survival/reproduction)?

Department Staff will brief the Commission on the elk hoof disease diagnostic findings to date, and assessment of those findings by the WDFW Elk Hoof Disease Technical Advisory Group. Department Staff will provide an update on the proposed management and research efforts in response to the diagnostic findings.

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### **Policy issue(s) you are bringing to the Commission for consideration:**

N/A

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### **Public involvement process used and what you learned:**

The Department has established a Technical Advisory Group (HDTAG) composed of veterinarians and researchers to guide the diagnostic effort, assist with interpretation and assessment of laboratory findings, and discuss disease management and research options. The HDTAG is made up of 16 veterinarians and researchers with expertise in microbiology, epidemiology, toxicology, food animal medicine, disease diagnostics, pathology, public health, wildlife veterinary medicine, and regulatory veterinary medicine representing several universities, government agencies, and local veterinary practices.

The Department established a Public Working Group (HDPWG) to discuss research and management questions and options, share information, and communicate with the public. The HDPWG is made up of 18 individuals representing multiple entities vested in this issue including County Commissioners, private and public landowners, local businesses, sportsman groups, government agencies, and universities.

The Department has held and participated in several public meetings. Input from the HDTAG, HDPWG, and the public meetings informed the management and research options in response to hoof disease.

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**Action requested:**

N/A

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**Draft motion language:**

N/A

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**Justification for Commission action:**

N/A

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**Communications Plan:**

In September 2012, the Department launched a website to share information about reports of hoof disease and an online reporting tool for the public to report sightings of limping animals.

From September 2012 to present multiple news releases have been shared with information on research conducted, updates on findings, opportunities for public comment, and reporting options. In less than two years the Department has participated in 9 public meetings, including a briefing to the Commission in June of 2013, in locations such as Long View, Olympia, Vancouver, Chehalis, and Cathlamet. These meeting have been well attended and allowed staff to share current research, receive public comment, and address concerns.

In January 2014 the Department also developed an informational brochure about hoof disease in Southwest Washington for distribution at sportsman shows, stores, offices, etc. In addition, the Department has included information regarding what is known to date about hoof disease in the 2013 and 2014 harvest regulations pamphlets.

WDFW veterinary staff and collaborators are reporting diagnostic findings at professional society meetings, in scientific journals, and veterinary association newsletters.

## WDFW Elk Hoof Disease Technical Advisory Group (TAG)

Name	Affiliation	Title/Expertise/Rationale	Websites
Dr. George Barrington DVM, PhD, DACVIM	WSU	Professor, Large Animal Internal Medicine	<a href="http://www.vetmed.wsu.edu/people-vcs/faculty/barrington.aspx">http://www.vetmed.wsu.edu/people-vcs/faculty/barrington.aspx</a>
Dr. Tom Besser DVM, PhD, DACVM	WSU	Professor, Veterinary Microbiology and Pathology; Faculty, Paul G. Allen School for Global Animal Health	<a href="http://www.vetmed.wsu.edu/people-vmp/faculty/Besser.aspx">http://www.vetmed.wsu.edu/people-vmp/faculty/Besser.aspx</a> <a href="http://globalhealth.wsu.edu/Our-Team/faculty/thomas-besser">http://globalhealth.wsu.edu/Our-Team/faculty/thomas-besser</a>
Dr. Julia Burco DVM, MPVM, PhD	ODFW	ODFW District Wildlife Veterinarian	<a href="http://www.dfw.state.or.us/">http://www.dfw.state.or.us/</a>
Dr. Anne Fairbrother DVM, PhD	Exponent Engineering and Scientific Consulting	Principle Scientist, Ecotoxicology and Environmental Risk Assessment	Included with notebook materials
Dr. John Gay DVM, PhD, DACVPM	WSU	Associate Professor, WSU Field Disease Investigation Unit	<a href="http://www.vetmed.wsu.edu/people-vcs/faculty/gayj.aspx">http://www.vetmed.wsu.edu/people-vcs/faculty/gayj.aspx</a> <a href="http://www.vetmed.wsu.edu/courses-jmgay/">http://www.vetmed.wsu.edu/courses-jmgay/</a>
Dr. Tom Gilliom DVM	WSDA	WSDA Field Veterinarian for Lewis and Cowlitz Co.	<a href="http://agr.wa.gov/FoodAnimal/AnimalHealth/">http://agr.wa.gov/FoodAnimal/AnimalHealth/</a>
Dr. Gary Haldorson DVM, PhD, DACVP	WSU	Clinical Instructor, Veterinary Microbiology and Pathology	<a href="http://www.vetmed.wsu.edu/people-vmp/faculty/haldorson.aspx">http://www.vetmed.wsu.edu/people-vmp/faculty/haldorson.aspx</a>
Dr. Sushan Han DVM, PhD, DACVP	CSU	Assistant Professor, Department of Veterinary Microbiology, Immunology, and Pathology	<a href="http://www.cvmb.colostate.edu/DirectorySearch/Search/MemberProfile/cvmb/4491">http://www.cvmb.colostate.edu/DirectorySearch/Search/MemberProfile/cvmb/4491</a> <a href="http://csu-cvmb.colostate.edu/vdl/Pages/exotics-pathology-service.aspx">http://csu-cvmb.colostate.edu/vdl/Pages/exotics-pathology-service.aspx</a>
Dr. Jason Humphrey DVM	Partner, Cascade West Veterinary Hospital	Knowledge of Local Animal Diseases and Conditions	<a href="http://cascadewestvet.com/">http://cascadewestvet.com/</a>
Dr. Paul Kohrs DVM	WSDA	Acting State Veterinarian	<a href="http://agr.wa.gov/FoodAnimal/AnimalHealth/">http://agr.wa.gov/FoodAnimal/AnimalHealth/</a>
Dr. Kristin Mansfield DVM, MPVM	WDFW	WDFW Wildlife Veterinarian	<a href="http://www.wdfw.wa.gov/">http://www.wdfw.wa.gov/</a>
Dr. Dale Moore DVM, MPVM, PhD, DACVPM	WSU	Director, WSU Veterinary Extension; Faculty, Paul G. Allen School for Global Animal Health	<a href="https://www.vetmed.wsu.edu/people-vcs/faculty/moore.aspx">https://www.vetmed.wsu.edu/people-vcs/faculty/moore.aspx</a> <a href="http://globalhealth.wsu.edu/Our-Team/faculty/dale-moore">http://globalhealth.wsu.edu/Our-Team/faculty/dale-moore</a>
Dr. Steve Parish DVM, DACVIM	WSU	Professor, Large Animal Internal Medicine	<a href="http://www.vetmed.wsu.edu/people-vcs/faculty/parish.aspx">http://www.vetmed.wsu.edu/people-vcs/faculty/parish.aspx</a>
Dr. Mike Paros DVM	Owner, Paros Veterinary Services;	Knowledge of Local Animal Diseases and Conditions	<a href="http://www.parosveterinaryservices.com">http://www.parosveterinaryservices.com</a>

