

Cameron A. Irvine

Aquatic Ecologist / Ecological Risk Assessor

Education

M.S., Environmental Science (EcoToxicology), Wright State University, 2003

B.Sc., Biology, University of Saskatchewan, 1994

Professional Registrations

Registered Professional Biologist of British Columbia (1999, RPBBC No. 1197)

College of Applied Biologists of British Columbia (2001)

Relevant Experience

I am an aquatic ecotoxicologist/ecological risk assessor with over 15 years of environmental and toxicity assessment experience. I have performed environmental assessments throughout North America, managed a watershed-scale stream restoration project to benefit freshwater fisheries in British Columbia, and contributed to the development of *in situ* toxicity testing methods. Recently, I successfully completed a multi-year toxicity reduction evaluation (TRE) identifying a novel invertebrate toxicant in treated wastewater. In relation to the Sacramento-San Joaquin Delta, I have been supporting special studies being conducted by the Central Valley Regional Water Quality Control Board (CVRWQCB) and various research agencies (e.g., UC Davis, UC Berkeley, SFSU) and working in conjunction with Drs. Werner, Weston, and Dugdale for the past three years. During these studies I have jointly developed study plans, reviewed and discussed results, and commented on the technical merits of delta smelt toxicity testing, ammonium uptake preference by algae, and pyrethroid source evaluations. As a member of the POD-CWT since 2007, and as a committee member for the March 2009 ammonia workshop, and contributor to the August ammonia summit I have come to understand the pelagic organism decline (POD) issues related to toxicity, and am intimately familiar with studies investigating potential Sacramento Regional Wastewater Treatment Plant (SRWTP) impacts on the POD. Highlights from my career include:

- Collaborating with regional dischargers and regulatory staff to investigate potential factors contributing to the pelagic organism decline (POD) in the Sacramento-San Joaquin Delta.
- Development of lab and field-based (*in situ*) toxicity testing of various exposure pathways and media with aquatic invertebrates and fish.
- Completing a multi-year toxicity reduction evaluation (TRE) identifying a novel invertebrate toxicant in treated wastewater.
- Design, permitting, and implementation of a landscape-scale rainbow trout habitat restoration project.
- Field ecological and wildlife investigations pertaining to population assessments, habitat use, mark and recapture, tissue sampling, and radio telemetry.
- Habitat assessments, wetland delineation, surface hydrology, and surveying.
- Supporting the USEPA's ecological risk assessment at one of the largest contaminated sediment superfund sites in the Western US.
- Conducting aquatic ecological risk assessments at two radionuclide and heavy metal contaminated legacy sites.

- Project management, public relations, sampling design, and remote field operations.
- Familiarity with state and federal regulations and tools pertaining to Superfund and ecological assessment: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Superfund Amendments and Reauthorization Act (SARA); Natural Resource Damage Assessment (NRDA) and Net Environmental Benefits Analysis (NEBA); Section 7 of the federal Endangered Species Act (ESA); Section 404 of the Clean Water Act (CWA); and, the California Environmental Quality Act (CEQA).

PROJECT EXPERIENCE

Environmental Toxicology

Project Manager: Special Studies and Permit Support for the Sacramento Regional County Sanitation District, Sacramento, CA. Technical advising, review, and special study coordination for SRWTP related to pelagic organism decline (POD) data requests from the Central Valley Regional Water Quality Control Board (CVRWQCB). Meeting coordination and attendance to evaluate and present SRCSD interests to POD parties (e.g., POD Contaminant Work Team and CVRWQCB). Contribute technical comments and review regulatory activities and requests related to the POD and potentially affecting permit negotiations, especially related to ammonia/ammonium.

Project Manager: Toxicity Reduction Evaluation (TRE) for the Sacramento Regional Wastewater Treatment Plant, Sacramento, CA. Extensive data review and statistical analysis of influent, process, and effluent data to identify potential toxicants to compliance whole effluent toxicity (WET) testing species. Study design and coordination to identify toxicant sources. Implementing controls to reduce toxicity to *Ceriodaphnia dubia* from bacteria in composite autosamplers. Reporting toxicity results and TRE coordination with the CVRWQCB and laboratory resources.

