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**Research & Development Projects  
Canadian Conservation Institute  
2007 - 2008**

Conservation and Scientific Services  
Canadian Conservation Institute  
Department of Canadian Heritage  
1030 Innes Road  
Ottawa ON K1A 0M5  
Canada

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## ADHESIVES

**Project Title:** **Effect of Modifiers on the Stability of a Vinyl Acetate/Ethylene (VAE) Copolymer Emulsion Adhesive**

**Project Description:** The purpose of this study is to identify modifiers that do not adversely affect the stability or that improve the stability of a vinyl acetate / ethylene (VAE) copolymer emulsion adhesive so that a relatively good conservation emulsion adhesive can be formulated by the conservators themselves, tailored to their needs.

This project is a direct spin-off of previous research done on poly(vinyl acetate) (PVAC) adhesives. PVAC adhesives are very popular adhesives being used in every facet of conservation - furniture, paper, ethnographic objects and textiles to name just a few. In the previous CCI PVAC research, the vinyl acetate/ethylene (VAE) copolymer emulsion group (i.e., adhesives such as Jade No. 403) had very good properties upon aging (neutral pH, low volatile emission, low yellowing, good flexibility, adequate strength) and suggested a closer examination was warranted. As well, although several PVACs were identified in the PVAC research with good qualities for conservation, there were still problems in that some choices were unpleasantly odoriferous, some were too tacky and some were no longer available. A good conservation emulsion adhesive was still elusive. It was decided to examine the VAE group in more detail and at the same time investigate the question of additives. Are the additives necessary? What do they do to the aging properties of an adhesive? Can we start with a VAE that has no additives and add our own modifiers in known concentrations and see what happens upon aging? This research will help to answer these questions.

Common additives (modifiers) will be selected and added in known concentrations to a well-characterized VAE emulsion. Samples will be made and subjected to dark and light aging for several years. Yellowing, pH, flexibility, cohesive strength, gloss and removability will be monitored for significant changes upon aging. Results will be written up and submitted for publication in an appropriate conservation journal.

The many conservators in Canada and abroad who use VAE emulsion adhesives such as Jade No. 403 or Vinamul 3252 will benefit from this work.

**Dates:** 1994 -2009

**CCI Project Leader:** Jane Down

**Project Team:**

**Links/Partnerships:**

**Progress Summary:** 2003-2004: The project was begun in 1994. The VAE emulsion adhesive selected for testing by a group of conservators and scientists was Dur-O-Set E-150 which did not contain any additives except those added for polymerization and emulsion stabilization. The modifiers selected for testing were plasticizers dibutyl phthalate, dtridecyl phthalate, and polyethylene glycol dibenzoate; solvents toluene, methanol and diacetone alcohol; wetting agents anionic di-(2-ethylhexyl) sulphosuccinate and non-ionic acetylenic glycol; thickeners methyl cellulose, wheat starch, fumed silica, polyethylene oxide, and neutral acrylic acid salt; fillers calcium carbonate, talc and china clay; freeze-thaw stabilizer

ethylene glycol, and humectant glycerin. Initial testing of the prepared films of VAE containing the modifiers began in 1995 for pH, yellowing, and gloss. Flexibility, strength and removability testing began in 1996. Measurements on all samples were taken each year until 1998. In February 1998, the data from the first two years was assessed. Since, in most cases, differences upon aging were not dramatic, it was decided to skip the third year of testing in order to lengthen the aging period. The results for the first two years were written up in a report, which is now available from CCI.

In 2000-2001, the 4<sup>th</sup> year measurements for pH, yellowing, gloss, strength and flexibility were taken and all data was analyzed. The samples continue to age awaiting a final measurement after about 10 years of aging.

2004-2005: Samples continued to age (dark and light aging), however, the lights in the light aging chamber were extinguished in July 2003 when they were covered and moved from the testing room - to allow renovations to commence.

2005-2006: No progress.

2006-2007: No progress

**Project Proposal:** 2007-2008: Before this project can move forward, the renovations must be complete, the labs unpacked and the chamber around the Instron built. Also, the light aging chambers must be installed in their new room, turned on, cleaned, refitted and re-calibrated. Then the VAE samples must age for a few more years so that the total light aging will equate to about 10 years. Once this has happened, then the final dark and light aging measurements can be taken for stress/strain, pH, gloss and removability, and the project can be written up for publication in a referred journal..

**Dissemination:** J.L. Down, "Adhesive Projects at the Canadian Conservation Institute", Preprints of the SSCR Resins Ancient and Modern Conference, Aberdeen, Scotland, pp. 4-12, 13-14 September, 1995.

J.L. Down, "Towards a Better Emulsion Adhesive - A Preliminary Report on the Effect of Modifiers on the Stability of a Vinyl Acetate / Ethylene Copolymer Adhesive", Technical Report No. 1 (Ottawa: Canadian Conservation Institute) 1999.

**Research Type:** Applied Scientific Research

**CCI Number:** 68451

## ADHESIVES

**Project Title:** Evaluation of Cyanoacrylate Adhesives for the Conservation of Fossils

**Project Description:** The purpose of this study is to determine if cyanoacrylate adhesives are suitable for the conservation of fossils. Valuable vertebrate fossils are being conserved regularly with cyanoacrylate adhesives. This puts these priceless specimens at risk because cyanoacrylate adhesives have never been scientifically assessed for their long-term stability or suitability for this application. This project attempts to begin this process by examining various aspects of cyanoacrylate adhesives in relation to fossils. If cyanoacrylates degrade, they produce formaldehyde so this formation can be followed in the presence and absence of fossil material to determine if fossil material catalyses or slows the degradation of various types of cyanoacrylate adhesives (i.e., ethyl, butyl, and ones containing polymers to thicken the cyanoacrylate) (phase 1). Since the literature suggests that moisture and exposure to light cause cyanoacrylate adhesives to degrade, various cyanoacrylates are being examined under low, medium and high relative humidity and also under UV light to see if fossil/cyanoacrylate bond strengths are retained (phase 2). There are also questions concerning application techniques, removability of the cyanoacrylates from the fossil material, and comparisons to other adhesives that need to be examined (phase 3).

The project will be divided into three phases. The results of one phase will influence how the next phase is conducted.

All results will be written up and published in a journal widely available to the palaeontology community.

The palaeontology community in Canada and abroad will benefit from this work.

**Dates:** 2002 - 2007

**CCI Project Leader:** Jane Down

**Project Team:** Jane Sirois, Elzbieta Kaminska. The Society of Vertebrate Palaeontology; Jim McCabe, Royal Tyrrell Museum of Palaeontology, Drumheller, AB

**Links/Partnerships:** The Society for Vertebrate Palaeontology has partially funded the project.

**Progress Summary:** 2002- 2004: In October 2002, Jane Down received the Society of Vertebrate Paleontology Preparator's Award which helped to partially fund the first phase of this research. The research made use of the fact that if cyanoacrylates degrade, they produce formaldehyde. This degradation was monitored in the presence and absence of fossil material collected from different sites. Fossil samples were received from Dinosaur National Monument in Utah, Badlands National Park in South Dakota, Royal Tyrrell Museum in Alberta, and the Mammoth Site in South Dakota. Since cyanoacrylates seem to degrade in alkaline environments, a variety of fossil material from the different sites that was acidic, neutral and alkaline was selected for testing to see if this or the diverse mineral content affected the degradation process. Ethyl, butyl and ethyl cyanoacrylate with added poly(methyl methacrylate) were selected for testing to determine if one degraded less than another (in the medical literature, it was shown that butyl cyanoacrylate degraded more slowly than the ethyl variety under specific medical conditions).

To characterize the fossil material, a composition and elemental analysis of the fossil was determined by SEM/XES, XRD, and ICP analysis. Further characterization was accomplished by determining the moisture content, ash content (% inorganic material) and porosity of the fossil material.

The procedure for determining formaldehyde concentration from the hydrolysis of various cyanoacrylate adhesives in the presence and absence of various fossil materials was developed and implemented. The results confirmed that butyl cyanoacrylate degrades more slowly than ethyl cyanoacrylate, whether fossil is present or not. The results also suggest that acidic fossil material slows the degradation of cyanoacrylates, while neutral and alkaline fossil materials increase the degradation. The age of the cyanoacrylate may also play a role in its degradation, the older cyanoacrylates showing more degradation than the younger samples.

2004-2005: Paper entitled "The Degradation of Cyanoacrylate Adhesives in the Presence and Absence of Fossil Material" was completed and the manuscript sent to the Journal of Vertebrate Paleontology in July 2004. Manuscript received back, fall 2004. Revision in progress.

2005-2006: The revisions to the paper entitled "The Degradation of Cyanoacrylate Adhesives in the Presence and Absence of Fossil Material" were completed and submitted for publication.

2006-07: Awaiting publication.

**Project Proposal:** 2007-08: Awaiting publication.

**Dissemination:** E. Kaminska, "The Stability of Cyanoacrylate Adhesives in the presence and Absence of Fossil Material", in press December 2003.

A talk entitled "The Degradation of Cyanoacrylate Adhesives in the Presence and Absence of Fossil Material" was presented at the annual CAC conference in Quebec City in May 2004.

**To be revised** - A talk entitled "The Degradation of Cyanoacrylate Adhesives in the Presence and Absence of Fossil Material" was presented via a narrated Powerpoint presentation to the Society of Vertebrate Paleontology in their Preparator's Symposium on October 19, 2005.

A talk entitled "The Degradation of Cyanoacrylate Adhesives in the Presence and Absence of Fossil Material" was presented at the AIC conference in Minneapolis to the Object Group in June 2005.

**Research Type:** Applied Scientific Research

**CCI Number:** 68832

## ADHESIVES

**Project Title:** Evaluation of Tapes and Heat-set Tissues

**Project Description:** The purpose of this project is to study the chemical, mechanical and removability properties of various commercially available tapes and heat-set tissues to understand their impact on paper and to determine which might be less damaging. These materials continue to be widely used – but their impact on substrates is poorly understood.

Commercially available tapes and heat-set tissues will be analyzed to determine major chemical components and pH measurements will also be taken. The results will be used to screen the products, to reduce the number for full scale testing.

Full scale testing will assess the following upon aging for 5-10 years in the dark under ambient conditions and under standard illumination conditions:

- substrate damage by DP, pH, colour, translucency, PAT and outgassing measurements;
- removability by conventional conservation methods, 180° hot and cold peel off paper tests, and a solvent immersion weight loss method; and
- mechanical properties by 180° peel off various substrates and tensile testing of the composites.

Ease of application and carrier suitability will also be assessed in the full scale testing. From the results, an overall assessment of suitability will be made. A report will be written and submitted for publication.

All conservators who use tapes and heat-set tissues or who have to remove these products from artifacts will benefit from this work.

**Project Date:** 2001-2013

**CCI Project Leader:** Jane Down

**Project Team:** Season Tse; Scott Williams; Sherry Guild; John Grace, Wanda McWilliams (Library and Archives Canada), Elissa O'Loughlin (The Walters Art Museum, Baltimore, MD)

**Progress Summary:** 2001 - 2004: A meeting was held on June 6, 2001 at CCI with the project leader and all CCI and outside team members. The purpose of the meeting was to formulate the project and work plan. Work began on the screening program during the fall of 2001 when a list of various tapes and heat-set tissues was compiled and all tapes and tissues were ordered. As the tapes and tissues came in, they were catalogued and classified for analysis.

2002-2003: the tapes and heat-set tissues (147 in all) were analyzed by Infrared Spectrophotometry for their major chemical components by Scott Williams. A preliminary look at the analyses for screening purposes has been carried out and the products have been placed in tables according to their carrier type and adhesive. Because it is not possible to obtain enough samples to do standard pH measurements on all the tape components, other methods of measuring pH on very small samples were investigated. These included a microelectrode technique, pH pencil, and universal indicator. It appears that the microelectrode technique will work best but further development of the technique is required before the pH measurements can commence.

2004-2005: Various methods of measuring pH of the tapes were tried. It was hoped that pH of the adhesive component alone and the carrier alone could be accomplished but all methods failed. Surface pH is not acceptable because the long extraction time required for the components causes the drop of water to evaporate and absorb CO<sub>2</sub>. Measuring surface pH under nitrogen did not work. It was thus decided to measure the extracted pH of the composite i.e., adhesive and carrier together. A reliable and effective method of measuring pH with the microprobe has been developed. The pH measurements of all the tapes and heat-set tissues are well under way and should be finished by early March 2005. The use of AD strips to measure harmful volatiles for the screening of the tapes and heat-set tissues was not effective. The technique is not sensitive enough. It is hoped that by the end of the fiscal year (March 2005), that the screening of the products can occur (i.e., chemical analysis and pH will be completed by then). A meeting of the original group who helped to plan the project will be convened in March 2005 to do the screening as a group so that consensus can be reached on which products to test in the full scale testing program.

2005-2006: The pH measurements of all the tapes and heat-set tissues (THST) were completed. These results and the chemical analysis results were used to screen the products in a meeting of the THST committee held in March 2005. Forty-four of the 146 products were selected to undergo the full-scale testing program. The criteria used for selection was that the product was rejected for testing if the pH was less than 6 or greater than 8, although a token very low and very high pH product were included; contained poly(vinyl chloride), rubber, rosin or styrene butadiene, although a token product of each was included; or the product was coloured although a token black product was included. The products were also tested for optical brighteners and the paper products were tested for lignin but these tests were not used for screening. The results of the screening were presented at two conferences, the IADA conference "This Will Stick Forever" in Budapest, Hungary in May 2005, and the AIC conference in Minneapolis in June 2005. A paper on the screening and planned full-scale testing entitled "The CCI Tapes and Heat-set Tissues Project: Description and Status" was written and submitted to PapierRestauration for publication. Further work on the preliminary tests and sample preparation for the full-scale testing could not be accomplished because the renovations were not complete.

2006-2007: No progress.

- Project Proposal:** 2007-2008 Once CCI's reconstruction is complete, and equipment reinstalled, preliminary testing can begin. When preliminary testing is complete, sample preparation will begin.
- Dissemination:** A talk entitled "Report on the CCI Tapes and Heat-set Tissues Project" was presented at the IADA conference "This Will Stick Forever" in Budapest, Hungary in May 2005, and the AIC conference in the RATS Group in Minneapolis in June 2005.
- Jane L. Down, R. Scott Williams, Season Tse and Sherry Guild, "The CCI Tapes and Heat-set Tissues Project: Description and Status Report", PapierRestauration, Vol. 7, No. 1, pp. 13-17, 2006.
- Research Type:** Applied Scientific Research
- CCI Number:** 68827

## **AMBER**

**Project Title:** **Characterization of Canadian Amber**

**Project Description:** The purpose of this project is to characterize a group of amber samples from a variety of Canadian sources using FTIR spectroscopy and GC-MS to determine chemical composition and whether amber from different locations can be distinguished.

Preliminary results indicated that Canadian ambers have unique fingerprints that are different from those of European ambers. The chemistry of Canadian ambers is not well known. The project will investigate the chemistry of these materials that were important to early Native people and may help archaeologists establish trade routes.

The users of this work are Canadian museums and archaeologists.

**Project Dates:** 2001-2010

**CCI Project Leader:** Jennifer Poulin

**Project Team:** Kate Helwig

**Links/Partnerships:** Geological Survey of Canada, Canadian Museum of Nature, Canadian Museum of Civilization, Royal Tyrrell Museum of Palaeontology and others.

**Progress Summary:** 2001-2003: obtained twenty amber samples from a variety of sources and undertook preliminary FTIR spectroscopic analysis. Undertook background literature search.

2003-2004: began to develop GC-MS method to characterize amber.

2004-2005: initial analysis of samples was undertaken.

2005-2006: All amber samples were analyzed by GC-MS

2006-2007: No progress

**Project Proposal:** 2007-2008: Further analysis of amber samples by pyrolysis-GC-MS and FTIR microscopy will be undertaken.