## WDFW Elk Hoof Disease Technical Advisory Group (TAG)

	Faculty, The Evergreen State College		<a href="http://www.evergreen.edu/faculty/instructor/parosm/">http://www.evergreen.edu/faculty/instructor/parosm/</a>
Dr. Jennifer Wilson-Welder PhD	USDA/ARS/NADC	Research Microbiologist	<a href="http://www.ars.usda.gov/pandp/people/people.htm?personid=47385">http://www.ars.usda.gov/pandp/people/people.htm?personid=47385</a>
Dr. Ron Wohrle DVM	WDOH	State Public Health Veterinarian	<a href="http://www.doh.wa.gov/AboutUs/ProgramsandServices/EnvironmentalPublicHealth/EnvironmentalHealthSafetyandToxicology/ZoonoticDisease.aspx">http://www.doh.wa.gov/AboutUs/ProgramsandServices/EnvironmentalPublicHealth/EnvironmentalHealthSafetyandToxicology/ZoonoticDisease.aspx</a>

**Anne Fairbrother, DVM, Ph.D.**  
**Principal Scientist and Office Director**

**Professional Profile**

Dr. Anne Fairbrother is a Principal Scientist in Exponent's EcoSciences practice, with more than 30 years of experience in ecotoxicology, wildlife toxicology, contaminated site assessment, and regulatory science. She has conducted large-area (>100 sq mile) risk assessments in tropical, desert, and mountain ecosystems, determining risk thresholds for plants and wildlife. She provided consultation on future development of mine pit lakes, assessed the risks to livestock during mine closure operations, and conducted assessments of risk to terrestrial and aquatic organisms from selenium and mercury. She has assessed risks to wildlife from organic chemicals, including DDT, PCBs, dioxins, and petroleum hydrocarbons.

Dr. Fairbrother has supported industry groups and businesses in product review and registration, particularly agrichemicals. She has worked in support of U.S., Canadian, and European regulatory processes for both the public and private sectors. Dr. Fairbrother has testified in front of governmental Boards of Review and Science Advisory Boards, and has briefed Congressional committees. She has prepared expert testimony, been deposed, and served as an expert witness at trials on environmental risks of pollutants for legal cases within the U.S.

Dr. Fairbrother has drafted guidance documents for ecological risk assessments including the EPA's *Framework for Metals Risk Assessment*, the BC Ministry of Environment guidance for implementing Tier 1 ecological risk assessments and incorporating weight of evidence practices into ecological risk assessments of contaminated sites, and participated in setting ecological soil screening and clean-up values.

While a scientist at the EPA, Dr. Fairbrother led research into the ecological risks of genetically modified crops, methods for assessing risks of nanomaterials, and some of the early guidance for field assessments of Superfund sites and effects of pesticides on birds. She researched and developed methods for assessment of chemical effects on bird immune and endocrine systems.

Dr. Fairbrother has published more than 100 peer-reviewed articles, books, and book chapters that reflect her expertise in wildlife toxicology, immunotoxicology, endocrine-disrupting chemicals, and ecological risk assessment. She has served on several National Academy of Sciences committees, most recently on the Committee on Ecological Risk Assessment under FIFRA and ESA; European Research Council review panels; and numerous other scientific boards, expert panels, and editorial boards. A veterinarian and Certified Wildlife Biologist, Dr. Fairbrother served as President of the Society of Environmental Toxicology and Chemistry, American Association of Wildlife Veterinarians, and Wildlife Disease Association. Dr. Fairbrother holds an adjunct professorship at Oregon State University, Department of Environmental and Molecular Toxicology.

## **Academic Credentials and Professional Honors**

Ph.D., Veterinary Science, University of Wisconsin, Madison, 1985  
M.S., Veterinary Science, University of Wisconsin, Madison, 1982  
D.V.M., Veterinary Medicine, University of California, Davis, 1980  
B.S., Wildlife and Fisheries Biology, University of California, Davis, 1976

Distinguished Service Award, Wildlife Disease Association, 2002  
Gold Medal for Commendable Service, EPA, 2005  
Bronze Medal for Commendable Service, EPA, 2006, 2008

## **Licenses and Certifications**

Certified Wildlife Biologist, The Wildlife Society, 1995  
40-hour Hazwoper Training and Certification

## **Publications**

Fairbrother A, Purdy J, Anderson T, Fell R. Focus Article: Risks of neonicotinoid insecticides to honey bees. *Environ Toxicol Chem* 2014; 33:719-731.

Wentzel R, Fairbrother A. Next Steps in the Development of Ecological Soil Clean-up Values for Metals. *Int Environ Assess Manage* 2013; DOI: 10.1002/ieam.1451.

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Fowles JR, Kerkvliet N, Fix M, Fairbrother A. Glucocorticoid effects on natural killer cell activity, antibody response, and plasma chemistry in mallards. *Comp Develop Immunol* 1993; 17:165–177.