Research Associate: Field Investigations Supporting a Baseline Risk Assessment for the Naval Air Station Patuxant River, MD. Sampling and analysis investigations were performed to support a baseline ecological risk assessment and further evaluate the potential for risks to ecological receptors. Sediment and surface water samples were collected from areas concern. Concurrent *in situ* toxicity testing was performed in sediment and water column exposures to evaluate the potential for risks from NAPL and DNAPL contaminants of potential ecological concern. These tests formed one of several lines-of-evidence in this basin-wide assessment.

Research Associate: Nyanza Chemical Waste Dump Superfund Site. Manchester, NH. Roy F. Weston, Inc. This study was designed to evaluate *in situ* stressors and sediment toxicity in the Sudbury River system, Ashland, MA. Survival of and bioaccumulation of contaminants in sediment and water column invertebrates were evaluated with *in situ* field testing protocols to identify organism exposure and effects from VOCs, SVOCs, and metals. The combination of *in situ* exposures, comprehensive chemical sampling, and hydrologic measurements were critical for providing site characterization information to elucidate exposure-effects relationships. These RI/FS results helped direct decisions to implement pump and treat groundwater cleanup at this site.

Ecological Risk Assessment

Ecological Risk Assessor: Upper Columbia River. Seattle, WA. USEPA. The Upper Columbia River watershed is under investigation due to legacy discharges from a metals smelting facility. Supporting the USEPA review and oversight of a baseline ecological risk assessment (BERA) evaluating the potential for ecological risks over several hundred miles of the Upper Columbia River watershed. Conduct data analyses and co-authoring guidance documents on behalf of USEPA, reviewing and commenting on the screening ecological risk assessment (SLERA), draft BERA Work Plan, quality assurance project plans (QAPPs), and interim reports, coordinating meetings and liaise between the principal responsible party, regulators, and participating parties, including first nation stakeholders. Oversight was also performed on behalf of the USEPA during novel sturgeon sediment toxicity testing at the University of Saskatchewan.

Ecological Risk Assessor: United Heckathorn Superfund Site. Richmond, CA. USEPA. Ecological remedial goals were developed for this site where legacy pesticide processing had contaminated sediments with DDT and dieldrin. Empirical and mechanistic models were developed with site-specific sediment and tissue concentrations. These models estimated sediment concentrations that would have no or minimal effects on fish and on wildlife that consume fish or other biota exposed to sediment.

Ecological Risk Assessor: Hanford 100-B/C Area Pilot Screening Ecological Risk Assessment, Richland, WA. DOE/Bechtel-Hanford Inc. A screening-level ecological risk assessment (ERA) was performed as part of this pilot risk assessment for the Hanford 100-B/C Site. This ERA evaluated chemical exposures to media and tissues and radionuclide concentrations in exposure media against DOE's Biota Concentration Guides. Multiple lines-of-evidence were evaluated where data were available for each receptor (Exposure media-based point-by-point comparison to single chemical toxicity benchmarks; tissue-based point-by-point comparison to single chemical toxicity benchmarks; refined dietary exposure based comparison to single chemical toxicity benchmarks; site-specific histopathology; site-specific community indices). Each LOE contributed to the overall WOE for determining the potential for risk to receptors.

Ecological Risk Assessor: Effects of Radiation on Ecological Receptors. White Paper. DOE/Bechtel-Hanford Inc. Evaluated the basis of protection offered by existing radiation dose guidance: long-term (chronic) radiation screening levels for terrestrial and aquatic biota established by the International Atomic Energy Agency (IAEA). Aquatic and terrestrial invertebrates and wildlife, and terrestrial plant receptor groups potentially present at the Hanford Site were included in this review of past and current literature. No-effects and low-effects doses of published radiation-effects data were compiled from studies reporting molecular/genetic, behavioral, pathological, reproductive, growth, mortality, and population-level effects classes. Based on this literature evaluation, the acute and chronic exposure guidelines established by IAEA would be protective of Hanford Site special-status species.

Ecological Risk Assessor: Rocky Flats. Aquatic Exposure Units Comprehensive Ecological Risk Assessment, Golden, CO. Kaiser-Hill. Contributed to methodology and template development of the Aquatic Exposure Units ERA of the Rocky Flats Comprehensive Risk Assessment. Radionuclide and chemical contaminant concentrations were evaluated for each aquatic drainage following site remediation to human health PRG levels. Regulatory and multiple stakeholder involvement were managed in a truncated time-line to complete this complex ERA involving a large support team.