**Dissemination:**

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 86101

## ARCHAEOLOGY

**Project Title:** Iron Stain Removal from Archaeological Composite Artifacts made of Wood and Iron

**Project Description:** The waterlogged wood component in archaeological wood/iron artifacts is frequently seriously stained with iron corrosion products that are often orange in colour. The purpose of this project is to determine which of eight chemical solutions is the most suitable for quickly removing surface staining from the wood while minimizing the damage to iron prior to treatment of the waterlogged wood. The eight chemical solutions are: 10% w/v sodium hydrosulfite, 2% w/v thioglycolic acid, 2% w/v oxalic acid, 1% w/v poly(vinyl pyrrolidone), 1% v/v phosphoric acid, 1% v/v phosphoric acid plus 1% w/v poly(vinyl pyrrolidone), 1% w/v ethylenediaminetetraacetic acid plus 0.5% w/v pentasodium salt of diethylenetriaminepentaacetic acid, and 1% w/v ethylenediaminetetraacetic acid plus 10% w/v sodium hydrosulfite. This project is one in a planned series that will deal with chemical treatments of metals. The experimental work was carried out at Parks Canada because of specific issues about staining raised by archaeologists. Since the problem is general, it is thought that most archaeologists who deal with these materials will find the results from this work to be valuable. Users who will benefit from this work are archaeological metal conservators.

**Dates:** 2006-2009

**CCI Project Leader:** Lyndsie Selwyn

**Project Team:** Cliff Cook, Tara Grant, Sherry Guild, Charlotte Newton, Season Tse, Jan Vuori

**Links/Partnerships:** Michael Eisen, Parks Canada, Sylvie Labroche (Arc'Antique) and Ron Fairman

**Progress Summary:** 2006-2007: Assessed and organized the experimental work carried out by Sylvie Labroche and Ron Fairman during internship at Parks Canada. Prepared an outline for a paper containing this data and wrote the experimental and results section. Also wrote a related paper on electrophoresis that was accepted and published in *Reviews in Conservation*.

**Project Proposal** 2007-2008: Review literature for chemistry and conservation applications of the chemicals tested in preparation for writing the chemical background section and discussion section of the paper on stain removal.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 93854

## ARCHEAEOLOGY

**Project Title:** Comparison of PEG and Glycerol for the Treatment of Archaeological Leather

**Project Description:** The purpose of this work is to determine if polyethylene glycol of molecular weight 400 (PEG 400) is more suitable than glycerol for the conservation treatment of wet and deteriorated archaeological leather.

Leather samples tanned by various methods and impregnated with PEG 400 or glycerol will be evaluated. The shrinkage temperatures and energies required to cause denaturation in the samples will be measured to compare the effectiveness of the two treatment methods. These two parameters will be measured by Scanning Differential Calorimetry (DSC). Lower shrinkage temperature and lower denaturation energy indicate greater degradation.

Users of this information about the relative ability of PEG 400 and glycerol to help stabilize leather are conservators treating archaeological leather artifacts. This has application for the treatment of aboriginal untanned and semi-tanned skin artifacts.

**Dates:** 2003- 2008

**CCI Project Leader:** Malcolm Bilz

**Project Team:** Charlotte Newton, Tara Grant, Gregory Young

**Links/Partnerships:** The comparison of the suitability of PEG 400 and glycerol for treating leather is of interest to conservators in and outside Canada, and has been raised at International conservation forums. The interaction of glycerol and collagen and the post-treatment behaviour of glycerol are research topics of interest to members of the Archaeological Leather Group.

**Progress Summary:** 2003-2004. Three types of leather were chosen; brain-tanned deer hide, vegetable-tanned cow hide and archaeological vegetable-tanned deer hide. Five samples were cut from each type. One was wet with water as a control and two were impregnated with PEG 400 at 25% or 100% and two were impregnated with glycerol at 25% or 100%. Initial runs have been carried out on the Differential Scanning Calorimeter to calibrate the instrument and to develop heating regimes for testing the samples. The shrinkage temperatures will be measured with dried samples and with samples in water.

Preliminary Differential Scanning Calorimetry tests on samples treated with 100% PEG 400 and 100% Glycerol showed lower shrinkage temperatures and required less energy to cause denaturation for the glycerol treated samples. It is thought that glycerol molecules (molecular weight 92), being smaller than PEG 400 molecules, infiltrate and swell the fibrillar and molecular structure of the collagen. This reduces the cooperative stability of the hydrogen bonding, making the glycerol treated samples less stable.

2004-2005 Limited progresses due to other pressures. Samples from each of the 15 leather treatments have been prepared for analysis by wet and dry differential scanning calorimetry.

2005-2006: Most of the analysis has been completed for three types of leather samples, which were untreated or treated, with either polyethylene glycol (PEG)

400 or glycerol. This included differential scanning calorimetry (DSC) to determine denaturation onset temperatures and enthalpies, thermogravimetric analysis (TA) to determine moisture contents and thermal microscopy followed by image analysis to give more precise onsets and endpoints.

2006-2007: Analysis by Conservation Research has been completed but some analysis by other groups remains to be completed for three types of leather samples which were untreated or treated with either polyethylene glycol (PEG) 400 or glycerol.

**Project Proposal:** 2007-2008: The data will be analyzed to compare the effect of PEG 400 and glycerol treatments on the three leather types both in the short term and in the long term. A paper will be written to describe the research and to make recommendations for using PEG 400 or glycerol for treating leather artifacts.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 74597

## ARCHEAOLGY

**Project Title:** Development of a Conservation Treatment for Waterlogged Basketry

**Project Description:** The purpose of this study is to develop a better method for the conservation of waterlogged North West coast basketry artifacts - together with a better understanding of the factors, which affect treatment. Current treatments lead to a material, which is either “damp” to the touch and with strong tendencies to dirt retention or dry brittle and fracturing. The main issue to be resolved seems to be to find a way to adjust the concentration of impregnant. Polyethylene glycol of molecular weight 200 (PEG 200) will be assessed for effectiveness in penetrating waterlogged archaeological basketry materials.

This research is important at present because waterlogged archaeological basketry provides a diagnostic tool that can be used to identify which aboriginal groups had been present in particular locations. This evidence may be helpful in resolving land claims issues. Aboriginal groups and archaeologists on the North West Coast are interested in this research and are providing sample material. On the successful outcome of the research a basketry workshop will be developed for interested participants

Users of the results of this research are conservators working with basketry artifacts. Most archaeological basketry in Canada originates from aboriginal communities, especially those on the West Coast of Canada.

**Project Dates:** 2005 - 2007

**CCI Project Leader:** Malcolm Bilz

**Project Team:** Tara Grant, Charlotte Newton, Gregory Young

**Links/Partnerships:** Barbara Winter (Simon Fraser University), David Schaepe (Stó:lō Nation Archaeologist), Ann Stevenson and Kathryn Bernick (University of British Columbia Museum of Anthropology),

**Progress Summary:** 2003-2004 The structure of intact western red cedar inner bark (a basketry material) has been found to present more resistance to PEG penetration than western red cedar wood. Microscopy has revealed that one source of this resistance is that inner bark has relatively thicker cell walls and smaller lumina for liquids to access the walls. Higher PEG concentrations are required for penetration into inner bark than into wood. The cobalt thiocyanate staining technique has been used to indicate the presence of PEG in the inner bark cell walls.

2004-2005 The project was delayed because of the temporary closure of the CCI laboratory during construction work.

2005-2006: This project has been put on hold until CCI laboratories are operational again

2006-2007: This project has been put on hold until CCI laboratories are operational again

**Project Proposal:** 2007-2008: When CCI laboratories are operational again; it is proposed to reinstate the project to study the penetration of polyethylene glycol into actual archaeological basketry material. Initial results showed big differences in the

behavior of the un deteriorated basket compared to the archaeological material. This difference would be a major impact on the treatment recommendations. It is proposed to evaluate various grade of PEG at various concentrations and see which is most suitable for archaeological basketry.

- Dissemination:** "Treating waterlogged basketry: a study of polyethylene glycol penetration into the inner bark of western red cedar", Bilz, Malcolm, Tara Grant and Gregory Young, Proceedings of the 7<sup>th</sup> ICOM-CC Working Group on Wet Organic Archaeological Materials conference, Grenoble, France, 1998, pp. 249-253
- Research Type:** Applied Scientific Research
- CCI Number:** 69393

## COLLECTIONS - RISK

**Project Title:** **Analysis of mammal storage-cabinet infestation severity through a ten-year annual regime of specimen inspections.**

**Project Description:** The goal of this project is to devise a visual inspection protocol, and treatment regime that allows collection staff to protect collections from pest damage despite the lack of in-cabinet chemical protectants. With the elimination of in-cabinet protectants through banning or removal of naphthalene, dichlorvos (DDVP), etc. millions of natural history specimens are becoming dependent on cabinet integrity and other layers of an integrated pest management (IPM) approach for protection. This project was developed as a long-term study in 1994 when the two researchers recognized the need to acquire and publish economic components to suggested practices in IPM. An intensity scale for appraising infestation levels in cabinets was developed, and within this scale an action level at which to treat infested material was set. The Mammalogy Division staff incorporated the inspection protocol into their annual work and participated in a ten-year study that recorded pest, location, severity, and time spent in carrying out the inspection. A database was developed to house the information and facilitate analysis of the results. One of the outcomes to date has been assessment of cabinet type against repetitive infestation frequency to demonstrate the need for replacing particular cabinet types as part of the Mammalogy collection-rehousing plan. The extended cost of keeping ineffective cabinets in terms of cumulative specimen damage and staff effort in treating subsequent infestations could be quantified.

The targeted audience is anyone considering having staff visually inspect for pest problems in collections on a thorough annual basis, who needs information on time involved and efficacy of the process to decide if the measured benefit would justify applying our protocol to their situation.

**Project Date:** 2003 - 2008

**CCI Project Leader:** Tom Strang

**Project Team:** Jeremy Jacobs (Smithsonian Institution)

**Links/Partnerships:** J. Jacobs, National Museum of Natural History, Smithsonian Institution, Mammals Division.

**Progress Summary:** 2003-2004: Ten years of data collected across three mammal ranges (study skins). Database constructed and populated with results.

The 2003-4 inspection results were obtained. Through on-site collaborative work in early 2004 the authors verified the database against primary records, filmed inspection processes, and photo-documented situations to illustrate their paper. The database has been populated with all summary data and preliminary analysis completed. Questions raised by this analysis are being addressed by further examination of our primary data sheets and spatial relationships in the storage range. Preliminary results of the work have been delivered in recent IPM workshops and meetings, in particular the joint workshop developed and delivered in 2004 by T. Strang and Dr. R. Kigawa of the National Research Institute for Cultural Property, Tokyo, Japan.

2005-2006: Additional 2005 inspection results obtained. Geo-referencing of cabinets completed, before one specimen range was disassembled and

moved to an improved local in the same building. An improved cabinet replacement policy has been developed as a result of the study. Results delivered in two one-day SPNHC workshops on IPM at the annual meeting at The Natural History Museum, London, June 2005.

2006-2007: Reviewed technical considerations for migration of the inspection database to a GIS (Postgres/GRASS) Gathered spatial data (tier levels, cabinet, and drawer numbers) with inspection results. Acquired and tabulated inspection results from 2005/6 trials.

**Project Proposal:** 2007-2008: Complete data analysis. Write paper for publication in peer reviewed journal.

**Dissemination:** PM workshops were delivered in with 2004 Dr. R. Kigawa of the National Research Institute for Cultural Property, Tokyo, Japan. Preliminary results presented at SPNHC workshop in 2005. IPM Working Group meeting, American Museum of Natural History, New York 2005 (Strang) and 2006 (Jacobs) interim reports.

Guide to visual inspection written for Natural History Museum inspection training session and protocol applied in one day trial with all collection care staff participating, Stockholm, Sweden 2005.

**Research Type:** Collections Preservation Research

**CCI Number:** 85852

## COLLECTION - RISK

**Project Title:** Evaluating Risk for Intergraded Pest Management

**Project Description:** Strang's PhD research will examine the necessary elements and tools of intergraded pest management for collections in framing an IPM risk analysis model for preserving cultural property. The purpose will be to guide good decision-making in the IPM process. The primary benefit to CCI is that we will be able to give sounder advice on reducing the risk of pests to Canadian and international cultural heritage managers.

**Project Dates:** 2006-2010

**CCI Project Leader:** Tom Strang

**Project Team:**

**Links/Partnerships:** Goteborg University, Goteborg, Sweden, and collaborating institutions.

**Progress Summary:** 2006-2007: Case studies in applying IPM and alternate treatments within large institutions were collected in Canada and Japan. These cases will be written up as part of the thesis to illustrate decision process, knowledge on which the decisions were made, economic impacts, and outcomes to the institutions. MOU developed.

**Project Proposal:** 2007-2008: Continue to develop risk framework for integrated pest management (IPM) for cultural heritage. Edit cases. Continue collaborative research work that ties into this goal and resolves key questions

**Dissemination:** None relating to this specific project to date.

**Research Type:** Collections Preservation Research

**CCI Number:** 94075

## COLLECTION - RISK

**Project Title:** Fracture of wood due to RH fluctuations

**Project Description:** The magnitude of RH fluctuation necessary to crack wood samples (when restrained) will be determined, so that one can better estimate the tolerable range of RH fluctuations for museum collections.

Elimination of RH fluctuations in museums has been challenged in the last decade as unnecessary and wasteful. CCI's contribution to this trend has been to adopt a fatigue fracture mechanics argument, and to extrapolate from observable damage with historic extremes to a predicted absence of damage at about 1/4 to 1/8 of such fluctuations, based on mechanical data on wood and other materials. Up to now, however, no experimental confirmation of this fracture model, or its fatigue aspect, has been attempted, nor has there been a full explanation of the argument published. This project will address those two concerns, focused on a collection material that provokes much of the concern about RH fluctuations – wood. This project will address the issue of fracture during single cycles, a later phase will address multiple cycles. Large samples will be held in a specially shaped clamp to allow “stable crack growth.” Sample size is known to play a key role in fracture development during uniform stress conditions, and has been ignored in the “tensile strength” models used to date in conservation science. Thus large restrained panels of wood split more readily than small restrained pieces of wood, and they always split near the middle, all else being equal. (More brittle materials form more closely spaced cracks, e.g., paint ~1cm, hard varnishes ~2mm .) The project will thus also serve to introduce this fracture model to the conservation science community.

The knowledge generated will be useful to those attempting risk assessment of current climate control conditions in a museum, and for those responsible for advice and standards on climate control in museums.

**Project Dates:** 2007-2009

**CCI Project Leader:** Stefan Michalski

**Project Team:** José Luiz Pedersoli (ICCROM)

**Links/Partnerships:** The experimental work would take place at the ICCROM laboratories in Rome, using a large steel clamp and some wood samples already prepared several years ago at CCI for a brief prototype test (which successfully fractured a piece of wood to a known RH fluctuation). Further partnerships with interested Fellows visiting ICCROM or other research agencies will be pursued. (aside: For example, a group in Poland has published recently on the use of acoustic emission to track response of wood polychromes to RH fluctuations. This would be an excellent collaboration, if we could make use of their acoustic emission knowledge. Initially, however, the project will be small scale, and within the scope of the two main researchers, to make wood crack first!)

The data will also be essential for the RH sections of the book planned by CCI and GCI , *Handbook of the museum environment*.

**Project Proposal:** 2007-2008 Impact on Preservation of Heritage Collections in Canada  
Medium. Results will enable more cost-effective guidelines for climate control of museums, which influences not only collection preservation, but also the built heritage often used as museum buildings. The knowledge will impact resource allocations in many museums

Potential or pending loss of collection  
Low. Potential fracture of wooden objects will be reduced for extreme events. But the main purpose is to reduce current paranoia over RH control, which indirectly may lead to collection loss if museums go bankrupt or close on the assumption that they need expensive facilities and energy bills to control RH.

More effective and affordable collections preservation  
High. Results will enable more cost-effective guidelines for climate control of museums

Canadian Climatic Conditions.  
High. The issue of low RH in winter is a particular problem of Canadian museums, and ever since Lafontaine's prescient suggestion of a seasonal setback in the first TB on environment, CCI has been a leader in the reasonable approach to this issue.

Impact on the Accessibility and Understanding of Canadian Collections  
Low. If small seasonal museums can heat in winter and know where risks to their furniture occur, then they may be able to consider more public events in winter, thereby improving access.

Significant Materials and Object Types  
Medium. Wood is ubiquitous in historic collections

Canadian Artists and Creators  
NA

**Research Type:** Applied Scientific Research

**CCI Number:** 96636

## COLLECTIONS - RISK

**Project Title:** Light Damage Calculator and Database

**Project Description:** The goal of this project is to develop a tool, which will allow the best available estimates of colour fading of museum artifacts via computer.

