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Papers arising from the ICCROM FORUM on Conservation Science
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CONSERVATION SCIENCE

Papers arising from the ICCROM 2013 Forum on Conservation Science

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Editorial

The papers gathered together in this supplement to *Studies in Conservation* (supplement 2 for 2015) present the findings of the ICCROM Forum on Conservation Science. This international think tank event which took place in Rome in 2013 was brought into being through the collaboration and support of an international consortium of 16 institutional partners, and provided a venue for critical reflection regarding the current role and future directions of science in the field of cultural heritage conservation worldwide.

The Forum recommendations focus on enhancing the integration, relevance and impact of conservation science within the cultural heritage conservation sector, and its capacity to deliver wider societal benefit. In its findings, the Forum highlighted key issues such as the setting of strategic priorities, and promoting engagement and dialogue with stakeholders beyond the sector (e.g. policy makers and the public), as well as the need to strengthen the role of specific actors within the sector (e.g. conservation organizations and educational institutions) to carry this forward.

To communicate the findings of the Forum, the recommendations developed by the eight discussion groups on the final day of the Forum have been summarized and further elaborated by individual authors into the series of position papers presented in this volume. Each paper relates to the work of a single discussion group, apart from that by Heritage and Golfomitsou, which provides an overview of the Forum findings as a whole and outlines follow-up initiatives. Four of the papers are concerned with broad issues of relevance and effectiveness: the paper by Brokerhof focuses on enhancing the contribution of conservation science to heritage conservation, Lagnesjö discusses the contribution to wider societal priorities, Bell outlines how to set strategic priorities for the sector, and Michalski examines tools for assessing needs and impact. A further four papers focus on specific actors both within and beyond the sector: Corbeil considers the role of conservation organizations, Golfomitsou sets out new paradigms for education and training, Lee details the processes of policy making and the needs of policy makers, and Lithgow elaborates opportunities for enhancing collaboration and co-working with the public.

While these papers in part present the individual viewpoints of the authors, nevertheless it is important to recognize that each stems fundamentally from the findings of the Forum discussion groups, and therefore contains the collective contributions of all those involved. In writing these papers, each author has made considerable efforts to remain faithful to the spirit and recommendations of the Forum. Yet, at the same time through reflection and in light of their own personal experiences, the authors have managed to convert the somewhat raw statements that inevitably result from such group work into polemical inspiring pieces that take stock of the current status of the field and make compelling arguments for change. We wish to thank all those who contributed to the success of the Forum and the production of these papers, most notably the consortium partners, the Forum participants, the authors of these papers, and also the fellow colleagues, interns and consultants at ICCROM, without whose efforts the Forum, and this publication would not have been possible. An appendix with the names of all participating institutions of the Forum Consortium of partners, their designated contact persons, the participants at the Forum, and the composition of the various discussion groups is provided at the end of the volume.

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Summary paper

Conservation science: Reflections and future perspectives

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The ICCROM Forum 2013 on Conservation Science resulted in a series of recommendations for improving the relevance and impact of science within cultural heritage conservation. These recommendations are outlined in this paper. Central to the Forum recommendations is the responsibility of conservation science to provide benefit through research and innovation. This relies on shared strategic vision and good governance, to identify priority needs and align efforts accordingly. To enhance the effectiveness of conservation science research, it is imperative to adopt an approach based on needs assessment, collaboration, and sharing. However, to establish whether desired goals are being met, systematic assessment of what is delivered and how it is used is required. Evaluation tools provide a structured way to identify needs and to measure results, offering a basis for learning and improvement. A new initiative is outlined, launched by ICCROM in follow-up to the Forum, to develop a common framework for needs and outcome assessment for heritage conservation science. To achieve this will require participation and support at multiple levels, and collaboration is called for to continue and sustain this effort.

Keywords: Conservation science, Heritage science, ICCROM, Evaluation methods, Needs assessment

Introduction

Solving problems through scientific inquiry is one of the bedrocks of cultural heritage conservation. Conservation science is a well-established field, nevertheless, new paradigms in science and culture and the expectations of society make it imperative to revisit established approaches, especially in the ways conservation science operates and connects within the heritage sector and beyond. Conservation science has multiple recipients and there are numerous ways, over and above the production of publications addressed to specialized audiences, by which these various communities can engage with, shape and share the outcome of its endeavours.

The ICCROM Forum on conservation science

ICCROM (The International Centre for the Study of the Preservation and Restoration of Cultural Property) is an intergovernmental organization with 134 member states, created in 1956 by UNESCO. Its mandate is to promote the conservation of cultural heritage, moveable and immoveable worldwide. Part of ICCROM's role is to identify issues of common concern, and stimulate fundamental debate around these issues. One of the ways in which it achieves this is through the organization of think-tank meetings known as the ICCROM Fora, which provide a space for discussion on topics of primary concern within the conservation field. For the 2013 Forum, ICCROM detected a critical need for reflection regarding the current role and future directions of science in the field of cultural heritage conservation. Through the collaboration of a consortium of 16 institutional partners from 14 countries who represented different types of heritage conservation, research and training organizations, the ICCROM Forum on Conservation Science took place in Rome in October 2013.