Sampling and Analysis Task Manager: Baseline Risk Characterization Sampling and Analysis, Guyama, Puerto Rico. Chevron Philips Puerto Rico Core, Inc. Developed a sampling and analysis plan to collect site sediment, water, and benthic invertebrates for chemical analyses and definitive toxicity testing. Results of chemical analyses supported a baseline risk assessment with site-specific dietary concentrations for wildlife exposure modeling. Toxicity testing evaluated the potential for risk from water and sediment media and helped to develop media-specific protection goals (MSPGs) for surface water and sediment. Tests integrated interactive effects of all media contaminants, including those of uncertain toxicity. Conclusions of no potential for ecological risk contributed to accelerated closure at this facility.

Ecological Risk Assessor: Site-Wide Screening-Level Risk Characterization, Guyama, Puerto Rico. Chevron Philips Puerto Rico Core, Inc. Performed an ecological risk assessment where complete soil and aquatic exposure pathways were identified at the site and exposure to terrestrial plants, soil invertebrates, aquatic life, and birds were considered as part of a site closure plan. Data evaluation required extrapolating groundwater based chemical analysis to estuarine harbor water after modeling potential dilution factors. Soil sampling data were also separated between isolated source areas within the site to better characterize and identify the extent and magnitude of potential contamination and risks to soil invertebrates and plants. Focused evaluation of potential risk drivers found that rapid environmental breakdown and metabolic detoxification of some organic chemicals would reduce dietary exposures to wildlife so that risks were unlikely.

Data Analyst: Terrestrial Wildlife Exposure Model (TWEM). U.S. Army Center for Health Promotion and Preventative Medicine. Performed database QA/AC, application beta testing, and prepared application overview and use lessons as part of application development for this risk assessment tool. This component of the U.S. Army Risk Assessment Modeling System was developed for the Center for Health Promotion and Preventive Medicine (CHPPM) to help calculate wildlife exposure to contaminants of potential ecological concern. A prototype of this application was presented with other related applications at a workshop during the 25th Annual SETAC North America World Congress in Portland, OR, 2004.

Ecological Risk Assessor: Screening-Level Ecological Risk Assessment for the Frontier Fertilizer Superfund Site, Davis, CA. USEPA Region 9. Performed a screening-level ecological risk assessment at a former agricultural supply site where pesticides and other organic contaminants were of primary concern. Information relevant to ecological risk assessment was extracted from a complex third party database prior to data QA/QC and calculation of screening exposure point concentrations. Wildlife exposure modeling, threatened and endangered species considerations, and thorough literature review for toxicity benchmark values were performed.

Ecological Risk Assessment Team Member: Site-wide Ecological Risk Assessment for the UNOCAL Guadalupe Oil Field, CA. Performed an ecological risk assessment for this site-wide screening-level ecological risk assessment. Calculated estimates of potential risks from petroleum-derived materials and non-petroleum contaminants in order to support technically defensible risk management decision-making at a 2,700-acre site along the Central California coast. Thorough statistical analysis helped to characterize potential ecological risks from an immense geographical information system (GIS) based data compilation for numerous wildlife receptors and special-status species at the site. Risk estimates were integrated across multiple

plant and animal receptors, including threatened and endangered species, in terrestrial and wetland habitats. Habitat specific risk analysis for each receptor was evaluated in a spatial context with the use of GIS. Overall risk conclusions for a given wetland/waterbody or zone-section were based on results for all receptors in their respective habitat. Additional, statistical analyses provided insight into the relative risk contributions of a variety of contaminant sources at site.

Ecological Risk Analyst and Author: Screening Level Ecological Risk Assessment at Hill AFB, UT. Performed a screening ecological risk assessment as part of annual monitoring at a thermal treatment unit (TTU). Complete exposure pathways were identified for plants and invertebrates from soil, and to plants from groundwater. Organic and inorganic compounds analyzed in site soils and groundwater were evaluated for potential risks to terrestrial receptors. Spatial analysis of potential risk drivers was used to determine that no potential risk to receptors was anticipated.