In 1989, the Canadian Conservation Institute produced 3,000 plastic slide rules called the Light Damage Calculator. By 2000, these had sold out. The replacement tool will be software. This will allow incorporation of a database, which addresses the greatest user complaint about the slide rule: how do I know what lightfastness rating, 1 to 8, to use on the blue wool scale? The database will incorporate various literature compilations of lightfastness ratings, as well as approximations about broad classes of objects. All primary literature sources of each piece of data will be available in the database. The software tool will also allow different fading curve shapes to be used for fading predictions, not just the simple linear curve of delta E over time used in the slide rule. Thus the issue of fading "slowing down" as the colour becomes more damaged can be illustrated directly on the display. The old technical difficulties of making accurate predictions of fading with lightfastness ratings remain unchanged, but for museum users, the intent of this advice has never been high precision, just useful, best available approximations. The software tool will allow a didactic help file explaining all these issues and more, with unlimited illustrations. The targeted audience is all museums, galleries, archives, and private collectors.

**Project Date:** 2004-2008

**CCI Project Leader:** Stefan Michalski

**Project Team:** Stefan Michalski, Bruce Gordon, Qiong Pei

**Links/Partnerships:**

**Progress Summary:** 1998 - 2004: The software interface, all forms, and colour fading calculator code, based on Microsoft Access, were developed to an early prototype stage by 2001, and the project then placed on hold. It has been reactivated for 2004-2005.

2004-2005: Data entry of colorants continued. "Help file" prototypes developed for the software product, which include didactic material on museum light damage issues. Presentation of the calculator prototype given at 2004 AIC annual conference, Research and Technical Studies Session. Strong support and many useful suggestions received and incorporated from potential users. Began conceptualization and development of forms and outputs for sets of artifacts, i.e., collections, with various distributions of sensitivities (as compared to the single colorant calculation of the prototype.)

We are interested in feedback and suggestions prior to finalization, both technical and user oriented. Any readers of this research summary are welcome to contact the author at [stefan\\_michalski@pch.gc.ca](mailto:stefan_michalski@pch.gc.ca) with suggestions.

2005-2006: Developed better user interface forms, incorporating suggestions from various presentations. In response to further suggestions during ICCROM-CCI 2005 course exercises on collections risk assessment, explored possible structure of outputs for light risk assessment of an entire collection with a

distribution of light sensitivities, and how to present results. Refined table and relationships structure for explanatory notes and literature references supporting all data entries. Continued entry of lightfastness data from standard texts on dyes and colorants, using the new notes/references forms.

2006-2007: Decision made to focus on web-based delivery of the tool, (CCI web page). B. Gordon and Q. Pei developed web-based prototype, with new additional features that will allow users to submit data and examples via the web for consideration as part of the tools database.

**Project Proposal:** 2007-2008: Test web prototype on local server, populate with some additional data, make adjustments and corrections as needed, place on CCI web site and solicit comments

**Dissemination:**

**Research Type:** Collections Preservation Research

**CCI Number:** 865

## COLLECTION - RISK

**Project Title:** Preservation of Works on Paper with Iron Gall Ink in Canadian Collections – Collection Survey

**Project Description:** To design and develop a simple, possibly web based, survey tool to assess the extent and condition of iron gall ink material in Canadian collections.

Iron gall ink threatens to destroy collections in museums, galleries and archives all over the world. While the problem is acknowledged and there is active research and treatment development in Europe, there is little awareness of its problem in Canadian collections. Since many documents, critical to understanding the history of Canada were written with iron gall ink, and because of the inherent instability of these ink, resulting either in corrosion of paper or fading of the ink, it is important that institutions are aware of the urgent need to preserve them. The need to assess the extent of iron gall ink in Canadian collections was again identified as a CCI research priority in a focus group meeting, hosted by CCI, during the CAC conference in 2000. The survey tool serves two purposes, first it is a means to provide Canadian institutions with a self-assessment and bench-marking tool to determine the condition and quantify the risks of losing these historical documents or works of art in their collection. Secondly, with the use of the on-line survey by Canadian conservators and collection managers, we can have an accurate idea of the distribution of iron gall ink collections across Canada, monitor their conditions and suggest necessary strategies to preserve these collections for future generations. Users of this work include archives, libraries and galleries responsible for the preservation and care of collections of historic documents and works of art on paper containing gall ink.

**Project Dates:** 2003 - 2008

**CCI Project Leader:** Season Tse

**CCI Project Team:** Sherry Guild, Bruce Gordon, Stefan Michalski, Rob Waller (Museum of Nature), Maria Bedynski (Library and Archives of Canada), Harold Holland (Council of Archives of New Brunswick)

**Links/Partnerships:** Library and Archives of Canada (LAC), Greg Paoli (Decisionanalysis Risk Consultant)

**Progress Summary:** 2004-2005: A risk model has been created for works of paper containing iron gall ink. The survey, based on the risk model is being designed and a draft version was introduced and evaluated during the Iron Gall Ink Workshop, to be held at the LAC-GPC in February 21-23, 2005.

2005-2006: The risk model and risk assessment survey form was developed, modified, and presented as a poster at the 2<sup>nd</sup> Iron Gall Ink Meeting and Final Conference for Metals in Paper Research Group, on January 24-27, 2006, in Newcastle upon Tyne, UK. The results to date were summarized and published in the pre-conference publication.

Progress of the risk assessment survey will be presented in the annual CAC conference in Toronto, May 17-19, 2006, where Canadian conservators will be made aware of the diagnostic tool and the assessment survey colleagues. They

will be invited to take part in assessing the condition of their iron gall ink collections.

2006-2007: A presentation was made at the annual CAC Conference, Toronto, May 17-19, 2006. Title of presentation: *Iron Gall Ink Project Part II: Developing a Risk Assessment Tool using Better Survey Design through Risk Modeling* by Season Tse, Robert Waller, Sherry Guild

- A draft survey form, designed based on risk model, was used to collect data from the Hallen fond in the Library Archives Canada with the help of Ainsley Walton. The form was modified with input from Greg Hill and Ainsley Walton, so that only key information relevant to risk of ink corrosion or ink fading will be collected.
- A 2-day visit to the Archives of Ontario was made to see their iron gall ink collection and learn about their collection survey methodology, at the same time, sharing what we know about iron gall ink and related activities. The result of the visit was the development of a more streamlined survey methodology and further refinement of the survey form.
- A pilot survey was carried out at the New Brunswick Museum Archive. Staffs from the museum, and from the Provincial Archives of New Brunswick join us for the survey. It was a valuable opportunity to be familiar with the characteristics of Canadian iron gall ink, to assess their condition, to help local staff identify items at risk, and to develop a workable survey methodology and form.
- Learned Analytica software and began to develop an iron gall ink model for risk calculation with Greg Paoli.  
Began discussion with Greg Paoli and Stefan Michalski to explore the use of iron gall ink risk model as a possible case study towards the development of the CCI risk assessment tool.

**Project Proposal;** 2007-2008: Continue development of iron gall ink model for risk calculation using survey data. Explore the possibility of its use in development of CCI risk assessment tool. Invite international colleagues to review the risk model and risk assessment survey form.

**Dissemination:** Tse, S. Waller, R. "Proposed Risk Model and Survey Form for Iron Gall Ink Containing Paper Objects and Collections" Second Iron Gall Ink Meeting and Final Meeting for Metals in Paper European Thematic Network, January 24-27, 2006, Newcastle upon Tyne, UK, Pre Conference publication 2006. p.p. 107-108

**Research Type:** Collections Preservation Research

**CCI Number:** 90967

## COLLECTION - RISK

**Project Title:** Web-Based Collection Risk Assessment Tool

**Project Description:** To develop a user-friendly, web-based, collection risk assessment tool, in international partnership with ICCROM and ICN.

A risk model of a museum collection will be developed using Analytica, the standard risk analysis software for modeling complex systems with many uncertainties. It is especially suited to collaborations between diverse researchers who are asked to provide and critique content without being programmers. We will work with an expert in the development of such models to develop the base model, but we will also train in Analytica to allow our own experimentation and development of the tool. This base model will permit the addition of detailed sub-models for individual risks as they are developed. The base model will allow calculation of the collection state using expert judgments, typically using discrete category scales such as high medium low. The primary inputs will be incidence estimates, fraction of collection susceptible, fraction affected, the effect of various control options on each of these, and correlations between material state and value state for a variety of different value attributes. The model prototype and its web interface will be tested in a subsequent stage with several museums, as selected by the partners in each of their client groups.

Users of the tool will be collection care-takers of all levels, who will access a web page that asks straightforward questions. A single, easily updated Analytica model, data set, and set of expert judgments will be hidden in the background, available to calculate in real time the best available estimate of the risks to their collections.

This is linked to project on developing a risk model for pest management.

**Project Dates:** 2007 – 2009

**CCI Project Leader:** Stefan Michalski

**Project Team:** José Luiz Pedersoli (ICCROM), Season Tse, Tom Strang, Jean Tétrault.

**Links/Partnerships:** Agnes Brokerhof (ICN), Catherine Antomarchi (ICCROM), Greg Paoli Decisionanalysis Risk Consultants.

**Progress Summary:** 2006-2007 A decision was made to adopt the Analytica software tool for development of an overall risk model as well as individual risk models for specific agents. A teaching workshop on Analytica software was held and development progressed on a specific model for iron gall ink deterioration, and for fire. In addition the development work on the overall model progressed.

**Project Proposal:** 2007-2008 The objectives in the forthcoming year are to continue developmental work on the overall risk model as a priority and to complete the work on fire and iron gall ink. In addition work will commence on a model for pest management.

**Dissemination:**

**Research Type:** Collections Preservation Research

**CCI Number:** 96638

## CLEANING

<b>Project Title:</b>	<b>Mould Research Project: Determination of Effectiveness of Target Treatments in the Removal of Visible Mould Growth from Organic Substrates (Paper)</b>
<b>Project Purpose</b>	<p>This project will determine the efficacy of specific treatment methodologies to remove visible mould growth from organic substrates. The results of mould contamination of cultural artifacts are well understood; these objects can no longer be stored, displayed or handled without special precautions. When faced with a mould-contaminated object, the conservator will, as a first step, undertake to remove as much mould from the object as possible. Cleaning guidelines for contaminated objects that explain methodologies and comparative outcomes of those cleaning methodologies would be beneficial to conservators and collections managers. This project addresses one aspect of an outstanding concern (how clean is an object after cleaning for mould?) that was raised by the conservation community during a CCI focus group meeting held in 1999 at the CAC conference. Results of this project will provide a description of the effectiveness of specific interventions for the removal of mould (on paper, in this phase of the project) based on quantifiable mould removed from test samples. This project does not intend to comment on questions of “decontamination” as “acceptable” levels of mould contamination have not been identified. This project is a natural postscript to and builds upon the information amassed in this Institution’s TB 26 <i>Mould Prevention and Collection Recovery: Guidelines for Heritage Collections</i>.</p> <p>This project will be of interest to those responsible for collections with mould infestations.</p>
<b>Project Dates:</b>	Anticipated span of project: 2006-2010
<b>CCI Project Leader:</b>	Wendy Baker
<b>Project Team:</b>	Gregory Young, Season Tse (consultant), Paul Bégin (consultant), Tom Strang (consultant).
<b>Links/Partnerships:</b>	University-based micro-biologist or mycologist.
<b>Progress Summary:</b>	2006-2007: A compilation of literature concerned with the treatment of mould-contaminated artifacts was initiated. Further study of selected literature will establish a baseline of treatment protocols and outcomes. Preliminary contact was made with a micro-biologist who can advise in the subsequent phases of the overall project. Discussions with CCI scientists have begun on the outlines of a pilot project for the experimental phase of the research.
<b>Project Proposal:</b>	<p>2007-2008: This phase of the project aims to identify experimental procedures, establish necessary parameters for testing (health and safety standards), as well as finalize cleaning methodologies for testing.</p> <ul style="list-style-type: none"><li>• Continue the review and study of selected literature to identify different treatment (reference to paper).</li><li>• Consult with paper conservators to establish most current practices for mould removal.</li><li>• Review and research most appropriate mould species or species to culture on test samples</li></ul>

- Evaluate sample preparation techniques and materials.
- Determine appropriate location and specifications for work area that will meet Health and Safety regulations for working with mould contaminated samples.

**Users:** Canadian and international collections  
For many collections mould infestation is a major concern; libraries and archives, in the case of mould associated with paper and paper/leather bindings. Results can be used to inform guidelines for disaster response, for both static and travelling collections as well as the general public.

**Dissemination:**

**Research Type:** Treatment Development

**CCI Number:** 86046

## FINISHES

<b>Project Title:</b>	<b>Transparent finishes on wooden furniture in Canada, to 1914</b>
<b>Project Description:</b>	<p>The purpose of this project is to identify the composition of original transparent finishes used on wooden furniture made in Canada before WW1 and to develop a protocol for sampling finishes.</p> <p>Identification of transparent finishes will help to determine future treatment paths and increase knowledge of finish materials used in Canadian collections through the creation of a transparent finishes database. The information gathered will test the accuracy of published recipes or assumptions' regarding clear finishes, and may uncover regional differences.</p> <p>Furniture with a known provenance from New Brunswick, Quebec and Ontario will be sampled first to employ existing contacts and their curatorial documentation to support the analysis work.</p> <p>A protocol for sampling will be developed to ensure consistent and accurate results that will allow researchers to compare an eventually large number of samples from across Canada.</p> <p>Scientific analysis of the samples will determine what comprises the finish. This baseline information will be organized into a database available to all on a read-only basis. Continuation of the sampling/analysis project will broaden the database and its usefulness to curators, conservators, and other museum professionals, as well as to historians and students of material culture across the country.</p>
<b>Project Dates:</b>	2007-2010
<b>CCI Project Leader:</b>	James Hay
<b>Project Team:</b>	Alastair Fox, Patrick Quirion, Jennifer Poulin
<b>Links/Partnerships:</b>	CMC (Gatineau) Parks Canada (Ottawa), CCQ, Musée de la Civilisation (Québec City), potentially the ROM, Spadina House in Toronto.
<b>Progress Summary:</b>	2006-2007: Create sampling protocol. Proceed to select first five to be sampled from the National Capitol Region, with two samples from different places on each piece. Analyze those pieces, and create database to archive the results.
<b>Project Proposal:</b>	2007-2008: select next round of 15 pieces to be sampled, acquire samples, analyze them, add to database.
<b>Dissemination:</b>	
<b>Research Type:</b>	Treatment Development
<b>CCI Number:</b>	96609

## LEATHER/SKIN

**Project Title:** Analytical Development: Image Analysis for Microscopical Shrinkage Temperature Measurements of Collagenous Fibers

**Project Description:** The goal of the study is to incorporate quantitative image analysis to improve the precision and accuracy of the thermal microscopical technique. Thermal microscopy provides a straightforward, highly sensitive, full sample means of assessing the condition of collagenous materials: skins, hides, leather, parchment, etc. CCI introduced the method into conservation in 1987. It is now employed broadly in conservation and continues to evolve. This project integrates techniques of digital, time-lapse image capture and analysis for the first time to quantify objectively the structural change of fiber samples during hydrothermal denaturation.

The new technology will dramatically improve CCI's research and conservation support functions in this field, providing CCI clientele with enhanced analytical service for collagenous artifacts in archival, archaeological, ethnographic and natural history collections.

The microscopical method of measuring collagen fiber thermal stability and deterioration is discussed in numerous articles, conference proceedings and workshops; it has been employed as a primary research tool and as a supporting technique for treatments in this area for many years. The addition of image analysis will be a significant improvement to the method.

**Project Dates:** 2002 - 2008.

**CCI Project Leader:** Gregory Young

**Project Team:**

**Links/Partnerships:** Walters Art Museum, Baltimore, MD National Archives and Records Administration, Washington, D.C.

**Progress Summary:** 2003-2004: Most of the developmental work is completed. This involved the establishment of three series comprised of multiple, reproducible processing steps aimed at isolating and quantifying even minute visible changes in samples during heating by thermal microscopy. The three series provide complementary numerical data on fiber denaturation. Sources of experimental error continue to be identified and corrected, including heating effects on the microscope, curve-fitting anomalies and sample movement unrelated to denaturation.