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Glicken (Fairbrother) A, Kendrick JW. Hoof overgrowth in Holstein Frisian dairy cattle. *J Heredity* 1977; 68:386–390.

## **Books**

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Clark J, Fairbrother A, Kapustka LA. Adaptation and acclimation of terrestrial organisms to metals in soil. International Copper Association Special Publication, SETAC Press, Pensacola, FL, 2001.

Fairbrother A. Seminars in Avian and Exotic Pet Medicine—Toxicology. Guest Editor and Introduction for Volume 8(1). WB Saunders Company, Philadelphia, PA, 1999.

Fairbrother A, Kapustka LA. Hazard classification of inorganic substances in terrestrial systems. International Council on Metals and the Environment, Ottawa, Canada, 1997.

Glickman L, Fairbrother AA, Guarino M, Bergman HL, Buck WB, Cork LC, Hayes HM, Legator SM, McConnell EE, Mcnelis DN, Temple SA. The use of animals as sentinels of environmental health hazards. National Academy Press, Washington, DC, 1991.

## **Book Chapters**

Fairbrother A. Prevention and reduction of chemical contamination on ecosystems. pp. 243–248. In: Ecosystem Health and Sustainable Agriculture, Volume 2: Ecology and Animal Health. Norrgren L and Levengood JM (eds), The Baltic University Program, Uppsala University, 2012.

Grim KC, Fairbrother A, Rattner BA. Wildlife toxicology: Environmental contaminants and their national and international regulation. In: New Directions in Conservation Medicine: Applied Cases of Ecological Health. Aguirre AA, Ostfeld R, Daszak P (eds), Oxford University Press USA, 2012.

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Moore DRJ, Warren-Hicks WJ, Qian S, Fairbrother A, Aldenberg T, Barry T, Luttik R, Ratte H-T. Uncertainty analysis using classical and Bayesian hierarchical models. In: Application of Uncertainty Analysis to Ecological Risks of Pesticides. Warren-Hicks WJ, Hart A. (eds), SETAC Press, Pensacola, FL, 2010.

Hodson PV, Reash RJ, Canton SP, Campbell PV, Delos CG, Fairbrother A, Hitt NP, Miller LL, Ohlendorf HM. Selenium risk assessment. In: Ecological Assessment of Selenium in the Aquatic Environment. Chapman PM, Adams WJ, Brooks ML, Delos CG, Luoma SN, Maher WA, Ohlendorf HM, Presser TS, Shaw DP (eds), SETAC Press, Pensacola, FL, 2009.

Fairbrother A. Risk management safety factors. In: Encyclopedia of Ecology. Jorgensen SE (ed), Elsevier: Oxford, 2008.

Lewis MA, Fairbrother A, Menzer RE. Methods in environmental toxicology. In: Principles and Methods of Toxicology, Fifth Edition. Hayes AW (ed), Taylor and Francis: Philadelphia, PA, 2007.

Fairbrother A, Hope B. Terrestrial ecotoxicology. pp. 138–142. In: Encyclopedia of Toxicology, Second Edition. Wexler, P. (ed), Elsevier: Oxford, 2005.

Mount DR, Ankley GT, Brix KV, Clements WH, Dixon DG, Fairbrother A, Hickey CW, Lanno RP, Lee CM, Munns WR, Ringer RK, Staveley JP, Wood CM, Erickson RJ, Hodson PV. Effects assessment. pp. 53–118. In: Reevaluation of the State of the Science for Water-Quality Criteria Development. Reiley MC, et al. (eds), SETAC Press: Pensacola, FL, 2003.

Fairbrother A, Kapustka LA. A historical perspective of environmental concerns to frame the issues. pp. 1–17. In: High-Potency Herbicides Impact on Nontarget Plants. Ferenc SA (ed), SETAC Press: Pensacola, FL, 2001.

Fairbrother A. Putting the impacts of environmental contamination in perspective. pp. 671–689. In: Ecotoxicology of Wild Mammals. Shore RE, Rattner BA (eds), Ecological and Environmental Toxicology Series, John Wiley and Sons: Chichester, UK, 2001.

Fairbrother A, Lewis MA, Menzer RE. Methods in environmental toxicology. In: Principles and Methods of Toxicology, Fourth Edition. Hayes AW (ed), Taylor and Francis: Philadelphia, PA, 2000.

Fairbrother A, Bennett RS. Multivariate statistical applications for addressing multiple stresses in ecological risk assessments. pp. 69–115. In: Multiple Stressors in Ecological Risk and Impact Assessment: Approaches in Risk Estimation. Ferenc SA, Foran JA (eds), SETAC Press: Pensacola, FL, 2000.

Fairbrother A, Ankley GT, Birnbaum LS, Bradbury SP, Francis B, Gray LE, Hinton D, Johnson LL, Peterson RE, Van Derkraak G. Reproductive and developmental toxicology of contaminants in oviparous animals. pp 283–362. In: Reproductive and Developmental Effects

of Contaminants in Oviparous Vertebrates. In: DiGiulio RT, Tillit DE (eds), SETAC Press: Pensacola, FL, 1999.

Klump JU, Adams WJ, Cardwell R, Fairbrother A, Harris HJ, Ingersoll CG, Power M, Reid LM. Conceptual approaches to identify and assess multiple stressors. pp. 1–26. In: Multiple Stressors in Ecological Risk and Impact Assessment. Foran JA, Ference SA (eds), SETAC Press: Pensacola, FL, 1999.

Kelsch T, Powell RL, Dixon KR, Fairbrother A, Helgen JC, Klaine SJ, Mayer FL, Pascoe GA, Shaw SL, Theriot RF. Regulatory issues and risk assessment. pp. 275–314. In: Ecotoxicology and Risk Assessment for Wetlands. Lewis MA, Mayer FL, Powell RL, Nelson MK, Klaine SJ, Henry MG, Dickson GW (eds), SETAC Press: Pensacola, FL, 1999.