Ecology

Project Biologist and Co-manager: Nulki-Tachick Watershed Restoration Project, Vanderhoof, BC. Saik'uz First Nation. Executed an integrated watershed approach to investigate the ecological and biophysical factors affecting rainbow trout (*Onchorhynchus mykiss*) spawning and rearing in the Nulki-Tachick lakes watershed of central British Columbia. Mark and recapture studies and spawning surveys directed habitat restoration in critical areas to remediate forestry and land-use impacts. Designed and implemented Juvenile trout rearing habitat restoration using large woody debris, boulders, culvert removal/replacement with riffle creation, riparian bank stabilization, and related permitting. Draft horses were used to place large woody debris and boulders, bioengineered bank stabilization structures reduced sedimentation from seven banks, riparian fencing were erected in livestock grazing areas, and collaboration with timber licensees in road deactivation and stream crossing modifications were part of restoration activities. Local First Nation residents were trained as fisheries and restoration technicians to foster a sense of stewardship for their natural resources. The Nulki-Tachick Watershed Restoration Project workplan was achieved within the target budget of CDN \$1.2 million and earned regional recognition as a successful project jointly operated by a First Nation, Government, and Industry.

Aquatic Ecologist: McArthur River Uranium Mine, Saskatchewan, Canada. Cameco Corporation. Developed a baseline environmental monitoring program for the McArthur River Uranium Mine in Northern Saskatchewan to quantify several indicators of environmental quality, improve the ability to predict contaminant loading in the receiving environment, and measure adverse environmental effects. Developed sampling and analyses plans and conducted baseline aquatic investigations for an environmental impact assessment (EIA). Lead field investigations to assess fish tissue chemistry and community structure, chemical analyses on sectioned lake sediment core samples, and water quality sampling. Stream and lake benthic invertebrate communities were also sampled to provide a measure of community diversity relating to ecosystem integrity.

Aquatic Ecologist: Cigar Lake Uranium Mine, Saskatchewan, Canada. Cameco Corporation. Co-authored reports, conducted field investigations, and responded to provincial review panel comments regarding baseline fisheries resources, chemical data, and a proposed tailings management facility.

Aquatic Ecologist: Rabbit Lake Mine, Key Lake Mine, Saskatchewan, Canada. Cameco Corporation. Developed sampling and analyses plans and conducted aquatic investigations for status of the environment (SOE) reports. Lead field investigations to assess fish tissue chemistry and community structure, chemical analyses on sectioned lake sediment core samples, and water quality sampling. Stream and lake benthic invertebrate communities were also sampled to provide a measure of community diversity relating to ecosystem integrity as part of environmental effects monitoring (EEM) programs.

Aquatic Ecologist: Cluff Lake Uranium Mine, Saskatchewan, Areva (formerly Cogema Resources). Assisted in study design and conducted baseline aquatic effects monitoring data collections which integrated physical, biological, and toxicological components for a tailings management area expansion EIA.

Aquatic Ecologist: McClean Lake Uranium Mine, Saskatchewan, Areva (formerly Cogema Resources). Conducted reconnaissance investigations to determine areas suitable for fish habitat enhancement, rare plant surveys, and developed an index to environmental baseline data.

Site Assessment Environmental Scientist and Study Author: Carson River Nevada Superfund Site Mercury Evaluations, U.S. Environmental Protection Agency, Region IX, San Francisco, CA Authored a sampling and analysis plan for this remedial investigation phase work at this mercury containing tailings contaminated at the Carson River Superfund Site, Nevada. The studies will be used as input into the design of remedial actions.

Environmental Monitor: Managed Vegetation Dust Control Mitigation at Owens Dry Lake, CA. Los Angeles Department of Water. Saltgrass (*Distichlis spicata*) was planted as a large-scale dust control measure in over 2000 acres of the Owens Dry Lake area. Soil reclamation from a subterranean drip irrigation system was monitored daily throughout the spring, 2004, to determine when soil conditions were favorable for the survival of replanted vegetation and to focus replant efforts. A GIS data tracking system was initiated to allow daily updates to a spatial presentation of monitoring data, which was distributed to the replanting team.