2004-2005: A great deal of progress was made during 2004 towards standardizing the many steps used to transform the video images of microscopical samples into the numerical data used to identify the onset temperature of denaturation (fiber shrinkage). Particular focus was given to just one of three methods developed, because it showed the best specificity to movement associated only with denaturation. This was used during the year to undertake client-based research on the state of preservation of several parchment documents of international renown.

2005 - 2006: The arrival of new instrumentation will, for the first time, allow accurate measurements below standard laboratory temperatures. Improvement in sample preparation is underway. The final step in this work is to institute as

much automation into the technique as possible. This will allow a broader user base to undertake measurements in support of treatment and research. The project will be completed during the first half of the year. Two publications are in preparation.

2006 – 2007: Manuscript preparation was on hold while the method was employed in three research projects to record the effects of treatment materials and storage on research materials and actual artifacts.

**Project Proposal:** 2007-2008: "Present the new method at the AIC (sponsored) workshop on the analysis of skin materials. Complete manuscript and submit early in the year.

**Dissemination:** "Quantitative Image Analysis in Microscopical Thermal Stability Measurements" in *CCI Newsletter* No. 31 (June 2003, pp. 10–11).

"Preservation Study of the Declaration of Independence, Constitution and Bill of Rights" in *CCI Newsletter* No.33 (May 2004, pp. 15-16).

**Research Type:** Foundation Research

**CCI Number:** 81101

## **METALS**

**Project Title:** **An Investigation into the Causes of Indoor Bronze Sculpture Corrosion: A Case Study**

**Project Description:** The aim of the project is to investigate the causes of corrosion on indoor bronze sculptures at the National Gallery of Canada by analysing the metal alloys and samples of patina and corrosion from approximately forty bronze sculptures. This information, when combined with other studies, assists with assessing the cause of corrosion and in making conservation decisions, and is broadly applicable to other collections.

In 1997, conservators at the National Gallery of Canada started an investigation to determine the causes of corrosion on some of their indoor bronzes, in particular to determine whether the cause was environmental or an inherent feature of the type of patina applied to the sculpture. Between 1998- 2003, CCI and the National Gallery of Canada have been investigating the composition of patina and corrosion samples from about forty indoor bronze sculptures. Non-destructive, qualitative x-ray analysis of the metal alloys comprising the sculptures will be undertaken in 2003/04. The results from this investigation will be collected, interpreted and written up for publication.

Users of this project are curators, conservators, scientists, art historians, artists, collectors, and the general public in Canada and internationally.

**Project Dates:** 2003 - 2008

**CCI Project Leader:** Jane Sirois

**Project Team:** Elizabeth Moffatt, Lyndsie Selwyn, Nicolas Duxin and Doris Couture-Rigert (National Gallery of Canada, Project Co-Leader).

**Links/Partnerships:**

**Progress Summary:** 2003-2004: Samples of patina and corrosion have been analysed from thirty sculptures to date. Ten more sculptures were sampled in January 2003 and the analysis of the corrosion and patina samples will be completed by 31 March 2003.

2004-2005: Analysis of the corrosion and patina samples was completed for all forty sculptures. Metal edges on the base of nine sculptures were analysed non-destructively to obtain alloy compositions. The results from NGC's indoor air quality surveys and conservation surveys assessing the degree of corrosion on each sculpture, and results from the analysis of the sculptures analysed prior to 2004 were compiled.

2005-2006: Non-destructive x-ray fluorescence analysis of 40 sculptures was completed and all data compiled. Manuscript preparation was initiated.

2006-2007: A draft manuscript was prepared

**Project Proposal:** 2007-2008: A manuscript will be submitted for publication.

**Dissemination:** Couture-Rigert, D. and Graham, F., "An Investigation into the Causes of Bronze Corrosion at the National Gallery of Canada," presented at the 24<sup>th</sup> CAC Annual Conference, Whitehorse, May 1998 (lecture)

**Research Type:** Applied Scientific Research

**CCI Number:** 83332 (68418, 69420, 73799, 83004)

## **METAL**

**Project Title:** Treatment of Corroded Lead using an Electrochemical Technique

**Project Description:** Cathodic reduction at constant potential has successfully been used to treat lead suffering from active corrosion. This project is intended to help CCI develop the technique for application here. It will also enable us to gain expertise using this electrochemical technique.

The main goal of this project is to set up the electrochemical equipment to treat corroding lead. This procedure is particularly effective when treating lead where corrosion has obscured any surface inscriptions. The procedure was demonstrated to Lyndsie Selwyn by Dr. C. Degriigny in Nantes, France in 2000 during a visit sponsored by the Canada-France Agreement. New equipment was purchased in 2001.

Users who will benefit from this project are metals conservators in Canada.

**Project Dates:** 2006-2009

**CCI Project Leader:** Lyndsie Selwyn

**Project Team:** Robert Barclay, Tom Stone

**Links/Partnerships:** Liz Croome, Senior Conservator, Parks Canada, Winnipeg

**Progress Summary:** 2006-2007: Purchased four corroded lead tokens for use as experimental pieces. No progress.

**Project Proposal:** 2007-2008: Set up the potentiostat after long-term storage, check the electrodes, and learn the software needed to run the electrochemical experiments. Initial experiments in electrochemical treatment of corroded lead samples will be conducted.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 93852

## MODERN MEDIA

**Title:** Cold Storage of Optical Discs

**Project Description:** The purpose of this study is to examine the effect of cold temperatures on CD and DVD discs so that appropriate recommendations for lower temperature storage can be made.

Optical discs such as CDs and DVDs do not last forever. Projected lifetimes for these materials are anywhere from 2 years to over 100 years at standard conditions of 23°C and 50% relative humidity. However, unlike paper documents, it is conceded that for the information stored on these materials to survive multiple decades, it must be transferred to a new format before the machinery to read the carrier and software to interpret the information become obsolete. *This does not mean that the health of the information carrier can be ignored.* The carrier must be kept in the best possible condition so that when it is necessary to transfer the information, the carrier can be read without problems. *The health of the media should not be the factor that drives the transfer process, because unlike technological change, media health can be controlled.* In order to prevent media health from being a factor in the process, proper well-established handling procedures need to be followed at all times to ensure no physical damage occurs to the media. In addition, chemical degradation should be limited as much as possible by storing media at lower temperatures and relative humidity.

Lower temperature and relative humidity increases the longevity of archival materials. However, with optical disc carriers there have been no published scientific studies to examine the effect of cold temperatures. These materials contain many thin layers and delamination is always a concern with temperature and relative humidity changes. What happens to these media if they are left undisturbed in a cold environment for several months? What happens if the media are regularly removed out of cold storage?

Another question that needs to be answered is the lower limit for cold storage. The ISO standard for optical disc storage states that storage of discs below -10°C and 10% relative humidity is not recommended. However, examining the manufacturer's recommendations for several brands and formats of discs, a storage temperature down to -20°C and relative humidity down to 3% are occasionally quoted. With no data to support these figures, there is uncertainty on how to proceed. The advantage of storing discs around -20°C is that this is the lower limit for temperature in standard freezer units, making these conditions achievable for all. The general guideline for increase in longevity of archival materials is a factor of two for every 5°C drop in temperature. Therefore, by going down to around -20°C from the recommended low temperature of -10°C in the ISO standard, a gain of a factor of four in lifetime would be achieved. For good quality discs, -10°C should be more than sufficient to push the lifetime beyond the life of the technology. For poor quality discs, the lower temperature will ensure this is the case.

This study will focus on the immediate effects that cold temperatures may have on optical disc media. In particular, the focus will be on delamination of disc layers or any other changes as a result of being placed in cold storage or being frequently moved in and out of cold storage.

**Project Dates:** 2006 - 2008

**CCI Team Leader:** Joe Iraci

**Team Members;**

**Links/Partnerships:**

**Progress Summary:** 2006-2007: Samples will be purchased and prepared for experimentation. Analysis of the samples for error rate and total amount of errors will be performed with an optical disc analyzer before treatment.

**Project proposal:** 2007-2008: Samples will be recorded and analyzed and the cold storage experiments will begin after the new laboratory is functional.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 94035

## MODERN MEDIA

**TITLE:** Cold Storage of VHS Tapes

**Project Description:** To determine a set of recommendations for the cold storage of VHS formats based on experimental work.

VHS tapes do not last forever. Projected lifetimes for these materials are anywhere from 10 years to over 30 years at standard conditions of 23°C and 50% relative humidity. However, unlike paper documents, it is conceded that for the information stored on these materials to survive multiple decades, it must be transferred to a new format before the machinery to read the carrier and/or software to interpret the information become obsolete. ***This does not mean that the health of the information carrier can be ignored.*** The carrier must be kept in the best possible condition so that when it is necessary to transfer the information, the carrier can be read without problems. ***The health of the media should not be the factor that drives the transfer process, because unlike technological change, media health can be controlled.*** In order to prevent media health from being a factor in the process, proper well-established handling procedures need to be followed at all times to ensure no physical damage occurs to the media. In addition, chemical degradation should be limited as much as possible by storing media at lower temperatures and relative humidity.

Lower temperature and relative humidity increases the longevity of archival materials. However, with magnetic tape carriers there have been no published scientific studies to examine the effect of cold temperatures. What happens to these media if they are left undisturbed in a cold environment for several months? What happens if the media are regularly removed out of cold storage?

Another question that needs to be answered is the lower limit for cold storage. The ISO standard for magnetic tape storage states that storage of tapes below 8°C is not recommended. This recommendation is based on anecdotal evidence where some (or one) tape brand experienced lubricant separation from the tape at lower temperatures. The advantage of storing tapes at lower temperatures of around -20°C is that this is the lower limit for temperature in standard freezer units, making these conditions achievable for all. The general guideline for increase in longevity of archival materials is a factor of two for every 5°C drop in temperature. Therefore, by going down to around -18°C from the recommended low temperature of 8°C in the ISO standard, a gain of a factor of 32 in lifetime would be achieved which is significant.

**Project Dates:** 2006 -2009

**Team Leader:** Joe Iraci

**Links/Partnerships:**

**Progress Summary:** 2006-2007: Samples will be purchased and prepared for experimentation. Analysis of the samples prior to treatment will be performed.

**Project proposal:** Sample storage & drying conditions will be established this year, project completion will take place the following year.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 94036

## MODERN MEDIA

**Title:** Effect of Jewel Cases on the Longevity of CDs and DVDs

**Project Description:** The purpose of this project is to examine the effect of jewel cases on the stability of optical discs.

Jewel cases are the recommended storage containers for CDs and DVDs and are effective in reducing the amount of physical damage that can occur. However, there has been some discussion in the literature that jewel cases are negatively affecting the chemical stability of the discs. It has been speculated that this is due to the portion of the jewel case that holds the disc in place (the holding tray). Consequently, recommendations have been made by some to replace standard trays with more expensive trays. Not much data are available to determine if there is a problem with jewel cases or not. Therefore, this project will investigate whether jewel cases are a threat to disc stability.

In this project a variety of different jewel cases will be examined. Jewel cases of different thicknesses and with different holding trays will be used and an analysis of the case composition will be performed. The effect of jewel cases on disc stability will be studied by inserting audio CDs and various types of recordable CDs into different jewel cases and subjecting the packages to accelerated aging. Discs will be analyzed for error rates and a variety of other properties before and after accelerated aging. Similar experiments will be repeated for DVD discs. The results of this research will be useful to any institution that uses and stores optical discs such as archives, libraries, museums, private institutions, as well as the general public.

**Project Dates:** 2004 to 2008

**CCI Team Leader:** Joe Iraci

**Team Members:** Scott Williams

**Links/Partnerships:**

**Progress Summary** 2004-2005: Four different types of jewel cases in combination with two different types of recordable CDs were examined in order to establish if any negative effects toward the discs were caused by the cases. In addition, some experiments performed focused on the effect that the paper enclosure materials had on disc stability.

2005-2006: A variety of jewel cases were tested in combination with several different types of CDs and CD-Rs. In addition, jewel case samples containing paper enclosure materials were prepared and tested in order to evaluate the effects such enclosures would have on CD and CD-R stability.

2006-2007: More CDs and CD-Rs as well as DVD-Rs were tested in jewel cases and with paper materials in the jewel cases. The addition samples were required in order to confirm certain observations. The data was analyzed and a draft paper was written.

**Project proposal** 2007-2008: The results of the draft paper will be evaluated. Additional experiments may be conducted to validate some of the conclusions in the draft paper. The paper will then be submitted for publication.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 88899

## MODERN MEDIA

**Title:** **Effect of Pollutants on the Relative Stabilities of Optical Discs**

**Project Description:** The purpose of this study is to examine the relative stability of optical discs in a polluted environment.

The original study performed at CCI compared the relative stability of optical discs in terms of temperature and relative humidity effects. This is relevant because the condition of the metal reflective layer is key in determining whether a disc will function properly or not. The metal reflective layer is thin and vulnerable to physical damage, but it is also vulnerable to corrosion caused by pollutants. Many discs use non-inert metal materials such as aluminum, aluminum alloys, silver, or silver alloys and it is important to know to what degree these discs suffer in poor environments.

Where possible the same samples used in the temperature/relative humidity experiments will be used in this study. Where the same samples are not available, substitutes will be used. Additional samples will also be included. The samples should be polluted without any enclosure.

Samples will be prepared at CCI and then analyzed for error rates. The samples will then be shipped to CRCDG for treatment in their pollution chamber. The pollutant gases, levels, time, temperature, and relative humidity to be used will be determined in cooperation with project partners. After treatment, the samples will be returned to CCI for error rate analysis.

Presently, a study being performed at CCI is the effect of jewel cases on the stability of CDs and CD-Rs. As an extension to this study, the protective effect of jewel cases on the discs in a polluted environment will be examined. Samples of CDs and CD-Rs in jewel cases with normal holding trays or corrosion intercept trays will be tested. Corrosion intercept products are designed to inhibit the corrosion of metal protective layers in optical discs. These products are expensive (when compared to jewel cases made of standard materials) and it would be useful to evaluate their effectiveness.

Many of the CDs and DVDs in collections have non-inert metal layers. Therefore, the results of this study will benefit all institutions collecting and recording information onto these types of carriers.

**Project Dates:** 2006 - 2009

**CCI Team Leader:** Joe Iraci

**Team Members:** Léon-Bavi VILMONT, CRCDG (France), Jean Tétréault (CCI)

**Links/Partnerships:** CRCDG in France.

**Progress Summary:** 2006-2007: Samples will be purchased, prepared, and analyzed and then sent to CRCDG for pollutant exposure.

**Project proposal:** 2007-2008: Samples will be recorded, analyzed, and then sent to CRCDG for exposure to pollutants. After the exposure, the samples will be re-analyzed.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 94034

## MODERN MEDIA

**Project Title:** Stability of Optical Discs and Magnetic Tapes

**Project Description:** Experiments on the disaster recovery of optical discs have indicated quite a bit of variability between different discs. This variability may also exist in terms of the longevity of discs. In this project, CDs will be tested according to standards to determine their variability in longevity and allow disc types to be ranked for relative stability. This will provide archives and libraries with an indication of which discs are good quality and will verify (to some degree) claims that manufacturers are making about their products. Similar experiments will also be performed on VHS tapes.

A variety of discs will be tested (audio CDs, CD\_Rs, CD\_RWs, DVDs, DVD-Rs, DVD-RWs). The discs will be aged at 80 degrees Celsius and 85% RH for intervals of 500, 1000, 1500, and 2000 hours. The Block Error Rate (BLER) as well as other key parameters will be monitored. This will allow the relative comparison of stabilities between different types of discs. Actual lifetime values will not be determined because this would require a much longer time frame to complete and require extensive resources.

Users are archives, libraries, museums or any institution that collects information on these information carriers.

**Project Dates** 2003 - 2008

**CCI Project Leader:** Joe Iraci

**Project Team:** Scott Williams

**Links/Partnerships:** The Canadian Council of Archives

**Progress Summary:** 2003-2004: A large number and variety of discs have been aged. More will be aged in 2004. As new products are introduced, more aging will be conducted. The tape aging experiments have not been started.

2004 -2005: A variety of audio CDs, DVD movie discs, recordable CDs and DVDs, and erasable CDs and DVDs were aged in order to examine the stabilities of media currently being produced. The aging data obtained from these samples was compared to data from some older media that have been previously aged. It is becoming clear that the discs of choice for longevity are recordable CDs using the phthalocyanine dye and gold metal layer. Other recordable CDs using different dyes and other formats of discs do not compare favourably in terms of stability. No aging of VHS tapes was performed.