Peakall DB, Fairbrother A. Biomarkers for monitoring and measuring effects. pp. 351–376. In: Pollution Risk Assessment and Management. Douben PET (ed), John Wiley and Sons: Chichester, UK, 1998.

Fairbrother A. Establishing the health of ecosystems. pp. 101–108. In: Multiple Stresses on Ecosystems. Cech JJ, Wilson BA, Crosby DG (eds), Lewis Publishers: Boca Raton, FL, 1998.

Fairbrother A. Ecotoxicological principles for avian field studies. pp. 11–16. In: Radiotelemetry for Avian Field Studies. Brewer LW, Fagerstone KA (eds), SETAC Press: Pensacola, FL, 1998.

Kapustka LA, Fairbrother A, Williams BA, Glicken J, Bennett RS. Environmental risk assessment for sustainable cities. Technical Publication Series [3], UNEP International Environmental Technology Centre, Osaka, Japan, 1996. ISBN 92-807-1505-4.

Fairbrother A. Cholinesterase inhibitors. In: Non-Infectious Diseases of Wildlife, Second Edition. Fairbrother A, Locke L, Hoff GL (eds), Iowa State University Press, Ames, IA, 1996.

Fairbrother A, Knapp CM. Ecological aspects of land spreading sewage sludge. pp. 75–80. In: Sewage Sludge: Land Utilization and the Environment. Clapp CE (ed), ASA-CSSA-SSSA, Madison, WI, 1994.

Menzer RE, Lewis MA, Fairbrother A. Methods in environmental toxicology. pp. 1391–1418. In: Principles and Methods of Toxicology, Third Edition. Hayes AW (ed), Raven Press, New York, NY, 1994.

Fairbrother A. Clinical enzymology. pp. 63–92. In: Nondestructive Biomarkers in Vertebrates. Fosi C, Leonzio C (eds), Lewis Publishers: Boca Raton, FL, 1993.

Fairbrother A. Immunotoxicology of captive and wild birds. pp. 251–262. In: Wildlife Toxicology and Population Modeling: Integrated Studies of Agroecosystems. Kendall R, Lacher TE (eds), Lewis Publishers: Boca Raton, FL, 1993.

Weeks BA, Anderson DP, DuFour AP, Fairbrother A, Goven AJ, Lahvis GP, Peters G. Immunological biomarkers to assess environmental stress. pp. 212–234. In: Biomarkers: Biochemical, Physiological, and Histological Markers of Anthropogenic Stress. Huggett RJ, Kimerle RA, Mehrle PM, Bergman HL (eds), Lewis Publishers: Boca Raton, FL, 1992.

Fairbrother A. Decontamination and mitigation of baculoviruses. pp. 843–850. In: Microbial Ecology: Principles, Methods, and Application to Environmental Biotechnology. Levin M, Seidler R, Rogul M (eds), McGraw Hill: New York, NY, 1991.

Rattner BA, Fairbrother A. Sources of variability in cholinesterase measurements. pp. 89–108. In: Cholinesterase-Inhibiting Insecticides—Their Impact on Wildlife and the Environment. Mineau P (ed), Elsevier Science Publishers B.V., Amsterdam, Holland, 1990.

Fairbrother A, Bennett JK, Marden B, Hooper NJ. Methods of cholinesterase analysis, A United States perspective. pp. 35–72. In: Cholinesterase-Inhibiting Insecticides—Their Impact on Wildlife and the Environment. Mineau P (ed), Elsevier Science Publishers B. V., Amsterdam, Holland, 1990.

### **Books Edited**

Fairbrother A (ed). Test Methods for Hazard Determination of Metals and Sparingly Soluble Metal Compounds in Soils. SETAC Press: Pensacola, FL, 2002.

Fairbrother A, Locke L, Hoff, GL (eds). Non-Infectious Diseases of Wildlife, Second Edition. Iowa State University Press: Ames, IA, 1996.

### **Selected Published Abstracts**

#### *International*

Powell DE, Fairbrother A, Mackay D, Woodburn KB. Interrelationship of bioaccumulation metrics (BCF, BAF, BMF, and TMF) and how they may be incorporated into a screening-level probabilistic risk assessment. Presented at Society of Environmental Toxicology and Chemistry European Annual Meeting, Basel Switzerland, May 2014.

Fairbrother A, Burton A, Klaine S, Springer T, Woodburn K, Powell D. Benthic invertebrate exposure and chronic toxicity analysis for CVMS materials – a probabilistic risk assessment approach. Presented at the Topical Scientific Workshop on risk assessment for the sediment compartment by invitation from the European Chemicals Agency, Helsinki, Finland; May 2013.

Fairbrother A, Wentsel R, Wood W, Sappington K, Noyes P. Framework for inorganic metals risk assessment. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Montreal, Canada, November 2006.

Gallagher K, Morris J Willis, J., Alwood A, Bauer D, Boethling R, Brody M, Burgin D, Chow F, Dreher K, Fairbrother A, Henry T, Karn B, Libelo L, Lingle S, Nabholz J, Prothero S, Savage N, Sayre P, Scalera J, Schoepf W, Street A, Utterback D, Williamson T, Zepp R. Nanotechnology: environmental opportunities and challenges. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Montreal, Canada, November 2006; and Society for Risk Analysis Meeting, Baltimore, MD, December 2006.

Schumaker N, Nagy L, Fairbrother A. PATCH: A spatially explicit wildlife population model for assessing risks of pesticides to songbirds. Presented at the Wildlife Disease Association World Congress, Cairns, Australia, June 2005.

Fairbrother A, Wentsel R. Framework for inorganic metals risk assessment. Presented at Society of Environmental Toxicology and Chemistry, European Annual Meeting, Lille, France, May 2005.

Fairbrother A. Communicating probabilistic risk outcomes to risk managers. Presented at Society of Environmental Toxicology and Chemistry, European Annual Meeting, Hamburg, Germany, April 2003.