Environmental Monitor: Hickman Bridge Scour Countermeasures Project, Waterford, CA. Stanislaus County Department of Public Works. Monitored construction activities to maintain environmental permit compliance for the protection of migratory Chinook salmon and valley elderberry longhorn beetle habitat. Coordinated site activity discussions with resource agencies (California Department of Fish and Game; California Department of Transportation; California Regional Water Quality Control Board; California Department of Water Resources) to ensure compliance and assess new information acquired during activities on-site.

Project Biologist: Prairie Dog Colony Assessment, Pinedale, WY. Genesis Laboratories. Conducted population assessments and black-tailed prairie dog colony delineation in Wyoming pasture. Populations were assessed using palm-OS based GPS tools as part of a biological survey and inventory program for the Bureau of Land Management.

Professional Organizations/Affiliations

Association of Professional Biologists of British Columbia / College of Applied Biologists (CAB)
Society of Environmental Toxicologists and Chemists - North America (SETAC-NA) and
Northern California Chapter (Nor-Cal SETAC)
Chair of the Peer Review Sub-Committee of the SETAC-NA Technical Committee (SNA-TC)

Honors and Awards

1999 - 2002 Wright State University Tuition Fellowship and Graduate Research/Teaching Assistantship
1993 - University of Saskatchewan Honors Scholarship
1992 - University of Saskatchewan Biology Club Scholarship

Specialized Computer Skills

Designed and administered an environmental biology and chemistry database for mining facilities in northern Saskatchewan (Microsoft Access). Data manager for the Institute of Environmental Quality. Microsoft Office - Excel, Word, Access, and PowerPoint; SYSTAT 9; ESRI Arcview (GIS); Sigma Plot 10.

Professional Training

First Aid and CPR-Level C with AED Certification (current)
OSHA Hazardous Materials Health and Safety 40-hour (current)
Site Safety Coordinator (current)
Natural Resources Liability and Asset Management Workshop (2005)
Construction Site Safety (2004)
Radiation Safety Training (2002)
Laboratory Animal Care Training (2002)
Whole Effluent Toxicity (WET) Introductory Course (1999)
Wilderness First Aid (1999)
First Aid Transport Endorsement (1999)
Watershed Habitat Restoration Workshop, Pt. Hardy, BC (1998)
Backpack Fish Electroshocking; Crew Supervisor (1997)
ATV Rider Safety Course (1994)
PADI Open Water Diver Certification (1992)

Languages

English
Conversational Spanish

Publications and Presentations

Sample, B. and C.A. Irvine. In Press. Radionuclides in Animal Tissues. Chapter XX. In N. Beyer, Ed. Environmental Contaminants in Biota: Interpreting Tissue Concentrations. Second Edition. Taylor and Francis.

Sample, B., Irvine, C., Gustavson, K., and Lin, Sharon. 2010. Developing Remediation Levels to Address Ecological Risk at the United Heckathorn Superfund Site. Poster. Presented at the 31st Annual Meeting of SETAC North America. Portland, OR.

Sample, B. and C.A. Irvine. 2010. Overview of radiation effects in biota. Platform. Presented at the 31st Annual Meeting of SETAC North America. Portland, OR.