2005-2006: Final editorial changes in consultation with the publisher were made on the paper - The Relative Stabilities of Optical Disc Formats. Some additional optical disc media was tested to determine their stabilities relative to previously tested discs.

2006-2007: Some additional samples such as the gold DVD-R were tested in order to compare the stability of these samples with discs previously aged.

**Project Proposal:** 2007-2008: As new optical disc products are introduced, some additional experiments may be conducted to determine the relative longevity of the new materials.

**Dissemination:** Iraci, J. The Relative Stabilities of Optical Disc Formats. Restaurator 26, pp. 134-150, 2005.

**Research Type:** Applied Scientific Research

**CCI Number:** 83365

**Note: Ongoing – monitoring program**

## **PAINTINGS**

**Project Title:** CCI Lining Project; Phase III - Assessment of the Performance of Lining Supports on Model Paintings

**Project Description:** The Lining Project is a long-term project to study the behaviour of various lining systems lining systems and to investigate their ability to minimize defects in a painting. The previous research of Marion Mecklenburg and Gerry Hedley increased our understanding of the mechanicalbehaviour of paintings and lining supports and as a result, fabrics such as polyester, are being used as lining supports. Are these supports behaving as we think they are in supporting the stresses in a painting?

The purpose of the project is to assess the effectiveness of selected lining supports to dominate the stiffness in a painting and in so doing, to support the stresses in a painting in response to both short-term strain (shock) and long term strain (cupping and cracking, RH and T change). This will assist the conservator in making the most appropriate choice of lining fabric for a particular painting.

Development of a standard experimental procedure will allow comparative testing of additional lining supports as well as less interventive methods of structural stabilization.

The first phase of the project involved the measurement of the mechanical properties (tension and change in dimension (published), stress relaxation and modulus of elasticity (unpublished)) of modelpaintings under different conditions of relative humidity. The second phase investigated the bond strength of a BEVA 371 flocked adhesive and a wax-resin adhesive with different lining supports using 180° peel tests. In this final phase of the project, selected lining systems are being tested in terms of their ability to reduce cracking, delamination,cupping and sagging due to stretching, stress relaxation, and humidity and temperature fluctuations. Tension has been monitored continuously in uniaxial samples which have been exposed to 50%RH, 12%RH for several months and returned to 50%. Models used for analysis of the data have been taken from viscoelastic/plastic polymer mechanics. Initial results have been published. Equipment modifications are planned in order that testing can be continued at low temperature. Repetitive testing will be then be undertaken on additional samples to verify consistency of results. Future work will involve the testing of biaxial samples which have already been prepared.

**Project Dates:** 1993 - 2008

**CCI Project Leader:** Debra Daly Hartin

**Project Team** Stefan Michalski, Paul Heinrichs

**Links/Partnerships:** External linkages with other researchers working in the field, particularly ICOM-CC (Painting Group I).

**Progress Summary:** 1993-2003: Stress relaxation is an important criteria for lining supports. Viscoelastic polymer mechanics explains the rates of relaxation of the different layers of a lined painting. Lining with unimpregnated linen or a multifilament polyester fabric offered no significant support to the model paintings prepared with lead white oil grounds. A lining with unimpregnated polyester sailcloth

showed high initial tension and much slower relaxation than the model oil painting, so significant support was maintained. It can reduce cupping by stress alignment and can reduce cracking by some overstretching but at fast events like shock and after periods of low RH, the painting will carry the tension and will be vulnerable to defects. Several layers of sailcloth bonded together or a heavier weight cloth may extend support to these events as well. Impregnation can increase initial tension, slow subsequent relaxation and can slow the rate of response to change in RH; a size which does not saturate the fabric only influences tension a few days after an applied strain.

2006-2007: Installation of environmental conditioning unit and reassembly of mechanical testing and data capture equipment has been delayed due to lab closure and staff absence.

- Project Proposal:** 2007-2008: Environmental conditioning unit will be installed and mechanical testing and data capture equipment will be reassembled once labs are re-opened. The equipment will be tested and test procedures will be established. The testing of actual samples should begin during winter, 2008.
- Dissemination:** S. Michalski, D. Daly Hartin, "CCI Lining Project: Preliminary Testing of Lined-Model Paintings", *Preprints 11th Triennial Meeting of the ICOM-CC*; Edinburgh, 1996
- S. Michalski, D. Daly Hartin, "CCI Lining Project: Preliminary Testing of Lined-Model Paintings" poster at Conference on "Lining and Backing, The Support of Paintings, Paper and Textiles", UKIC, 1995
- D. Daly Hartin, S. Michalski, "Ongoing Research in the CCI Lining Project: Peel Testing of BEVA 371 and Wax-resin Adhesives with Different Lining Supports" *Preprints of the 10th Triennial Meeting of the ICOM-CC*; Washington, 1993
- D. Daly Hartin, S. Michalski "Lined Paintings - Research; Tests of Beva and Wax-Resin Linings", Gerry Hedley Memorial Forum: Mechanical Behaviour of Paintings - Experience and Theory; 1993
- D. Daly Hartin, S. Michalski, C. Pacquet, "Ongoing Research in the CCI Lining Project: Peel Testing of BEVA 371 and Wax-Resin Adhesives with Different Lining Supports", *Preprints 8th Triennial Meeting of ICOM-CC*; Sydney, 1987.
- Research Type:** Applied Scientific Research
- CCI Number:** 86055

## PAINTINGS

**Project Title:** Technical and Scientific Examination of A.Y. Jackson's Paint Boxes

**Project Description:** The purpose of the project is to document the painting materials contained in paint boxes that belonged to A.Y. Jackson, as well as the paint boxes' technology.

A.Y. Jackson (1882-1974) was a prominent Canadian artist. A member of the Group of Seven, he had a far-reaching impact on Canadian landscape painting. There are at least two paint boxes that belonged to A.Y. Jackson, one in the collection of the Ottawa Art Gallery, another which was acquired in 2004 by the Canadian Museum of Civilization with the collaboration of CCI. The study of the painting materials still contained in these paint boxes provides an ideal opportunity to study the materials of A.Y. Jackson without having to sample paintings. The study will also provide an opportunity to acquire information about the technology of these particular paint boxes and will contribute to a larger study on paint box technology undertaken by Professor Barbara Klempan at Queen's University.

Samples of the materials in the paint boxes will be removed and analysed using several techniques. The construction of the paint boxes will be documented as well as labels and markings that may help to link the boxes to a specific manufacturer.

The users of the results of this project are art historians, curators and conservators in Canada. Analysis of painting materials in paint boxes will provide reference data for paintings for which the attribution is uncertain.

**Project Dates:** 2005-2009

**CCI Team Leader:** Marie-Claude Corbeil

**Team Members:** Jennifer Poulin and Barbara Klempan (Assistant Professor, Paintings Conservation, Queen's University), Philip Cook (Waterloo coop student)

**Links/Partnerships:** Ottawa Art Gallery, Canadian Museum of Civilization

**Progress Summary:** 2005-2006: The paint boxes were examined and analysis of samples of painting materials was completed.

2006-2007: A lecture on the project was presented at the CAC Annual Conference in May 2006.

**Project Proposal** 2007-2008: A draft of an article on the project will be prepared.

**Dissemination:** Klempan, B., Corbeil, M.-C., Poulin, J., and Cook, P., "A Technical and Scientific Study of Two of A.Y. Jackson's Paintboxes," presented at the 32<sup>th</sup> CAC Annual Conference, Toronto, May 2006. (lecture)

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 89315

## **PAINTINGS**

**Project Title:** **Materials and Techniques of Marc-Aurèle Fortin (1888-1970)**

**Project Description:** The purpose of the project is to analyse the materials and document the techniques used by Marc-Aurèle Fortin in order to build a database, which will assist in devising treatments and selecting appropriate display and storage conditions. The project will provide reference analyses for paintings for which the attribution is questioned.

The retrospective exhibition being organized by the Musée national des beaux-arts du Québec for 2010 provides an excellent opportunity to study the works of Fortin, who painted using a broad range of materials. A representative selection of paintings will be examined and samples will be taken for analysis using various methods. An article based on the results of the project will be included in the catalogue of the exhibition.

Users of the work are curators, conservators, scientists, art historians, artists, law enforcement agencies, collectors, and the general public in Canada.

**Project Dates:** 2007-2010

**CCI Project Leader:** Marie-Claude Corbeil

**Project Team:** Elizabeth Moffatt, Claude Belleau (Musée national des beaux-arts du Québec), Jennifer Poulin

**Links/Partnerships:** Musée national des beaux-arts du Québec; Musée Marc-Aurèle Fortin

**Progress Summary:**

**Project Proposal:** 2007-2008: Paintings will be selected and sampled.

**Dissemination:**

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 96903

## PAINTINGS

**Project Title:** **Materials and Techniques of Cornelius Krieghoff (1815-1872)**

**Project Description** The purpose of the project is to analyze the painting materials and document the techniques used by Cornelius Krieghoff in order to build a database, which will assist in devising treatments and selecting appropriate display and storage conditions. The project will provide reference analyses for paintings for which the attribution is uncertain.

The exhibition *Kriehoff: Images of Canada*, organized by the Art Gallery of Ontario and curator Dennis Reid, provided an excellent opportunity to study the works of the prolific nineteenth-century artist Cornelius Krieghoff. The exhibition, which opened in Toronto in November 1999, travelled to four other Canadian cities (Québec City, Ottawa, Vancouver and Montréal) before the end of 2001. Krieghoff's well know subject matters include autumn and winter landscapes and portrayals of natives and habitants.

Over 300 samples of paint and ground were collected from more than 50 works. Paintings from each stage of Krieghoff's career were selected for inclusion in the study - The Early Years 1841-1844, The Montréal Period 1846-1863, The Québec City Period 1853-1863, The European Period 1864-1870 and The Late Québec Period 1870-1872. Lenders who have agreed to participate in the analytical study are the Art Gallery of Ontario, Glenbow Museum, Kastel Gallery of Montréal, McCord Museum of Canadian History, Montréal Museum of Fine Arts, Musée du Château Ramezay, Musée national des beaux-arts du Québec, National Archives of Canada, National Gallery of Canada, Power Corporation, Royal Ontario Museum and the Thomson Collection.

The users of this work are curators, conservators, scientists, art historians, artists, law enforcement agencies, collectors, and the general public in Canada and internationally.

Project results and information from the project will assist curators, conservators, and scientists by providing essential data on Krieghoff's materials and techniques, which are used both in authenticity and attribution studies, and in evaluating the conservation requirements of his works.

**Project Dates:** 2000 -2008

**CCI Project Leader:** Elizabeth Moffatt

**Project Team:** Marie-Claude Corbeil and Sandra Webster-Cook (Art Gallery of Ontario)

**Links/Partnerships:** Glenbow Museum; Library and Archives of Canada; McCord Museum of Canadian History; Musée des beaux-arts de Montréal; Musée du Château Ramezay; Musée national des beaux-arts du Québec; National Gallery of Canada; Royal Ontario Museum; Galerie Kastel Inc.; Power Corporation of Canada; Thomson Collection

**Progress Summary:** 2000-2004: Analysis of the paint samples began in 2000 and was completed during 2002. Data analysis and preparation of reports and a publication are in progress.

2004-2005: A comprehensive final report on the project was prepared for the Art Gallery of Ontario. The eleven other institutions and private collectors that participated in the study received individual reports, which provided detailed analytical results for the paintings in their respective collections.

2005-2006: A draft manuscript was prepared.

2006-2007: No progress.

**Project Proposal:** 2007-2008: A proposal for a presentation and a manuscript for publication will be submitted.

**Dissemination:**

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 74200

## **PAINTINGS**

**Project Title:** **Materials and Techniques of David B. Milne (1882-1952)**

**Project Description:** The purpose of the project is to analyze the materials and document the techniques used by David Milne at different times in his career in order to build a database, which will assist in devising treatments and selecting appropriate display and storage conditions. The project will provide reference analyses for paintings for which the attribution is uncertain.

Scientific research on David Milne's oil paintings was initiated when a large number of his paintings were assembled for a major Milne exhibition organized by the McMichael Canadian Collection and the Vancouver Art Gallery in 1991. The aim of this research is to determine the materials and techniques employed by Milne throughout his oil painting career. In collaboration with the conservation department of the McMichael Canadian Collection, over 280 samples were taken from a representative selection of thirty-seven oil paintings spanning Milne's career. These paintings came from the Milne Family Collection, the McMichael Canadian Art Collection, the Art Gallery of Ontario and the National Gallery of Canada.

The thirty-seven paintings were divided chronologically into four groups: group 1, 1911-1918; group 2, 1919-1928; group 3, 1929-1939 and group 4, 1939-1952. The first group represents some of Milne's early well-known paintings from New York City and Boston Corners, New York (1911- 1918). The paintings in the second group are from a period, which commenced in 1919, when Milne returned to Boston Corners after working as a war artist for a short time. During the years 1919-1928 Milne spent time in Boston Corners, N.Y., the Adirondacks, Mount Riga and Ottawa. The third group includes paintings from the years 1929-1939 when Milne returned to Ontario and the last group spans the period from 1939 until Milne's death in 1953, during which time Milne was in Toronto and then Uxbridge.

The users of the results of this project are curators, conservators, scientists, art historians, artists, law enforcement agencies, collectors, and the general public in Canada and internationally.

Project results and information from the project will assist curators, conservators, and scientists by providing essential data on Milne's materials and techniques, which are used both in authenticity and attribution studies, and in evaluating the conservation requirements of his works.

**Project Dates:** 1991 - 2008

**CCI Project Leader:** P. Jane Sirois

**Project Team:** Elizabeth A. Moffatt, Kate Helwig, Jeremy J. Powell, David Miller, Kristopher Legate (Young Canada Works in Science and Technology, Department of Canadian Heritage), and Annaïg Gautier (CCI intern)

**Links/Partnerships:** The McMichael Canadian Art Collection; National Gallery of Canada; the Art Gallery of Ontario; the Milne Family

**Progress Summary:** 1991-2004: Samples were taken from 37 paintings spanning David Milne's career from 1911 to 1946 belonging to The Milne Family collection, The National Gallery of Canada, the McMichael Canadian Art Collection and the Art Gallery of Ontario. In addition to these, other samples have been taken from David Milne's palette and paintbox.

Several analytical techniques were employed on both cross-sections and samples of discrete layers to obtain detailed information on the composition of the pigments and media used: Fourier transform infrared spectroscopy, gas chromatography/mass-spectrometry, x-ray diffraction, x-ray microanalysis and scanning electron microscopy, light microscopy, fluorescence microscopy, and polarized light microscopy.

The analysis of all samples has been completed (SEM/XES, XRD, FTIR and polarized light microscopy). The project data has been reviewed and compiled and a publication is in progress.

2004-2005: A draft manuscript describing the project and results is in progress.

2005-2006: A lecture entitled "A Technical Study of David Milne's Oil Painting Materials and Techniques" was presented at the 31<sup>st</sup> CAC Annual Conference in May 2005. Preparation of a draft manuscript began.

2006-2007: A manuscript will be submitted for publication.

**Project Proposal:** 2007-2008: Paper submitted; awaiting publication.

**Dissemination:** Sirois, P.J., Moffatt, E.A., Miller, D., Helwig, K., "A Material and Technical Investigation of Early Oil Paintings by David Milne," presented at the 21<sup>st</sup> IIC-CG Annual Conference, Calgary, May 1995. (lecture)

Sirois, P.J., Gautier, A., Miller, D., Moffatt, E. A., and Powell, J.J., "A Scientific Investigation of the Paintboxes of Paul Kane and David Milne," presented at the 22<sup>nd</sup> IIC-CG annual conference, Montreal, May 1996. (poster)

Sirois, P.J., "Delving into the Paintboxes of Paul Kane and David Milne," *CCI Newsletter*, no. 19, March 1997, pp. 6-7.