Clark J, Fairbrother A, Brewer L, Bennett RS. Effects of exogenous estrogen on mate selection of house finches. Presented at Society of Environmental Toxicology and Chemistry, European Annual Meeting, Vienna, Austria, May 2002.

Blanton ML, Driver CJ, Fairbrother A, Touart L. Detailed review paper for an avian two-generation and partial life-cycle reproductive and developmental toxicity test. Presented at Society of Environmental Toxicology and Chemistry, European Annual Meeting, Vienna, Austria, May 2002.

Trust KA, Fairbrother A, Hooper MJ. Effects of 7,12-dimethylbenz[a]anthracene on immune function and mixed-function oxygenase activity in the European starling. Society of Toxicology Annual Meeting, New Orleans, LA, March 1993; and Wildlife Disease Association Annual Meeting, Guelph, Canada, August 1993.

Fairbrother A. Biomarkers in wildlife. Society of Environmental Toxicology and Chemistry Annual Meeting, Toronto, Canada, November, 1989.

Fairbrother A. Immunotoxicology of wild and laboratory birds. Wildlife Disease Association 6th International Meeting, East Berlin, GDR, August, 1990.

Yuill TM, Hinsdill RD, Porter WJ, Fairbrother A. The hidden challenge: determining sublethal effects of wildlife diseases. Wildlife Disease Association 6th International Meeting, East Berlin, GDR, August, 1990.



*National (most recent 10-years)*

Kashuba R, Fairbrother A, Tinsworth R. Probabilistic methods to address ecological risk of secondary ingestion exposure to chemicals. Presented at the Session: Updates in Ecological Risk Assessment Models, at the Society for Risk Analysis (SRA) 2013 Annual Meeting, Baltimore, MD, December 8-11, 2013

Anderson T, Fell R, Purdy R, Fairbrother A. Assessment of risk of neonicotinoid pesticides to bees. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Nashville, TN, November 2013

Sample BE, Fairbrother A, Kaiser A, Adams W. Sensitivity of ecological soil screening levels to exposure model parameterization and toxicity reference values. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Nashville, TN, November 2013

Fairbrother A. Recommendations for ecological models to assess risks to endangered and threatened species. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Nashville, TN, November 2013

Fairbrother A. Assessing Risks to Endangered and Threatened Species from Pesticides. CropLife America and RISE annual conference. Washington DC, April 2013.

Fairbrother A, Kaiser A, Driscoll SK, Tinsworth R. Mitigating risk of rodenticides to nontarget wildlife – potential options and unintended consequences. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Long Beach, CA, November 2012.

Fairbrother A, Blust R. A critique of the status of knowledge about chemosensory effects of metals in fish. Presented at the American Fisheries Society Annual Conference, St. Paul, MN, August 2012.

Fairbrother A, Burton GA, Klaine SJ. Toxicity of decamethylcyclopentasiloxane (D5) to aquatic and terrestrial environments. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Boston, MA, November 2011.

McArdle MS, Kane Driscoll SB, Menzie CA, Fairbrother A. Guidance for a weight-of-evidence approach to ecological risk assessments in British Columbia. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Boston, MA, November 2011.

Mayfield DB, Fairbrother A. Standardization of wildlife toxicity reference values proves elusive. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Boston, MA, November 2011.

Edwards M, Fairbrother A. Surface water quality in the upper Columbia River, Washington. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Portland, OR, November 2010.

Fairbrother A, Edwards M, Mayfield D. Contaminant analysis of fish in the upper Columbia River, Washington. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Portland, OR, November 2010.

Fairbrother A, Menzie C. Integrated exposure analysis for human health and ecological risks at contaminated site. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Portland, OR, November 2010.

Palmquist K, Fairbrother A, Salatas J, Guiney P. Environmental fate of pyrethroids in urban stream sediments and the appropriateness of *Hyaella azteca* model in determining ecological risk. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Portland, OR, November 2010.

Fairbrother A. The art and practice of weighing evidence for environmental assessment. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, New Orleans, LA, November 2009.

Fairbrother A, Dohmen P, Marchand M, McCarty LS, Solomon K. Use of (Eco) toxicity data as screening criteria for the identification and classification of PBT / POP compounds. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Tampa, FL, November 2008.

DeForest D, Fairbrother A, Adams BA. Selenium hormesis in birds—Implications for developing dietary and egg-based toxicity thresholds. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Tampa, FL, November 2008.

Fairbrother A, Dohmen P, Marchand M, McCarty LS, Solomon K. Use of (Eco) toxicity data as screening criteria for the identification and classification of PBT / POP compounds. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Tampa, FL, November 2007.

DeForest D, Fairbrother A, Adams BA. Selenium hormesis in birds—Implications for developing dietary and egg-based toxicity thresholds. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Tampa, FL, November 2007.

Grim KC, Fairbrother A, Monfort S, Tan S, Rattner B, Gerould S, Beasley V, Aguirre A, Rowles T. Results of a wildlife toxicology workshop held by the Smithsonian Institution—Identification and prioritization of problem statements. National Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Milwaukee, WI, November 2007.

Hope B, Allard P, Fairbrother A, Hull R, Johnson MS, Kapustka LA, McDonald B, Sample BE. Representation and consequences of uncertainty in the toxicity reference value. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Milwaukee, WI, November 2007.

Allard P, Hill R, Mann G, Mackintosh C, Hull R, Kapustka LA, McDonald B, Hope B, Sample BE, Fairbrother A, Johnson MS. Using dose-response relationships for wildlife TRVs. Presented at the Society for Risk Analysis Annual Conference, Milwaukee, WI, November 2007.

Kapustka L, Fairbrother A, Sample BE. Linking assessment endpoints and wildlife TRVs. Presented at the Society for Risk Analysis Annual Conference, Milwaukee, WI, November 2007.

Hull RN, Allard P, Fairbrother A, Hope B, Johnson MS, Kapustka LA, McDonald B, Sample BE. Summary of recommendations for wildlife TRV development and use. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Milwaukee, WI, November 2007.