- Ballard, A., R. Brewer, F. Brewster, C. Dahm, **C. Irvine**, K. Larsen, A. Mueller-Solger, A. Vargas. 2009. Background/Summary of Ammonia Investigations in the Sacramento-San Joaquin Delta and Suisun Bay. Distributed by CalFed for the March 2009 Ammonia Workshop. http://www.science.calwater.ca.gov/events/workshops/workshop_ammonia.html
- Irvine, C.A.**, M. Maidrand, J. Miller, M. Miller, R. Parales, and B. Sample. 2008. A Toxicity Reduction Evaluation Identifying Bacterial Chronic Toxicity to *Ceriodaphnia dubia* from a POTW Effluent. Platform. Presented at the 29th Annual Meeting of SETAC North America. Tampa, FL.
- Werner, I., **C. Irvine**, and C. Foe. 2008a. The Effects of Wastewater Treatment Effluent-Associated Contaminants on Delta Smelt. Ammonia Toxicity Sampling and Analysis Plan. Final. July.
- Maidrand, M.B., **C.A. Irvine**, J. Miller, M. Miller, and B. Sample. 2008. Is Your Sampling System Causing Effluent Toxicity? Poster. Presented at WEFTEC, Chicago, IL.
- Maidrand, M, J. Miller, M. Miller, **C.A. Irvine**, and B. Sample. 2006. Weight of Evidence that Chronic *Ceriodaphnia dubia* Toxicity in a POTW Effluent is of Biological Origin. Poster. Presented at the 27th Annual Meeting of SETAC North America. Montreal, ON.
- Irvine, C.A.** and B.E. Sample. 2006. Correlation Analysis on Bioassays and Media Chemistry Reveal Sediment and Surface Water Chemical Stressors to Aquatic Receptors at Puerto Rico Chemical Plant. Poster. Presented at the 27th Annual Meeting of SETAC North America. Montreal, ON.
- Sample, B. and **C.A. Irvine**. 2006. A Review and Analysis of Ecological Dose-Effects from Radiation Exposure. Poster. Presented at the 27th Annual Meeting of SETAC North America. Montreal, ON.
- Irvine, C.**, Sample, B., 2005. A Review and Analysis of Ecological Dose-effects from Radiation Exposure. App. J, 100-B/C Pilot Project Risk Assessment Report, DOE/RL-2005-40, Draft A, Richland, WA, USA.
- G.A. Burton Jr., M.S. Greenberg, C.A. Rowland, **C.A. Irvine**, D.R. Lavoie, J.A. Brooker, L. Moore, D. Raymer, and R.A. William. 2005. *In situ* exposures using caged organisms: a multi-compartment approach to detect aquatic toxicity and bioaccumulation. Environmental Pollution. 20:133-144.
- American Society for Testing and Materials (**ASTM**) Draft Standard. In Review. 2004. Standard Guide for Assessing Freshwater Ecosystem Impairment Using Caged Fish and Invertebrate Assays. Report No. ASTM E47 XXXX-200X
- Burton, G.A. Jr., L.T. H. Nguyen, C. Janssen, R. Baudo, R. McWilliam, B. Bossuyt, M. Beltrami, A. Green. 2005. Field validation of sediment zinc toxicity. Env. Tox. & Chem. 24:3. 541-553. (Research Associate).
- Arenal, C.A., C.L. Tsao, B.E. Sample, and **C.A. Irvine**. 2004. Poster. Ecological Risk Assessment for the COB Energy Facility, Bonanza, Oregon: Air Emissions and Process Wastewater Application. Presented at the World Congress and 25th Annual Meeting of SETAC North America. Portland, OR.
- Irvine, C.A, G.A. Burton Jr., and M.S. Greenberg. 2003. Colloid influence on *D. magna* feeding and tissue residues following contaminant exposure. Platform. Presented at the 24th Annual Meeting of SETAC North America. Austin, TX.