Sirois, P.J., Stewart, C, Helwig, K, Moffatt, E.A., and Legate, K, "A Technical Study of David Milne's Oil Painting Materials and Techniques," presented at the 31<sup>st</sup> CAC Annual Conference, Jasper, May 2005. (lecture)

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 55696

## PAINTINGS

**Project Title:** **Material and Techniques of Jean-Antoine Aide-Créquy (1749-1780)**

**Project description:** The purpose of the project is to analyse the materials and document the techniques used by Jean-Antoine Aide-Créquy. Jean-Antoine Aide-Créquy is an important artist in the history of Canadian painting, as he created his works shortly after the English Conquest of 1759, during a transition period in which importing artwork from France was not possible; as a result, local painting emerged. A study of the materials and techniques used by Aide-Créquy will enhance our understanding of this important period in the history of Canadian art by identifying the materials available for the painting at the time.

There are only eight paintings left by this artist, most of them signed and dated. Two paintings have already been analyzed while they were being treated at the Centre de conservation du Québec. The other six paintings belong to parishes and religious communities in the regions of Québec and Charlevoix. They will be examined on site, and samples will be taken from them for analysis using various methods.

Users of the project are art historians, curators and conservators in Canada.

**Project Dates:** 2005 - 2009

**CCI Team Leader:** Marie-Claude Corbeil

**Project Team:** Elizabeth Moffatt, Elisabeth Forest (Centre de conservation du Québec)

**Links/Partnerships** Canadian institutions in which Aide-Créquy's work are conserved.

**Progress Summary:** 2005-2006: Four paintings were examined and sampled, and analysis began.

2006-2007: A fifth painting was examined, and sampled and analysis continued.

**Progress Proposal:** 2007-2008: The last painting will be sampled and analysis will be completed. An article on the project will be prepared and submitted for publication.

**Research Type:** Applied Scientific Research (Analytical)

**CCI number:** 89313

## **PAINTINGS**

**Project Title:** **Materials and Techniques of Jean-Paul Riopelle (1923-2002)**

**Project Description:** The purpose of the project is to analyse the materials and document the techniques used by Jean-Paul Riopelle in order to build a database, which will assist in devising treatments and selecting appropriate display and storage conditions. The project will provide reference analyses for paintings for which the attribution is questioned.

A number of paintings allegedly by Riopelle were examined in our laboratory, which turned out to be fakes. Riopelle is one of the most renowned 20<sup>th</sup> artists in Canada and internationally. His works, especially those of the 1950s, have reached high prices. It was recognized that we should build a database of his materials and techniques in order to assist curators and law enforcement agencies.

Users of the work are curators, conservators, scientists, art historians, artists, law enforcement agencies, collectors, and the general public in Canada and internationally.

Project results and information from the project will assist curators, conservators, and scientists by providing essential data on Riopelle's materials and techniques, which are used both in authenticity and attribution studies, and in evaluating the conservation requirements of his works.

**Project Dates:** 2001-2008

**CCI Project Leader:** Marie-Claude Corbeil

**Project Team:** Kate Helwig, Jennifer Poulin, Philip Cook (Waterloo coop student)

**Links/Partnerships:** Montreal Museum of Fine Arts; Musée national des beaux-arts du Québec; Musée d'art contemporain de Montréal; Yseult Riopelle

**Progress Summary:** 2001-2003: Thirty-eight paintings were examined and sampled, and analysis of the samples began.

2003-2004: Analysis focussed on selected samples to address specific conservation issues. A manuscript was written on that body of data for IIC Bilbao 2004.

2004-2005: Analysis of all 300 samples by scanning electron microscopy/x-ray spectrometry, x-ray diffraction and polarized light microscopy was completed. Analysis by FTIR spectroscopy and GC-MS continued.

2005-2006: Analysis of samples from paintings was completed. A selection of painting materials from Riopelle's studio in France was obtained.

2006-2007: Analysis of painting materials from Riopelle's studio was undertaken. Analysis of samples from an additional painting were obtained and analyzed. An article was written and published.

2007-2008: Analysis of painting materials from Riopelle's studio [was](#) completed. Final reports for contributing institutions [were](#) prepared [and sent](#).

**Project Proposal:** [Project completed](#)

**Dissemination:** Corbeil, M.-C., "Discovering the Paintings of Jean-Paul Riopelle," *CCI Newsletter*, no. 32, November 2003, p. 9.

Corbeil, M.-C., "Considerations Regarding Riopelle's Pictorial Technique and Conservation," in *Jean Paul Riopelle - Catalogue raisonné*, vol. II, edited by Yseult Riopelle, Moudan, Acatos and Montréal, Hibou Éditeurs, 2004, pp. 19-25.

Corbeil, M.-C., "La technique picturale de Jean-Paul Riopelle: esthétique et conservation," presented at the 30<sup>th</sup> CAC Annual Conference, Québec City, May 2004. (lecture)

Corbeil, M.-C., Helwig, K., and Poulin, J., "Analysis of the Painted Œuvre of Jean-Paul Riopelle: From Oil to Mixed Media," in: *Modern Art, New Museums*, Contributions to the Bilbao Congress, Bilbao, 13-17 September 2004, edited by A. Roy and P. Smith, London, The International Institute for Conservation, 2004, pp. 170-173 + colour plates 61-62.

Corbeil, M.-C., Helwig, K., and Poulin, J., "Une étude scientifique de la technique picturale de Jean-Paul Riopelle," *Technè*, no. 24, 2006, pp. 47-52 + colour plates p. IV.

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 77821

## **PAINTINGS**

**Project Title:** **Materials and Techniques of Louis Dulongpré (1759-1843)**

**Project Description:** The purpose of the project is to develop a database of the materials, techniques and condition for a selected group of approximately fifteen to twenty oil paintings attributed to Dulongpré. This information will allow us to better understand the working methods of the artist and will also be a starting point to resolve problems of attribution.

The project will involve the examination of paintings from a number of museums. The work will include visual examination, technical photography, x-radiography and scientific analysis of the paint and ground layers. We expect that certain paintings will be sent to CCI for examination and that others will be examined on-site in the various participating museums.

Sampling and examination will take place in 2003-2005. Analysis and collation of results will be carried out in 2006-2008.

Users of the work are curators, conservators, scientists, art historians, artists, law enforcement agencies, collectors, and the general public in Canada and internationally.

Project results and information from the project will assist curators, conservators, and scientists by providing essential data on Dulongpré's materials and techniques, which are used both in authenticity and attribution studies, and in evaluating the conservation requirements of his works.

**Project Dates:** 2002-2010

**CCI Project Leader:** Kate Helwig

**Project Team:** Debra Daly Hartin, Jeremy Powell and Barbara Klempan (Art Conservation Programme, Queen's University)

**Links/Partnerships:** Gilbert Gignac (Library and Archives Canada); René Villeneuve (National Gallery of Canada); Conrad Graham (McCord Museum); Daniel Drouin (Musée national des beaux-arts du Québec) and others to be determined.

**Progress Summary:** 2002-2003: determined scope of project, contacted curators for advice about which paintings to examine, made final list of 20 paintings to be included in the study; developed a timeline for receiving paintings at CCI, contacted curators/museums to determine dates for loans, on-site visits.

2003-2004: examined and sampled three paintings from the McCord Museum in Montreal.

2004-2005: developed a condition report form and initiated cataloguing of photographic documentation; examined and sampled two paintings at the Library and Archives Canada.

2005-2006: No progress due to project leader's absence.

2006-2007: No progress due to project leader's absence.

**Project Proposal:** 2007-2008: Analysis of samples from three paintings from the McCord Museum will be completed and a report sent to the client. Examination and sampling of paintings at the National Archives of Canada and the National Gallery of Canada will be undertaken.

**Dissemination:** Helwig, K., and Daly Hartin, D., "A Starch-based Ground Layer on a Painting Attributed to Louis Dulongpré," *Journal of the Canadian Association for Conservation*, vol. 24, 1999, pp. 23-28.

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 82213

## **PAINTING**

**Project Title:** **Materials and Techniques of Norval Morriseau (1936-)**

**Project Description:** The purpose of the project is to analyze the painting materials and document the techniques used by Norval Morriseau in order to build a database, which will assist in devising treatments and selecting appropriate display and storage conditions. The project will also provide reference analyses for paintings for which the attribution is uncertain.

Norval Morriseau is one of Canada's best known First Nations' artists. A research project into Morriseau's materials and techniques was first proposed in 2001 by Robert Arnold and Peter Vogel. The retrospective exhibition, "Norval Morriseau: Shaman Artist", organized by Greg Hill, Assistant Curator of Contemporary Art, National Gallery of Canada, to be held February 3 to April 30, 2006, provides an excellent opportunity to initiate this research. The project would include examination, documentation and sampling a representative selection of Morriseau's works, including paintings on birchbark, plywood and canvas. Analysis would include identification of the pigments and binding media in the paints and ground layers, and documentation of the artist's technique, supports, signatures, etc.

The project is also timely given recent media reports on the proliferation of Morriseau forgeries and his family's attempt to find the source. A committee of Morriseau experts has recently been established to create a central repository of Morriseau archives and records, to prepare a catalogue raisonné, and to authenticate Morriseau works.

The users of the results of this project are curators, conservators, scientists, art historians, artists, law enforcement agencies, collectors, and the general public in Canada and internationally.

Project results and information from the project will assist curators, conservators, and scientists by providing essential data on Morriseau's materials and techniques, which are used both in authenticity and attribution studies, and in evaluating the conservation requirements of his works.

**Project Dates:** 2005 - 2009

**CCI Project Leader:** Elizabeth Moffatt

**Project Team:** Marie-Claude Corbeil and Robert Arnold

**Links/Partnerships:** National Gallery of Canada, Canadian Museum of Civilization, Canada Council Art Bank, other institutions to be determined

**Progress Summary:** 2005-2007: Twenty-two paintings in the exhibition "Norval Morriseau: Shaman Artist" were examined and 150 paint samples were taken. Analysis of the samples was started.

**Project Proposal:** 2007-2008: Continue analysis of paint samples. Contact other institutions with Morriseau collections to ask them to allow examination and sampling of selected works. Submit a proposal for a presentation.

**Dissemination:**

**Research Type:** Applied Scientific Research (Analytical)

**CCI Number:** 92349

## PAPER

**Project Title:** **Preservation of Works on Paper with Iron Gall Ink in Canadian Collections – Research into Aqueous Treatment Methods**

**Project Description:** The purpose of this project is to evaluate the effects of eight conservation treatments on original iron gall ink documents.

Five iron gall ink documents, dating from the mid to late 19th century, donated by Archives nationales du Québec, were used for in this experiment. Each document was treated with eight separate conservation treatments. The documents were treated by Valeria Orlandini, an intern at the Gatineau Preservation Center, Library and Archives of Canada, in July 2002. The five sets of treated samples were artificially aged using heat (80 °C, 65% RH) light (fluorescent light bank without UV filter) and humidity (22 °C, 85% RH). Quantitative colour monitoring was carried out with the Minolta 2022 spectrophotometer. Changes in the appearance of the documents will be evaluated visually by a panel. Imaging methods such as the MuSIS camera, flatbed scanners, and conventional UV-fluorescence and IR photography will also be used. The methods of imaging will also be compared according to their accuracy in documenting colour and physical changes to the ink and the paper. The treated and aged samples will also be monitored for colour change every five years while stored in temperature and RH controlled laboratory environments.

Users are conservators and custodians of iron gall ink collections in archives, libraries and galleries interested in knowing the impact some of the conservation treatments may have on iron gall ink documents in their collection.

**Project Dates:** 2003 to 2008

**CCI Project Leader:** Season Tse

**Project Team:** Sherry Guild, Scott Williams, Carl Bigras, Maria Bedynski; Library and Archives of Canada (LAC)

**Links/Partnerships:** Valeria Orlandini (McKay Lodge Fine Arts Conservation Laboratory, Oberlin, Ohio); Harold Holland, Council of Archives of New Brunswick (CANB)

**Progress Summary:** 2003-2004: The treated and artificially aged samples have been mounted for evaluation.

2004 - 2005: Photo-documentation and MuSIS imaging of each sample were completed. The presence of Fe(II) ions in the treated and aged samples were tested using bathophenanthroline test. The aged samples visually evaluated by paper conservators attending the Iron Gall Ink workshop (February 21-23, 2005).

2005-2006: FTIR analyses and surface pH using a microprobe was carried out on selected treated aged samples. A summary of the research findings to date was presented in the 2<sup>nd</sup> Iron Gall Ink Meeting and Final Conference for Metals in Paper Research Group, on January 24-27, 2006, in Newcastle upon Tyne, UK. The results to date were summarized and published in the pre-conference publication (extended abstract), and was submitted to be published in the post conference proceedings.

2006-2007: Microextracted pH of all the unaged and treated samples were measured using IQ-240 pH meter with ISFET microprobe. The remaining aged samples will be measured using microelectrode when the labs become available.

An update of the research findings was presented in the annual CAC conference in Toronto, May 17-19, 2006. The title of the presentation: Canadian Iron Gall Ink Project. Part I: Update on Workshop, Research and Publications by Season Tse, Maria Trojan-Bedynski, Sherry Guild, Harold Holland and Valeria Orlandini

**Project Proposal:** 2007-2008: Complete FTIR and pH measurements of the aged samples, prepare publication to be submitted to JCAC. Explore the use of microfading tester to measure colour and fading properties of treated and untreated iron gall ink samples.

**Dissemination:** Tse, S. Guild S. Trojan-Bedynski M. Orlandini V. "Effect of Aqueous Treatments on 19th Century Iron Gall Ink Documents: Part 2: Artificial Aging by Heat, Humidity and Light." Second Iron Gall Ink Meeting and Final Meeting for Metals in Paper European Thematic Network, January 24-27, 2006, Newcastle upon Tyne, UK, Pre Conference publication 2006. p.p. 40-42

Tse, Season. "Preservation of Works on Paper With Iron Gall Ink in Canadian Collections." CCI Newsletter, Fall 2005 p.p. 1-3

**Research Type:** Applied Scientific Research

**CCI Number:** 92399

## PAPER

**Project Title:** Study on the Effectiveness of Bookkeeper Deacidification Technology Using the Arrhenius Relationship

**Project Description:** The purpose of the project is to evaluate the long-term effectiveness of Bookkeeper Deacidification on paper.

Deacidification involves the introduction of a material into paper to neutralize acids and provide a buffer to protect the paper from further attack. The deacidification agent is typically a dissolved compound in solution. The Bookkeeper method differs in that the chemical is not dissolved, but rather in the form of submicron particles suspended in a carrier. The library and archive community would like to know if this has an impact on the effectiveness of a deacidification treatment.

This study will apply the Arrhenius relationship between the rate constant of a reaction and the reaction temperature to estimate the effect of Bookkeeper deacidification on the rate of paper degradation at ambient conditions. The samples (untreated and deacidified) will be aged at five temperatures (between 50 and 90 °C) and the rate constants of depolymerization of cellulose will be determined for an acidic paper and the same paper deacidified by the Bookkeeper process. Other tests such as folding endurance, pH, alkaline reserve, and measurement of optical properties will be carried out. This is a long-term project (4 years) due to the length of time required for the lower temperature accelerated aging. Users are archives, libraries, museums or other institutions that collect and store paper based materials and require information or advice on the deacidification of these materials.

**Project Dates:** 2006 - 2010

**CCI Team Leader:** Paul Bégin

**Team Members:** Season Tse

**Links/Partnerships:**

**Progress Summary:** 2006-2007: On hold due to pending move of CCI's Tunney's Pasture laboratory and equipment to the main CCI building. Work on project outline and plan continued. This will be finalized once the new labs and equipment are operational.

**Project Proposal:** 2007-2008: Send samples to for deacidification and begin the accelerated aging experiments. Measure the physical and chemical properties of the untreated (unaged and aged) samples as well as the deacidified (unaged and some aged) samples.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 75369

## **PESTICIDES:**

**Project Title:** Collections Contaminated by Pesticides

**Project Description:** The purposes of this project are:  
to provide clients in Canadian museums and Aboriginal cultural centres with information on the health hazards associated with contaminated collections;  
to further develop analytical methods, such as GC/MS and portable XRF for detection of a wider range of pesticides, and to improve the existing methods of analysis to provide quantitative data.  
to participate in developing standardized analytical methods within the museum community to ensure all institutions are reporting analyses which are comparable, and  
to develop and evaluate pesticide mitigation procedures

Preliminary results have shown that many natural history specimens and Aboriginal artifacts have been treated with a variety of pesticide residues. Identification of these residues, safer handling protocols and health hazard information is needed by museums and Aboriginal communities caring for these objects to ensure the caretakers' safety. Techniques to remove pesticides from artifacts should be investigated in order to make these artifacts as safe as possible so that they may be used and handled.