Fairbrother A. Environmental immunotoxicants: Human-wildlife relationships. Presented at the Society of Environmental Toxicology and Chemistry Annual Conference, Milwaukee, WI, November 2007.

Fairbrother A, Sappington K, Wentsel R, Menzie C, Bottimore D, Downey P, Haber L, Harding-Barlow I, Nelson M, Thornton K. Principles for Metals Risk Assessment USEPA Framework. Presented at the Society for Risk Analysis Annual Conference, Baltimore, MD, December 2006.

Fairbrother A, Wentsel R, Sappington K, Wood W, P. Noyes. Framework for inorganic metals risk assessment. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Montreal, Canada, November 2006.

Morzillo AT, Fairbrother A. Effects of human activities on resident mammals within urban ecosystems. Presented at the 86th Annual Meeting of the American Society of Mammalogists meeting, Amherst, MA, June 2006.

Smith C, Stubblefield W, Clark J, Fairbrother A, Allen H, Schoeters I, Dwyer R. Distribution of soil bioavailability parameters throughout Europe and development of metalloregions. Major Scientific/Technical Contributions. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Portland, OR, November 2004.

Wentsel R, Fairbrother A. Overview of the development of the Framework for Metals Risk Assessment. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Portland, OR, November 2004.

Fairbrother A. Comparison of European and United States approaches to new and existing substances regulation. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Portland, OR, November 2004.

Adams W, Brix K, DeForest D, Toll J, Fairbrother A, Kapustka L. Ecological risk assessment at a copper smelter. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Portland, OR, November 2004.

Suter II GW, Fairbrother A, Munns Jr WR, Norton SB, Wentsel R, Kravitz MJ. Individuals versus organisms versus populations in the definition of ecological assessment endpoints. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Portland, OR, November 2004.

Smolders E, Fairbrother A, Hale B, Lombi E, McGrath S, McLaughlin M, Rutgers M, Van der Vliet L. Hazard assessment of metals and metal compounds in terrestrial systems. Presented at Society of Environmental Toxicology and Chemistry Annual Meeting, Austin, TX, November 2003.

## **Invited Presentations**

### *International*

Fairbrother A. 50 Years after Silent Spring. Have organophosphate and carbamate pesticides met the challenge? Seminar/Lecture: Toxicology Center, University of Saskatchewan, Saskatoon, SK, December 2012.

Fairbrother A. Environmental effects of manufactured nanomaterials. Invited plenary presentation at SETAC World Conference, Sydney, Australia August 2008.

Fairbrother A. Ecological risk assessment and wildlife toxicology. 1<sup>st</sup> International Conference on Environmental Issues, Hanoi, Vietnam, March 2004.

Fairbrother A. Genetically modified foods: Technological breakthrough or ecological nightmare? Keynote address at SETAC Asia Pacific conference, Christchurch, New Zealand, September 2003.

Fairbrother A, Turnley JG. Communication of probabilistic risk assessments. Invited presentation in special symposium on Probabilistic Risk Assessment at SETAC Europe 13<sup>th</sup> annual conference, Hamburg, Germany, April 2003.

Clark J, Fairbrother A, Brewer L, Bennett RS. Effect of exogenous estrogen exposure on mate selection by the female house finch. Invited presentation at SETAC Europe 12<sup>th</sup> Annual Conference, Vienna, Austria, May 2002.

Robinson S, Fairbrother A. Human health risks from organotins in household products. Proceedings of the Organotin Environmental Programme Association Meeting, Sardinia, Italy, October 2000.

Fairbrother A, Brix KV, DeForest DK, Adams WJ. Critical review of tissue-based selenium toxicity thresholds for fish and birds. Presented at Mine Reclamation Symposium, Williams Lake, British Columbia, June 2000.

Fairbrother A. Fellow of the Crown Research Institute, Wellington, New Zealand. Invited lectures to scientific staff, regulators and academics (University of NZ, Christchurch), October 2000.

Fairbrother A. Keynote speaker and invited lecturer, Zoo and Wildlife Veterinary Medicine, Continuing Education. Western Plains Zoo, Dubbo, Australia. September 1999.

Fairbrother A. Tier 1 (Screening Level) risk assessments in British Columbia. Workshop sponsored by the Ministry of the Environment, Vancouver, BC, November 1998.

*National (most recent 10 years)*

Invited presentation in Special Symposium: 50 Years after Silent Spring. Have Organophosphate and Carbamate Pesticides Met the Challenge? Society of Environmental Toxicology and Chemistry; Long Beach, CA, November 2012.

Seminar/Lecture: Introduction to Ecological Risk Assessment. Environmental and Molecular Toxicology Department, Oregon State University, Corvallis, OR April 2011.

Plenary: Federal environmental legislation in the U.S. for protection of wildlife and regulation of environmental contaminants. Smithsonian Wildlife Toxicology Symposium, Washington DC March 2007.

Keynote: History of development and use of bioindicators and biomarkers in the U.S. 14<sup>th</sup> International Conference on Bioindicators. Baltimore, MD April 2006.

Lecture: RCRA and CERCLA: Environmental containment, contamination, and clean up. School of Veterinary Medicine, University of Illinois, March 2005.

Co-instructor: Introduction to Ecological Risk Assessment. Dept. of Fisheries and Wildlife *and* Dept. of Environmental and Molecular Toxicology, Oregon State University, Corvallis, OR, Winter 2003–2007.

Lectures: Risk assessment overview and introduction to TSCA and FIFRA. Presented in an upper division graduate level course on environmental studies. Department of Environmental Science, Oregon State University, Corvallis, OR, Fall 2002, Winter 2003, 2004.

### **Selected Project Experience**

Conducted an invitational workshop of international bee experts to use a formal Causal Analysis approach to develop a framework for objectively diagnosing the cause(s) of declines in the health of managed honeybees. Follow up workshop reports, manuscripts, and educational materials are in preparation.