- Irvine, C.A.** and S. McIntosh. 2002. Nulki-Tachick Watershed Restoration Project: 1995-2000 Project Summary. Prepared for Forest Renewal British Columbia and Ministry of Environment, Lands and Parks. (Author, Project Co-manager, Principal Biologist). 56 pp.
- Irvine, C.A.**, G.A. Burton Jr., M.S. Greenberg. 2002. The Influence of Colloids on the Toxicity of Cadmium and Fluoranthene to Freshwater Invertebrates. Poster. Presented at the 23rd Annual Meeting of SETAC North America, Salt Lake City, UT.
- Burton, G.A. Jr., **C.A. Irvine**, J.P. Johnson, R.A. McWilliam, M.S. Greenberg, and B.A. Schwab. 2002. Weight of Evidence Sediment Quality Assessment: Don't Expect Concordance. Platform. Presented at the 23rd Annual Meeting of SETAC North America, Salt Lake City, UT.
- Irvine, C.A.**, G.A. Burton Jr., M.S. Greenberg, and J.P. Johnson. 2002. Effects of Aqueous Colloids on Feeding and Bioconcentration in *Hyaella azteca* and *Daphnia magna* Exposed to Fluoranthene and Cadmium. Poster. Presented at the 5th International Symposium on Sediment Quality Assessment, Chicago, IL.
- Burton, G.A. Jr., **C.A. Irvine**, J. Johnson, R.A. McWilliam, and M.S. Greenberg. 2002. Using Multiple Lines of Evidence to Assess Sediment Quality. Poster. Presented at the 5th International Symposium on Sediment Quality Assessment, Chicago, IL.
- Johnson, J.P., G.A. Burton Jr., **C.A. Irvine**. 2002. The Impacts of Aircraft Deicing Fluid on Lytle Creek (Wilmington, OH) Using *In Situ* Laboratory Approaches. Poster. Presented at the 5th International Symposium on Sediment Quality Assessment, Chicago, IL.
- Burton, G.A. Jr., **C.A. Irvine**, J. Johnson, R.A. McWilliam, J. Gallagher, B. Schwab, M.S. Greenberg, M. Leppanen. 2002. Biological Concern Values: A Simplistic and Realistic Assessment Tool for Weight-of-Evidence Approaches. Platform. Presented at the 11th Annual Meeting of SETAC Europe, Vienna, Austria.
- Burton, G.A. Jr., M.S. Greenberg, **C. A. Irvine**, J. Johnson, R.A. McWilliam, C.D. Rowland. 2002. *In Situ* Toxicity and Bioaccumulation Testing Using Caged Freshwater Species. Presented at the ASTM Symposium on Environmental Toxicology and Risk Assessment. E47. Pittsburg, PA.
- McWilliam, R.A., G.A. Burton Jr., **C.A. Irvine**, J. Johnson, B. Schwab. 2002. Separating Natural and Anthropogenic Stressors Using *in situ* and Laboratory Approaches. Poster. Presented at the 11th Annual Meeting of SETAC Europe, Vienna, Austria.
- Irvine, C.A.** 2001. The Influence of Colloid-Bound and Dissolved Phases of Metals and Organic Contaminants to the Toxicity of Freshwater Invertebrates. Awarded a personal research grant (Wright State University) of \$800.00 by Sigma Xi.
- Burton, G.A. Jr., and **C.A. Irvine**. 2001. What is the Extent of Sediment Metal Contamination? Occurrence, Ecological Significance, and Causality Issues. Prepared for the International Lead and Zinc Research Organization.
- Burton, G.A. Jr., J. Gallagher, B. Schwab, **C.A. Irvine**, J. Johnson, C. D. Rowland, M.S. Greenberg, M. McElroy, M. Leppanen, D.R. Lavoie and J.F. Nordstrom. 2001. Sediment Contamination Assessment Methods vs. Biological Concern Values. Poster. Presented at the 22nd North American Annual Meeting of SETAC, Baltimore, MD.
- Saik'uz First Nation and **C.A. Irvine**. 2000. Nulki-Tachick Watershed Restoration Project: 1999 Fisheries and Stream Restoration. Prepared for Forest Renewal British Columbia and