The users of this work are Canadian and American museums, Aboriginal cultural centers, members of Aboriginal communities with contaminated objects in their possession from, for example, repatriation.

**Project Dates:** 2005-2009

**CCI Project Leader:** Jane Sirois

**Project Team:** Jane Sirois, Jennifer Poulin, Malcolm Bilz, Tom Stone  
**Links/Partnerships:** Health Canada, informal partnerships only with museums.

**Progress Summary:** 2005-2006: Discussed with Health Canada how to provide clients with hazard information. A strategy to prepare pesticide fact sheets was developed.

2006-2007: Determination of the hazards relating to specific pesticides and development of safety guidelines  
- Preparation of pesticide fact sheets to outline hazards of pesticides identified in collections and to describe measures to be taken to minimize exposure to these pesticides. (Jane Sirois, Jennifer Poulin ARL)

**Project Proposal:** 2007-2008: Preparation and analysis of experimental material for XRF calibration and pesticide mitigation studies (ARL and CR).  
- Start evaluation of pesticide removal techniques and guidelines for mitigation (OIAF and CR)  
- Coordinate and present a one-half day workshop on pesticide contaminated collections at Symposium 2007.  
- Coordinate and facilitate a one-half day meeting on XRF of inorganic pesticide residues in contaminated collections at Symposium 2007.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 94075

## PIGMENTS

**Project Title:** Iron Oxide Pigments: Natural and Synthetic

**Project Description:** The purpose of the project is to undertake research on the history and characteristics of the iron oxide pigments and to prepare a manuscript "Iron Oxide Pigments: Natural and Synthetic," for inclusion in *Artists' Pigments: A Handbook of their History and Characteristics*, vol. 4, Barbara H. Berrie, Editor, to be published by the National Gallery of Art, Washington.

Colored iron oxides are widespread in nature and have long attracted the attention of artists and craftsmen. There is archeological evidence that iron earths were collected and transported more than three hundred thousand years ago. Processing could include washing the earth to remove quartz and hard impurities, heating yellow ochre to create red iron oxide, and mixing different earths together to produce a desired color. Methods to make synthetic iron oxides were known early, but were not employed on a large scale until the development of mars colors in the latter part of the eighteenth century. Both natural and synthetic iron oxides remain important artists' pigments.

The provisional section headings for the Chapter, subject to modification or omission, are as follows: *Introduction* (pigment definition; current terminology); *History* (archaic and historical names; history of use; dates of use); *General Pigment Properties* (colour and spectral reflectance; optical properties; permanence; chemical properties; compatibility; oil absorption and grinding properties; toxicity); *Composition* (chemical composition; sources; preparation; adulteration and sophistication); *Identification and Characterization* (optical and chemical microscopy; chemical identification; instrumental methods of analysis, e.g. x-ray powder diffraction, infrared spectroscopy; spectrochemical analysis; criteria for identification); *Occurrences*.

The users of this work are the National Gallery of Art, Washington (publisher); curators, conservators, scientists, art historians, artists and the general public in Canada and internationally.

**Project Dates:** 1994 - 2007

**CCI Project Leader:** Kate Helwig

**Project Team:**

**Links/Partnerships:** National Gallery of Art (Washington); pigment manufacturers; CCI Library; Material Technology Laboratory, Natural Resources Canada; Surface Science Western; Nancy Binnie, Conservation Processes and Materials Research, CCI (colour measurement studies).

**Progress Summary:** 1994-1996: literature search completed. References imported into "Reference Manager" software for ease of retrieval and production of a bibliography. Collection of reference materials was completed although samples of particular interest are still being solicited. Analysis of reference materials by FTIR, SEM/XES, PLM and XRD was initiated.

1997-1999: A draft manuscript of all sections, excluding *Identification and Characterization*, was completed. Analysis of standard samples continued.

The completed manuscript with illustrations and references was sent to the National Gallery of Art in Washington.

2002-2003: a revised manuscript was sent to the National Gallery of Art in Washington. Editing at the National Gallery to begin shortly.

2004-2005: Revision from the copy editor received and revised manuscript returned to the National Gallery of Art.

2005-2006: Corrections to the first set of proofs of the chapter were made.

2006-2007: Corrections to final proofs of chapter prior to publication will be made.

**Project Proposal:** 2007-2008: Chapter will be published.

**Dissemination:** Helwig, K., "A Note on Burnt Yellow Earth Pigments: Documentary Sources and Scientific Analysis," *Studies in Conservation*, vol. 42, no. 3, 1997, pp. 181-188.

Helwig, K., "Characterisation of the Iron Earth Pigments Using Infrared Spectroscopy," *Postprints of the Infrared Users Group Meeting*, Victoria & Albert Museum, London, September 12-13, 1995 (1998).

Helwig, K., "Pigment Research at CCI: From Titanium Whites to Iron Oxides," *CCI Newsletter*, No. 21, March 1998, p. 5.

Helwig, K., "Mars Colours: Preparation Methods and Chemical Composition," *Poster Summary Booklet, Preprints of Painting Techniques: History, Materials and Studio Practice*, 17th IIC Congress, Dublin, Ireland, 1998.

Helwig, K., "Characterization of the Iron Oxide Pigments Using Physical and Chemical Analysis," presented at the AGPIC 1998 Student Conference, Queen's University, Kingston, Ontario, 2 May 1998. (lecture)

Helwig, K., "The Iron Oxide Pigments: From Red Earth to Mars Colours," presented at the 44th International Conference on Analytical Sciences and Spectroscopy at Queen's University, Kingston, Ontario, 9 August 1998. (lecture)

**Research Type:** Applied Scientific Research

**CCI Number:** 69576

## STONE

**Project Title:** **Characterization of Imitation Stone in Outdoor Monuments and Sculpture**

**Project Description:** The number of exterior imitation stone monuments and sculptures requiring conservation treatment has been growing. Knowledge of the materials used in these monuments is important in determining the proper conservation treatment. As the composition of imitation stone varies greatly, identification can be difficult without analytical support. Little information is available in the literature on imitation stones used in outdoor religious sculptures and monuments. The purpose of this project is to provide knowledge about these materials. The project goals are to identify the types of "imitation stone", to document existing stones to act as reference materials for future analyses and to develop an analytical protocol to more easily categorize these types of materials. Knowledge of the different imitation stones mixtures used by various studios at different times and their characteristics may provide enough information to make conservation decisions without needing analysis for each sculpture. This knowledge can also assist with provenance when little information is available on a particular artifact.

Typical samples of imitation stone will be characterized by combining existing provenance information such as the date and studio where the sculpture was made, information on what materials may have been incorporated into certain types of stone, photo documentation of the artifact materials, and analysis. The project will start with literature research, assembling well-documented imitation stone sample and determining the major categories of imitation stone to be analyzed. Appropriate strategies will then be determined for efficient analysis of the material. Other expertise may be sought during the project to assist with some analytical aspects such as petrographic thin section preparation and interpretation, and atomic absorption spectrophotometry or ICP analysis.

The users of the results of this project are conservators, architectural historians, curators and art historians in Canada.

**Project Dates:** 2005 - 2008

**CCI Team Leader:** Jane Sirois

**Team Members:** Elizabeth Moffatt and Isabelle Paradis (Centre de conservation du Québec)

**Links/Partnerships:**

**Progress Summary:** 2004-2005: Six samples of imitation stone from religious monuments were collected by Isabelle Paradis, CCQ and submitted to CCI as examples. Analyses of several different types of imitation stone samples have been undertaken by ARL as service requests in the past. Information on outdoor religious sculptures and the studios, which provided these sculptures, has been collected by Isabelle Paradis (CCQ).

2005-2006: 15 samples of imitation stone were gathered, as well as articles from the literature. Thin sections, petrographic analysis, elemental analysis and photography of the samples were completed.

2006-2007: X-ray diffraction analysis of the thin sections and samples is in progress

**Progress Proposal:** 2007-2008: Investigation into analytical protocol of imitation stone samples will continue.

**Research Type:** Applied Scientific Research

**CCI Number:** 93922

## TEXTILES

**Project Title:** **Effectiveness of Bathophenanthroline Test Strips for identifying Iron Ions on Textiles.**

**Project Description:** The purpose of this project is to determine if iron (II) test strips, originally developed for identifying iron (II) and iron (III) ions in iron gall ink on manuscripts, can also be used to identify iron (ii) on a variety of textiles.

Dr. Han Neevel and Birgit Reissland at the Netherlands Institute for Cultural Heritage developed the non-bleeding bathophenanthroline test strips for identifying iron (II) and iron (III) ions in iron gall ink containing papers. The test strips were introduced to textile conservation for use on cellulosic textiles by Katherine Barker (NATCC 2002). This research will determine if the test strips can also be used on other types of fibres. If the test strips are effective and reliable, they would: provide a low tech means of confirming if brown/rust coloured stains on textiles contain iron; provide a means of monitoring the effectiveness of treatments to remove or chemically stabilize iron stains on textiles; and provide a means of identifying residual iron in printed or dyed textiles which were not adequately rinsed during manufacture.

Testing will be carried out on fabric samples stained with iron in the lab as well as on textiles from museum collections. The research project will benefit textile conservators and other conservators treating textiles which may contain iron, textile researchers, collection managers, and anyone caring for textiles

**Project Dates:** 2003 - 2008

**CCI Project Leader:** Jan Vuori

**Project Team:** Season Tse, Kate Barker (Textile conservation workshop, New York)

**Links/Partnerships:** Jim Donnelly (Canadian Museum of Civilization), Christine Grant (Parks Canada), Anne MacKay (McCord Museum of Canadian History), Shirley Ellis (Royal Ontario Museum), Lucie Thivierge (Parks Canada), Colleen Wilson and Kjerstin Mackie (Royal British Columbia Museum), Joan Marshall (private practice), Mary Frame (textile researcher), Doris and Bill Hoag (textile researchers), Chris Paulocik (Metropolitan Museum of Art)

**Progress Summary:** 2003-2004: To date some preliminary tests confirmed that the strips may be used to indicate the presence of iron (II) on cellulosic textiles. The results also indicated that the strips may be used on silk although the method must be altered slightly from that recommended for paper (i.e., more pressure and longer contact time is required). More testing is required to determine if the strips can be used on wool and on other fibre types.

2004-2005: Bathophenanthroline Fe (III) ion test strips were used on a variety of textiles in Canadian museum collections suspected of containing iron ions. For selected samples, results obtained with the test strips were compared to those obtained by instrumental analysis. Test kits were also prepared and sent to a number of textile conservators in Canada. Guidelines for using the test strips on textiles were developed based on our own experience and those reported by others using the kit. The results were summarized in a paper submitted to ICOM-CC 2005.

2005-2006: The results of the study to date were presented at the 14<sup>th</sup> Triennial meeting of the International Council of Museums Committee for Conservation, The Hague, September 2005.

2006-2007: No further experimental work was carried out due to lack of laboratory facilities. Work will resume once appropriate facilities are available.

**Project Proposal:** 2007-2008: Once laboratory facilities are available, - testing and analysis on additional samples, particularly wool and Prussian Blue dyed or painted samples, if obtainable, will be carried out. Some samples of iron-containing wool or Prussian blue dyed or painted textiles will be aged by light an/or heat to determine of this releases sufficient Fe(II) to be detectable with the strips.

**Completion date: 2007/08**

**Dissemination:** Vuori, J. and Tse, S. 2005. "A preliminary study of the use of bathophenanthroline iron test strips on textiles" in *Preprints of the 14<sup>th</sup> Triennial Meeting of the ICOM Committee for Conservation*, The Hague, ICOM-CC, 989-995.

**Research Type:** Treatment Development

**CCI Number:** 88301

## TEXTILES

**Project Title:** Evaluation of Treatments for Stabilization of Iron Containing Textiles

**Project Description:** The purpose of this project is to determine if calcium phytate and newly developed antioxidants are effective in protecting textiles that are either stained with iron or contain iron due to a manufacturing process such as iron mordanted dyes. Calcium phytate and tetra butylammonium bromide (TBAB) has been used successfully on iron gall ink containing papers - this project addresses the question as to whether they are also suitable for textiles.

The presence of iron, especially iron (II) ions, and other transition metal ions are known to catalyse oxidation and is therefore detrimental to organic substrates such as textiles and paper. Textiles containing iron as a mordant, for instant, often deteriorate to the extent that the fibres simply disintegrate. The results from a related project, "The effectiveness of iron ion test strips for identifying iron (II) and iron (III) on textiles" (83041), indicate that iron (II) ions are present in many textiles. Some of these textiles are already suffering from deterioration as a result of iron-catalysed oxidation, but others have not yet shown symptoms of deterioration. The question that conservators ask is, "now we know the cause of the problem, what is the solution?". A treatment to prevent or to mitigate the problem is required.

The effectiveness of calcium phytate in stabilizing papers containing iron gall ink has been thoroughly tested and found to be effective. In the presence of water, calcium phytate complexes iron (II) ions without removing them. Preliminary work by Vincent Daniels at the British Museum, found that sodium phytate was effective in stabilizing black-dyed New Zealand flax but the effectiveness of calcium phytate to complex iron on other fibres types as well as its effect on dyes and finishes has yet to be established. The purpose of this research is to determine if calcium phytate is also effective in complexing iron (II) and iron (III) ions in textiles that are either stained with iron or contain iron from a manufacturing process such as mordanting. A new compound, TBAB, has been identified by two European thematic research networks (InkCor and MIP) as effective in stabilizing iron gall ink paper. The advantage of this peroxide inhibitor is its solubility both in water and in organic solvents, and can therefore be used for treatment of objects that cannot be subjected to water. The long-term effects of the phytate and TBAB treatment will be compared to rust removal treatments such as dithionite, oxalic and hydrofluoric acids.

Users are textile, upholstery, and object conservators treating iron stained or iron containing textiles and fibres, paintings conservators dealing with corroded tacking margins.

**Project Date:** 2007-2009

**CCI Project Leader:** Season Tse

**Project Team:** Jan Vuori

**Links/Partnerships:** Iron test kits will be prepared and introduced to textile conservators and collectors in Canada, the US and the UK to assess the condition of textiles containing iron. Partnerships and collaborative efforts will be established as conservators and collectors become aware of the extent that their collection is being affected by iron.

**Progress Summary:**

**Project Proposal:** 2007-2008 – Select and prepare samples for treatment evaluation.

**Dissemination:**

**Research Type:** Applied Scientific Research

**CCI Number:** 83037

## TEXTILES

**Project Title:** Investigation of wide format digital inkjet printing of sheer fabrics for textile conservation

**Project Description:** Wide format digital inkjet fabric printing is increasingly being used to create patterned textiles for the purpose of loss compensation and reproduction. This project will focus on digital inkjet printing on sheer fabrics (silk crepe and polyester Tetex) that have special use in textile conservation as “overlays”. The purpose of this project is: to locate service providers in Canada with the specialized equipment necessary to carry out the printing and post printing processes; to evaluate the properties of the printed fabric in regard to colour matching, light fastness, wet fastness, rub fastness, and off gassing to confirm its suitability for conservation applications; and to develop guidelines that CCI and others can use to work with printers from a distance since most conservators across Canada do not have immediate access to a local wide format digital inkjet printing firm.

Conservators working on textiles, upholstery, and objects with textile components can all benefit from this technique.

**Project Dates:** 2007 - 2008

**CCI Project Leader:** Jan Vuori

**Project Team:** Carl Bigras, Janet Wagner, Renee Dancause, Greg Hill, Chris Paulocik (Metropolitan Museum of Art), Nancy Britton (Metropolitan Museum of Art).

**Links/Partnerships:** Hitoshi Ujiie, University of Philadelphia. Danny Gauthier (Centre design et impression, Montréal). Queen’s MAC program. Additional links/partnerships may be established as work proceeds.

**Project Proposal:** 2007-2008: Trials will be carried out working with one or more printers. Samples of silk crepe and Tetex will be sent to a commercial firm for coating as required for the specific ink type. The coated fabric will be sent to printers together with images of the desired pattern (eg. digital image files and 1:1 colour prints). Information to facilitate colour matching (eg. Pantone colour designation) will also be sent to the printer. The appearance (level of detail and colour match) will be evaluated and the physical properties (lightfastness, wet fastness, rub fastness and off gassing) will be tested using modified standard testing procedures. From this experience, guidelines will be developed to assist others to work with digital inkjet printers from a distance.