Conducted an invitational workshop of international experts to develop methods for setting ecological soil clean-up values for metals at contaminated sites in North America. Follow up workshop reports, manuscripts, and educational materials are in preparation.

Conducting an RI/FS for 150 miles of the upper Columbia River (Canadian border to the Grand Coulee Dam) and surrounding uplands to assess potential ecological risks of smelter emissions to aquatic life, plants, and wildlife. Studying contaminated sediments to ascertain bioavailable metals, conducting food-chain analyses for fish and wildlife, and evaluating soil and uplands in depositional areas to assess risks to plants and wildlife. Work is being conducted under agreement with EPA following procedures for CERCLA site assessments.

Conducting a natural resource damage assessment (NRDA) for marine wildlife in the Gulf of Mexico following the Mississippi Canyon Block 252 (BP) oil release accident in April 2010.

Providing expert reports and testimony on effects of anticoagulant rodenticides to nontarget wildlife, and the potential efficacy of reducing availability of over-the-counter consumer products based on second generation anticoagulants. In response to EPA's draft Notice of Intent to cancel multiple products.

Provided expert reports and court room testimony on water quality and bioavailability of metals for a case involving surface water management at a closed and remediated copper mine in Wisconsin.

Provided expert reports and testimony on ecotoxicity and risk for decamethylcyclotrasiloxane (Siloxane D5) in front of the Canadian Board of Review under the Canadian Environmental Protection Act (CEPA).

Conducted a site audit and provided recommendations for wildlife pest control at a food grade packaging facility.

Conducted a Detailed Ecological Risk Assessment of the tailings management system of the Gratzburg mine, Irian Jaya, Indonesia. This included assessing risks to plants and wildlife in jungles and estuarine mangrove ecosystems through food-chain analyses, ecological function studies, and floristic composition analyses. Performed extensive plant phytotoxicity and metal uptake studies to determine risk thresholds for tropical species. A detailed report was written estimating current and future (until mine closure in 2034) risks.

Served as an Expert Advisor to Cominco and its contractors for design and conduct of a terrestrial wide-area assessment under the Contaminated Site Regulations of British Columbia. This included development of appropriate assessment endpoints, conceptual site models, sampling and analysis plans, and final risk estimates. The area encompassed the upper Columbia River Valley and associated side valleys that had been subject to past deposition from the zinc-lead smelter plume.

Conducted an Ecological Risk Assessment for 165 square miles of property surrounding the Bingham Canyon, Utah, gold mine. Work included a survey of plants and wildlife on the site,

food-chain analysis of potential metal contamination, field measurements of small-mammal populations, nesting surveys of shorebirds, and development of management options for various portions of the site. Included a probabilistic risk assessment of effects of selenium on the local populations of wading birds.

Conducted an assessment of risk to terrestrial and aquatic organisms from an abandoned mercury mine in the Ochoco Mountains, Oregon, and determined risk-based cleanup levels. This was the first risk assessment to follow the newly published Oregon Department of Environmental Quality guidelines.

Assessed the potential for risk to livestock from use of wastewater on irrigated pasture during mine closure. Selenium and thallium were identified as contaminants of concern. Plant uptake studies were conducted to refine risk estimates for thallium, both in laboratory and field situations.

Provided expert consultations on review comments relating to potential future development of pit lakes at gold mines in Nevada. Included interpretation of information on contaminants of concern, potential for bioaccumulation, and wildlife food-chain contamination.

Conducted an assessment of the potential ecological risks posed by use of copper pipes in housing in California. Specific emphasis was on amount of copper discharged to San Francisco Bay. Other areas, such as the Southern California Bight and San Diego Bay, also were assessed. Endpoints included protection of aquatic life, achievement of water quality criteria, and methods for establishing water effect ratios for specific locations.

Collated and reviewed the literature from 2005 to 2010 on environmental effects of lead, in support of the 5-year update of the U.S. national ambient air quality standards (NAAQS) for lead.

Reviewed literature and available toxicity tests for various pesticides to develop Other Scientifically Relevant Information (OSRI) in response to EPA's request for endocrine disruptor Tier 1 screening.

Provided technical and managerial support to the organotin industry for submission of a screening information data set (SID) of information on 27 chemicals to the OECD's High Production Volume (HPV) data call-in program. Reviewed the available literature on physical/chemical properties, environmental fate, ecotoxicity, and human health effects for all the chemicals, and entered appropriate data into the IUCLID database system. Tests were placed with contract laboratories to fill data gaps. Structure-activity relationships and chemical categories were developed to reduce the need for testing. Developed test plans, SIARs, and dossiers for submission to the regulatory authorities.

Reviewed entire literature for effects of zinc and phthalate esters on terrestrial organisms (plants, wildlife, soil organisms). Qualified all studies for data quality and summarized the extent of the database. Provided all information in written report and electronic database of endpoints and data quality. Zinc data were used in the continent-wide ecological risk

assessment conducted by the European Union (EU) and subsequently were migrated to IUCLID for use in REACH.

Wrote a Tier I assessment and supervised the conduct of toxicity and exposure studies for registration with the U.S. Fish and Wildlife Service of a new non-toxic shot for waterfowl hunting. Successfully completed the registration process under the new regulations, which allow selected testing rather than a complete battery of tests. Information also was submitted to Environment Canada for review. Shot has been registered and successfully marketed in the U.S. for several years.

Directed studies in a fully compliant GLP laboratory following FIFRA pesticide registration guideline for mallard and bobwhite quail. Included acute, subchronic, and reproduction studies with novel chemical and biological pesticides, conducted for most of the large agricultural companies. Additional studies included tests specifically tailored to address questions of contaminant uptake from soil, potential food aversion from chemical-treated feed, and other studies to address specific aspects of exposure of wildlife to pesticides.