- Ministry of Environment, Lands and Parks. (Author, Project Co-manager, Principal Biologist).
- Burton, G.A. Jr., M.S. Greenberg, T.A. Hall, **C.A. Irvine**, J. Johnson, D.R. Lavoie, J.F. Nordstrom, and C.D. Rowland. 2000. Linking Multiple Assessment Tools in a Weight of Evidence Approach for Identifying Stream Stressors. Poster. Presented at the 21st North American Annual Meeting of SETAC, Nashville, TN.
- Irvine, C.A.** and S. McIntosh. 1999. The Nulki-Tachick Watershed Restoration Project: A Summary of the Past Four Years. Platform and Poster. Presented at the Visions in Shared Management Conference, Prince George, BC.
- Conor Pacific Environmental Technologies Inc. 1999. Contributions of Stocked and Wild Rainbow Trout to the Recreational Fishery and Spawning Population in the Nulki-Tachick Watershed. Prepared for the Saik'uz First Nation and British Columbia Ministry of Environment, Lands and Parks. (Primary Author, Project Manager, Principal Biologist).
- Conor Pacific Environmental Technologies Inc. 1999. Nulki-Tachick Watershed Restoration Project: 1998 Fisheries Investigations. Prepared for the Saik'uz First Nation and British Columbia Ministry of Environment, Lands and Parks. (Author, Project Co-manager, Principal Biologist).
- Irvine, C.A.** 1998. Contributions of Stocked and Wild Rainbow Trout to the Recreational Fishery and Spawning Population in the Nulki-Tachick Watershed. Awarded CDN\$15,000 by Fisheries Renewal British Columbia to Conor Pacific Environmental Technologies Inc., (Saskatoon, Saskatchewan) and the Saik'uz First Nation (Vanderhoof, British Columbia).
- Conor Pacific Environmental Technologies Inc. 1998. 1998 Nulki-Tachick Watershed Restoration Project: Instream Restoration and Bank Stabilization. Prepared for the Saik'uz First Nation and British Columbia Ministry of Environment, Lands and Parks. (Author, Project Co-manager, Principal Biologist).
- Conor Pacific Environmental Technologies Inc. 1998. 1997 Nulki-Tachick Watershed Restoration Project: Fisheries Investigations. Prepared for the Saik'uz First Nation and British Columbia Ministry of Environment, Lands and Parks. (Author, Project Co-manager, Principal Biologist).
- Terrestrial & Aquatic Environmental Managers Ltd. 1998. Fisheries Investigations of Alternate Waste Rock Disposal Lakes for the Cigar Lake Project. Prepared for the Cigar Lake Mining Corporation. (Field Biologist, Co-Author).
- Terrestrial & Aquatic Environmental Managers Ltd. 1997. Index to Environmental Baseline Information and Source Documents for the McClean Project Area. Prepared for COGEMA Resources Inc. (Author and Data Analyst).
- Terrestrial & Aquatic Environmental Managers Ltd. 1997. Taxonomy of Benthic Macroinvertebrates from the Midwest Joint Venture and Cluff Lake Areas - 1995 Cumulative Effects Monitoring (CEM) program. Prepared for Saskatchewan Environment and Resource Management. (Author).
- Terrestrial & Aquatic Environmental Managers Ltd. 1997. McArthur River Project 1996 Aquatic Baseline Monitoring Program. Prepared for Cameco Corporation, Saskatoon. (Field Biologist, Co-Author).

- Terrestrial & Aquatic Environmental Managers Ltd. 1996. McClean Lake Project Rare Plant Survey of a Transmission Line Tap. Prepared for Cameco Corporation, Saskatoon. (Principal Field Biologist and Co- Author).
- Cigar Lake Mining Corporation. 1996. Responses to the Cigar Lake Uranium Mine EIS Review Panel Comments. Prepared for the Atomic Energy Control Board (AECB) and Saskatchewan Environment and Resource Management. (Co-Author).
- Terrestrial & Aquatic Environmental Managers Ltd. 1996. 1995 Fish Analytical Results for the Waterbury Lake Study Area. Prepared for the Cigar Lake Mining Corporation. (Author).
- Terrestrial & Aquatic Environmental Managers Ltd. 1996. Aquatic and Terrestrial Baseline Investigations and Impact Assessment of the Box and Athona Gold Mines Project, Northern Saskatchewan. Prepared for the Greater Lenora Resources Corporation. (Biologist, Co-Author).
- Canadian Wildlife Service. 1992. 1992 North American Waterfowl Management Plan Central Flyway Waterfowl Banding Report, Spiritwood, Saskatchewan. Environment Canada, Saskatoon. (Crew Leader, Primary Author).
- Canadian Wildlife Service. 1991. 1991 North American Waterfowl Management Plan Central Flyway Waterfowl Banding Report, Yorkton, Saskatchewan. Environment Canada, Saskatoon. (Crew Supervisor, Co-Author).

GRANTS

- Irvine, C.A. 2001. The Influence of Colloid-Bound and Dissolved Phases of Metals and Organic Contaminants to the Toxicity of Freshwater Invertebrates. Awarded a personal research grant (Wright State University) by Sigma Xi.
- Irvine, C.A. 1998. Contributions of Stocked and Wild Rainbow Trout to the Recreational Fishery and Spawning Population in the Nulki-Tachick Watershed. Awarded CDN\$15,000 by Fisheries Renewal British Columbia to Conor Pacific Environmental Technologies Inc., (Saskatoon, Saskatchewan) and the Saik'uz First Nation (Vanderhoof, British Columbia).

Supplemental Information

Years Experience Prior to CH2M HILL: 10

CH2M HILL Hire Date: 21 July, 2003

Last Employee Update: 09/20/2010