The results of the project will also be disseminated to the conservation community by means of a conference presentation and/or publication.

**Dissemination:** Britton, N, Paulocik, P and Vuori, J. Wide Format Digital Inkjet Printing for Textile Conservation. Presented at the AIC 2006 and pending publication in *AIC Textile Specialty Group Postprints 2006*.

**Research Type:** Treatment and Methods Development

**CCI Number:** 95532

## TEXTILE

**Project Title:** **Setting Fugitive Dyes on Cotton and Silk Textiles: Adding Salts, Vinegar, and Using Cyclododecane and Different Drying Methods**

**Project Description:** The purpose of this research is to verify the effectiveness of 'traditional' washing methods (ie. addition of salts and vinegar to the wash water), and to evaluate new techniques (application of cyclododecane consolidant prior to washing) and drying methods (ie. use of suction devices, drying cloths and freeze drying) that can prevent or reduce migration of fugitive dyes in textiles during wet cleaning. Ultimately, the goal is to develop new treatment options that minimize the risks involved in wet treatments to dyed textiles.

Conservators often encounter historic textiles that are dyed or that incorporate coloured threads, often embellishment, that require treatment. Periodically, these textiles need further intervention than simply mechanical surface cleaning in order to improve their aesthetic qualities and inherent stability. However, wet or dry cleaning treatments are often not an option because of the known fugitiveness of the dye and the probability of loss of dye including other effects to the textile associated with this phenomenon. Various traditional methods, not adopted by the textile conservation field, have been used over the years to set fugitive dyes, including the use of various types and concentrations of salts in the wash bath and even vinegar. This research project will examine several of these traditional fixative methods, some in combination with various drying techniques in the hope that they will give results that could be translated to the conservation of historic textiles.

Silk and cotton yarns and fabrics will be custom-dyed in our laboratory with Solophenyl (a direct dye), which is a known fugitive dye. A series of experiments using the above methods will be carried out to ascertain the effect on the fugitive colourant of samples of white fabric stitched with the dyed thread, and to the dyed fabric. A comparison of the results will assist in determining the effectiveness of these wash bath additives and drying techniques to control dye migration in coloured yarns.

The research project will be of benefit to textile conservators who need to carry out immersion or local wet cleaning on coloured textiles.

**Project Dates:** 2002 - 2009

**CCI Project Leader:** Renée Dancause

**Project Team:** Season Tse, Jan Vuori, Sherry Guild

**Links/Partnerships:**

**Progress Summary:** 2002-2003: The research plan for the project was formulated and materials were purchased, including silk and cotton yarn and fabric. Several trial dyebaths were carried out to determine an appropriate depth of shade to use for dyeing the test yarn and fabric. The silk and cotton yarn and fabric was over-dyed (excess dye used in the dyebath) and used to make machine and hand-stitched test samples representative of artifacts with coloured components. The samples will aid in determining the efficacy of various techniques for controlling dye movement during wet treatments. Solophenyl dyes with poor washfastness were chosen for the dyeing.

2004-2005: No progress was made in 2004 due to lab closure.

2005-2006: No progress was made in 2005 due to lab closure

2006-2007: No progress was made in 2006 due to lab closure

**Project Proposal:** 2007-2008: When the Textile Lab is open and functional, it is planned that the following will be completed: washing methods practical research including deionized water, tap water, salts, vinegar; drying methods practical research including suction, drying cloth, freeze drying; consolidation practical research with use of cyclododecane.

**Dissemination:**

**Research Type:** Treatment Development

**CCI Number:** 80340

## Underwater Collection

**Project Title:** Collection and documentation of deteriorated of materials from heritage aircraft wrecks in fresh water

**Project Description:** The purpose of the project is to document the condition of materials from fresh water wrecks of historic aircraft. This is to prepare for the possible recovery of an Avro Arrow model or other significant aircraft.

The restoration of the WW2 Halifax bomber at RCAF Memorial Museum, Trenton offers an opportunity to collect reference samples for conservation research from an aircraft that was submerged in freshwater for 50 years. Materials assembled from the Halifax bomber, a fragment of a Velvet Glove missile recovered from Lake Ontario, and a Beechcraft Staggerwing float plane, will provide CCI with a reference collection for research on material condition. Information on condition and on their conservation treatment could help in predicting the condition and stability of other aircraft wrecks and in stabilizing wreckage already present in collections.

Such aircraft wreckage is unstable because the materials have deteriorated underwater. Understanding the condition of these materials will enable us to determine if treatments developed for aircraft from saltwater are suitable.

Materials which may be collected for research include cladding alloys, wood, plywood, synthetic laminates (wood substitutes), insulation (foam), Plexiglas, Bakelite, rivets, and paint. Sampling and description of the components being examined will be guided by the team carrying out the restoration project, and construction drawings and specifications for the Halifax bomber are available.

Wreckage materials will be collected and characterized by physical & chemical condition.

**Project Dates:** 2005-2008

**CCI Project Leader:** Nancy Binnie

**Project Team:** Scott Williams

**Links/Partnerships:** RCAF Memorial Museum Trenton  
Western Canada Aviation Museum, Winnipeg  
Fokker Aircraft Recovery Team  
Centennial Museum, in Shequiandah, Manitoulin Island  
Avocational or archaeological Groups wishing to retrieve aircraft under provincial permit such as the Avro Arrow models from Lake Ontario, or Fokker Standard Universal from Charron Lake, Manitoba.

**Progress Summary:** August 2004 - carried out site visit to RCAF Memorial Museum Trenton to view wreckage; collected photographs to illustrate materials and condition (for use in planning project).  
2005-2006: March 2006 - A limited literature survey has been carried out.  
2006-2007: Wreckage from planes recovered from freshwater was examined at The Canada Aviation Museum (CAV), Canada Bushplane Heritage Centre, and the Western Canada Aviation Museum.  
- Photographic documentation of construction details of the fuselage of a Fokker Standard Universal (unrestored) and wing sections and fuselage of a Travelair

2000 (partially restored) at CAV was carried out to complement a materials investigation for a planned aircraft recovery from Charron Lake, Manitoba.  
- Collaboration with the WCAM and Foller Aircraft Recovery Team whereby CCI assists with the conservation plan for a rare Fokker bushplane.

2006-2007: **Phase 1:** CCI will obtain samples from the Fokker Universal sea plane. **Phase 2:** Characterize materials by physical condition and chemical analysis.

**Project Proposal:**

2007-2008: Continue materials characterization and sample analysis as access to wreckage materials becomes available.  
- Laboratory analytical work has commenced to study the samples retrieved from the Fokker aircraft at Charron Lake. These include wood, plywood, paint, metals, corrosion, and insulation.

**Phase 3:** Determine if previously developed conservation treatments for aircraft wreckage from saltwater (US and Australian research) will be suitable for use on similar materials recovered from fresh water. This will be done through a search of literature reporting on aircraft recoveries, condition assessment, and conservation treatment, as well as consulting with other conservation and aircraft restoration specialists.

**If needed -- Phase 4:** Develop & evaluate conservation treatments for submerged wreckage materials

**Dissemination:**

Binnie, Nancy E., CCI Report 93769 Conservation Plan for a Fokker Standard Universal airplane through recovery phase, surface assessment, cleaning and transport, and laboratory stabilization of aircraft, Canadian Conservation Institute, June 2, 2006 (draft).

Binnie, Nancy E., Site to Shelf: Planning for the Recovery of a Historic Aircraft from Charron Lake, Manitoba, Canadian Conservation Institute Newsletter No. 38 (in press).

Binnie, Nancy E., Site to Shelf: A conservation plan for a historic aircraft, in Altitude, magazine of the Western Canada Aviation Museum, Winter 2006.

**Research Type:**

Collections Preservation Research

**CCI Number:**

74557

## UNDERWATER COLLECTIONS

**Project Title:** Corrosion Rates for Iron Components of Shipwrecks at Fathom Five National Marine Park

**Project Description:** A key issue in the management of underwater heritage is to understand the natural rates of decay. This project is a service provided to Parks Canada in which the aim is to find out what the natural rate of corrosion of iron in the freshwater Great Lakes environment.

This work is being carried out in Georgian Bay at Fathom Five National Marine Park, and rates will be determined using standard iron coupons installed on underwater test racks. A multi- year exposure is necessary as the corrosion rate is initially high, but eventually reaches a steady state rate after 5-8 years. Extrapolation of the steady state corrosion rate can be used to estimate the condition of fasteners and structural components on heritage shipwrecks, and will be used to predict the lifetime of the collection of 21 sail and steam vessels dating from the mid-19<sup>th</sup> to 20<sup>th</sup> centuries within Canada's first National Marine Conservation Area.

Samples are removed every year from shallow and deep-water stations. This is done regularly in the first few years, and then whenever convenient. Corrosion rates are established using the mass loss.

In August 2005, samples in the 1994 test station will have been in place for 11 years. Shallow and deep samples be recovered for analysis. Mini-test samples installed in October 1999 will have been in place for nearly 6 years and may also be recovered. Laboratory work will be carried out to establish corrosion rates. A final report and/or technical note will be prepared to describe the corrosion studies.

Users are cultural resources managers, underwater archaeologists, and conservation scientists.

**Project Dates:** 1994-2020

**CCI Project Leader:** Nancy Binnie

**Project Team:** Parks Canada – underwater marine archaeologists from the Underwater Archaeological Services Unit, and John Stewart (Conservation Scientist); and members from Fathom Five National Marine Park

**Links/Partnerships:** Fathom Five National Marine Park, Parks Canada Ontario Service Centre and Underwater Archaeological Services Unit

**Progress Summary:** 2005-2006: Metal samples from five locations were retrieved by the Underwater Archaeological Services of Parks Canada and returned to Ottawa. Samples were frozen in lakewater, and stored at Parks Canada/Walkley Road pending analysis.

1994-2006 Samples were installed in August 1994, August 1996, and September 1999. Recovery was carried out annually between 1994-1999, and in 2001.

Samples were analyzed and summary reports prepared (internal) for CCI and Parks Canada.

2004- 2005: No progress was made this year as FFNMP did not have a dive team available, and the UAS team was not working at FFNMP that year.

2005-2006: Samples were recovered from mini-test racks at most locations in 2006 by Jim Ringer, Underwater Archaeologist at Parks Canada. Samples were returned to CCI for analysis, but have been frozen in lake water and transferred to a freezer at Parks/1800 Walkley Road to await analysis when the CCI laboratory construction is complete

2006-2007: Corroded metal samples will be analyzed when laboratory reopens.

**Project Proposal:**

2007-2008:

- 1) Analysis of samples recovered in 2005 (pending laboratory completion).
- 2) Compile and collate all experimental data accumulated; prepare a new report to summarize findings.
- 3) New samples may be recovered in 2007 if field work at FFNMP is carried out, priority will be given to recovering samples from the Russel Island (30 ft) and King test racks (105 ft) that were not sampled in 2006. The data logger on the deep location will also be recovered.

**Dissemination:**

Stewart, J., Murdock, L.D., and Binnie, N., *The Design of a Monitoring Program for Iron Alloys on Underwater Historic Shipwrecks in Fathom Five National Marine Park, Ontario, Canada,* Materials Research Society Symposium Proceedings, The Materials Research Society, vol. 462, pp. 359-368, 1997.

- Stewart, J. and Argyropoulos, V., *The Corrosion of Ferrous-Metal at Fathom Five National Marine Park,* Historic Resource Conservation Branch, National Historic Sites, Parks Canada Report 20 February, 1994.
- Binnie, Nancy E., *Corrosion Rate Monitoring of Submerged Cultural Resources at Fathom Five National Marine Park, A report on the 1994 field trip,* CCI Service Request CPR Report No. 656, October 6, 1995.;
- Binnie N.E., *Corrosion Rate Monitoring of Submerged Cultural Resources at Fathom Five National Marine Park, A report on the 1995 field trip,* CCI Service Request CPR Report No. 657, June 19, 1996;
- Binnie N.E., *Corrosion Rate Monitoring of Submerged Cultural Resources at Fathom Five National Marine Park, A report on the 1996 field trip,* CCI Service Request CPR Report No. 695, November 6, 1996.
- Binnie N.E., *Corrosion Rate Monitoring on Station 161 (38MRD-1) and Station 180 (38MRD-2), Shipwreck Monitoring Program at Fathom Five National Marine Park,* CPMR Report No. 749, December 19, 1997.

**Research Type:**

Applied Scientific Research

**CCI Number:**

74557

## UNDERWATER COLLECTIONS

**Project Title:** Erosion of Wood in Freshwater Shipwrecks

**Project Description:** The purpose of this study is to obtain a quantitative measure of the rate of wood erosion for deteriorated, waterlogged wood samples on a typical freshwater shipwreck site where surfaces are covered with zebra mussels (*dreissena polymorpha*), and where recreational divers remove mussels from timbers. Loss rates can be used as a damage indicator for survival of wood in similar environments.

As part of a study to assess the impact of fresh water zebra mussels on the materials composing shipwrecks, two large wood plank samples from the *Princess Charlotte* (sunk in the 1840's near Kingston in Deadman Bay, Lake Ontario, were recovered from the site in November 1996 and characterized by methods which included: 1) studio photography; 2) 3-dimensional moulding, with casting of replica surfaces; 3) 3-D laser scans of the surface at the National Research Council of Canada; 4) pilodyn measurements; 5) wood species identification and wood loss estimated with a weighing technique; and 6) installation of erosion pin markers used as reference standards on other underwater sites to assess wood loss on surfaces. The samples were reinstalled on the site in December 1996 and left to undergo natural ageing. After an extended period of natural ageing (5-10 years), the plan is to recover the samples and reassess to determine changes. Between June 15-25, 2004, a team from Parks Canada/Underwater Archaeological Services Unit will be working nearby and the wood samples can be recovered during that period.

Users are underwater archaeologists, cultural resource managers, and conservators.

**Project Dates:** 1996 - 2010

**CCI Project Leader:** Nancy Binnie

**Project Team:** Jonathan Moore and Willis Stevens (Underwater Archaeologists, Underwater Archaeological Services/Parks Canada)  
Rejean Baribeau (Research Officer, Photometry and Radiometry, National Research Council of Canada)

**Links/Partnerships:** Parks Canada, Natural Research Council of Canada.

**Progress Summary:** Samples will have undergone 7.5 years of natural underwater exposure as of summer 2004.

1996-1997: Wood samples selected, characterized & reinstalled on site for long-term exposure.

2005-2006: No progress - unable to arrange for reinstallation of wood samples on site in 2005. Samples are stored in walk-in fridge at Walkley Rd and are checked regularly and water changed. Samples to be installed early spring 2006.

2006-2007: Wood samples were reinstalled on site by Parks Canada underwater archaeologists. There was no opportunity this year to examine wood in-situ losses at the Deadman Bay site this year.

- An on-site examination of composite artifacts (wood, plywood, paint, fasteners, and others) retrieved during the Charron Lake Fokker aircraft recovery project has permitted examination of samples where the original paint and wood surfaces have been protected through the action of corroding fasteners with biocidal consolidating corrosion products,

**Project Proposal:** 2007-2008: If opportunities are presented, to make further observations and collect samples from wood samples retrieved from the Fokker aircraft recovery project at Charron Lake, or later at the Western Canada Aviation Museum immediately after artifacts are taken there from the field.  
- Other field work opportunities to gather samples and condition information may be available this year with the Underwater Archaeological Section of Parks Canada in the Trent Severn Waterway or at Fathom Five National Marine Park during survey work of the Peterborough wrecks, prehistoric sites, or monitoring program activities.

**Dissemination:** Nancy E. Binnie, Peter Engelbert, Lorne D. Murdock and Jonathan Moore, September 2000, *Shipwrecks, Archaeology and Zebra Mussels: Is Mussel Attachment a Threat to Our Submerged Cultural Resources*, in Proceedings of the 10<sup>th</sup> International Aquatic Nuisance Species and Zebra Mussel Conference, hosted by the Department of Fisheries and Oceans, February 13 to 17, 2000, pp. 121-131.

**Research Type:** Applied Scientific Research

**CCI Number:** 74557