Conducted and published laboratory studies with the rat as a model of the pica child to determine the uptake efficiency of petroleum hydrocarbons from soils. Soil types included aged soils, treated soils, and lampblack. Information from the study can be used in exposure equations in place of default values when estimating total uptake of PAHs from different soil types during either human or ecological risk assessments of contaminated sites.

Researched effects of estrogen supplementation in house finch breeding behavior, including mate selection, changes in plumage coloration, and reproductive output. Animals were implanted with time-release devices for continual elevation of estrogen levels, and an ELISA method for measurement of fecal/urate estrogens was adapted to the house finch to monitor changes in hormones during the breeding cycle. Used videography to assess effects on nest behaviors.

## **Prior Experience**

Sr. Consultant and Lead for Environmental Risk Assessment and Toxicology, Parametrix, Inc., 2007–2008

Associate Director for Science, U.S. EPA, National Health and Environmental Effects Research Laboratory, Western Ecology Division, 2006–2007

Chief, Risk Characterization Branch, (Supervisory Life Scientist, hired at the GS-15 level [science promotion to Grade 15, 9/02]); U.S. EPA, National Health and Environmental Effects Research Laboratory, Western Ecology Division, Corvallis, 2002–2006

Director and Senior Ecotoxicologist, Terrestrial Ecotoxicology; Parametrix, Inc., 1999–2002

Sr. Wildlife Ecotoxicologist; Ecological Planning and Toxicology, Inc., 1994–1999

Chief, Ecotoxicology Branch, (Supervisory Ecologist, detailed at the GM-15 level), USEPA Environmental Research Laboratory, 1992–1994

Research Ecologist USEPA Environmental Research Laboratory (GS12 – GS14), 1986–1992

Courtesy Associate Professor, College of Veterinary Medicine, Oregon State University, 1987–2003



Courtesy Professor, Department of Environmental and Molecular Toxicology, Oregon State University, 2003–present

### **Academic Appointments**

- Associate Professor (Adjunct), Department of Environmental and Molecular Toxicology, Oregon State University, 2003 - present
- Associate Professor (Adjunct), College of Veterinary Medicine, Oregon State University, 1987–2003

### **Advisory Appointments**

- National Research Council Committee on the Design and Evaluation of Safer Chemical Substitutions
- National Research Council Committee on Ecological Risk Assessment Under FIFRA and ESA, 2011–2013
- European Research Council Expert Panel Reviewer, 2009–2011
- Department of Environmental and Molecular Toxicology, Oregon State University, Departmental Review Committee, 2013
- The Institute of Environmental and Human Health, Texas Tech University, Science Advisory Board, 2005–2012
- British Columbia Science Advisory Board for Contaminated Sites, 2003–present
- International Metals Consortium Ecological Technical Advisory Panel, 1995–present
- USPEA, Endocrine Disruptor Methods Validation Committee, 2004–2006
- Utah Division of Water Quality, selenium standard development, Science Advisory Panel, 2004–2008
- Novel Methods for Integrated Risk Assessment of Cumulative Stressors in the Environment (NOMIRACLE), Expert Advisory Panel, 2005–2007
- USEPA Risk Assessment Forum member, 2004–2007
- USGS BRD National Wildlife Health Center (NWHC) and Forest and Rangeland Ecology Science Center (FRESC), Peer Review Science Panel, 2005
- USEPA Office of Research and Development, Board of Scientific Counselors, 2001
- USEPA Science Advisory Panel (Pesticides), 2001
- Contaminated Soils Advisory Group, Society of Environment Toxicology and Chemistry, 1996–present
- Science Advisory Committee, US Environmental Protection Agency, Center of Excellence in Ecotoxicology, University of California, Davis, 1992–1998
- Science Advisory Panel for Soil Toxicity Criteria, British Columbia Ministry of Environment, 1996
- Peer Review Panel for Ecotoxicity Threshold Values, Superfund Program, US Environmental Protection Agency, 1995
- US Environmental Protection Agency Peer Review Panel, Ecological Risk Assessment Guidelines, 1995
- Blue Ribbon Peer Review Panel, US Fish and Wildlife Service, Patuxent Wildlife Research Center, 1990–1991

- National Research Council Committee Member, Use of Animals as Indicators of Environmental Health Hazards, 1988–1991

## **Editorships and Editorial Review Boards**

### *Editorial Boards*

- *Environmental Toxicology and Chemistry*, 1995–1997
- *Human and Ecological Risk Assessment*, 2004–present
- *Journal of Wildlife Diseases*, 1998–present
- *Risk Analysis*, 2001–present
- *Ecotoxicology*, 2009–present
- *Emerging Topics in Ecotoxicology* (book series), 2008–present
- *Bulletin of Environmental Contamination and Toxicology*, 2013

### *Associate Editor*

- *Journal of Wildlife Diseases*, 1986–1991
- *Journal of Wildlife Management*, 1995–1996
- *Chemosphere* (Risk Assessment section), 2003–2005
- *Ecotoxicology*, 1995–present

### *Guest Editor*

- Seminars in Avian and Exotic Pet Medicine *Toxicology* Vol 8, Jan 1999
- Fact Sheets on Environmental Risk Assessment, [www.icmm.org](http://www.icmm.org), 2001–2002
- *Ecological Applications* special issue on mercury in Clear Lake, CA, 2006–2007

## **Peer Reviewer (in addition to above journals)**

- *Archives of Environmental Contamination and Toxicology*
- *Ecological Applications*
- *Ecotoxicology and Environmental Safety*
- *Environmental Science and Technology*
- *Risk Analysis*
- *Etc.*

## **Professional Affiliations**

- American Veterinary Medical Association—AVMA  
– Committee on Environmental Issues, 2001–2003 (Chair, 2002–2003)
- American Association of Wildlife Veterinarians—AAWV  
– President, 1991–1993
- Society of Environmental Toxicology and Chemistry—SETAC  
– President SETAC North America, 2002–2003

- Society for Risk Analysis—SRA
- Wildlife Disease Association—WDA  
– President, 1995–1997