The Forum brought together participants from all regions of the world, who represented a wide variety of professional backgrounds and career stages, and included conservation scientists, educators, conservators, managers, and other conservation professionals. In total, 80 people were selected from the following 27 countries: Australia, Belgium, Brazil, Canada, Chile, China, France, Germany, India, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, New Zealand, Poland, Portugal, Qatar, Senegal, South Africa, Spain, Sweden, Switzerland, The Netherlands, United Kingdom, and the United States.

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The Forum focussed on conservation science issues, rather than a discussion of heritage science and cultural heritage studies in general, and devoted itself to three key themes posed as driving questions:

(1) How can conservation science be of greater benefit to conservation practice?
(2) How can conservation science contribute to wider societal priorities?
(3) How can we build an integrated and impactful future for science in conservation?

More information about the organization of the ICCROM Forum on Conservation Science can be found in Heritage *et al*. (2014).

Findings of the Forum

The Forum concluded that conservation science is an interdisciplinary applied science domain, the primary purpose of which is to support the preservation, understanding, and sustainable use of cultural heritage, with the goal of promoting wider societal engagement with heritage for current and future generations. The scope of the conservation science covers both the preservation of the material aspects of heritage and its intangible values, to which end the natural, social, and formal sciences all have a contribution to make.

The Forum recommendations focus on enhancing the integration, relevance, and impact of the conservation science within the cultural heritage conservation sector, and its capacity to deliver wider societal benefit. These recommendations are elaborated in the papers presented in this volume of *Studies in Conservation* by Brokerhof (2015) on contributing to heritage conservation, Lagnesjö (2015) on contributing to wider societal priorities, Bell (2015) on setting strategic priorities for the sector, and Michalski (2015) on tools for assessing needs and impact. In addition, key issues highlighted included promoting engagement and dialogue with stakeholders beyond the sector such as policy makers and the public as discussed in the papers by Lee (2015) and Lithgow (2015) in this volume, and the role of specific actors within the sector — in particular conservation organizations and higher education institutions — to carry this forward (see the papers by Corbeil (2015) and Golfomitsou (2015), this volume).[1]

Looking at the recommendations as a whole, a number of distinct common themes arise, which are summarized in the following two sections. In essence, they relate to the central issue of responsibility in terms of the ability of the sector to provide benefit through relevant research and innovation, and also being seen as doing so in order to leverage support. This relies in turn upon strategic vision and good governance, which are key to the health of the sector, to identify priority needs and align efforts accordingly, and also through the monitoring and assessment of outcomes — a view which is also widely endorsed within the wider science sector (see for example European Commission, 2015a).

Strategically positioning the sector

Many of the Forum recommendations relate to strengthening and strategically positioning the conservation science sector. The five key points are summarized as follows.

Defining a shared vision and mission

The Forum recommendations spoke of the need to develop a shared vision and mission statement for the sector to clarify its purpose and role, and place it more clearly within policy and funding frameworks.

Strategy development

Collaboration between producers and users of conservation science knowledge is required to develop research strategies at multiple levels (organizational, national, regional), based on assessment and prioritization of needs, to enhance the relevance and effectiveness of conservation science, and gain leverage with policy makers and funding bodies.

Demonstrating benefit

Demonstrating benefit is a priority. To attract political and financial support, conservation science must provide evidence of the benefits that it delivers. At present, the field lacks basic tools and data to demonstrate its effectiveness.

Influencing policy

Conservation science should seek to play a more active role in policy making processes, and contribute towards long-term sustainable heritage policies. This requires strengthening of relationships with policy makers as well as a greater understanding of policy making processes, including the expected timeframes for the delivery of scientific evidence and advice. Such efforts could be facilitated through political science and governance studies.

Improving communication

There is a need to communicate better and more strategically at different levels within the sector and beyond. Here, in addition to improving communication between heritage professionals, heritage organizations can play a leadership role reaching out to multiple target audiences including policy makers and the public. Moreover, education programmes can contribute through communications skills training to develop the capacity of heritage professionals to share their work with different audiences through multiple dissemination platforms.

[1]Further information regarding the Forum and its findings can be accessed via the ICCROM website www.iccrom.org

Delivering better, more relevant science

For conservation science to contribute more effectively to the heritage sector, the following four recommendations were made by the Forum.

Assessing needs and outcomes

In line with the need to demonstrate benefit (as outlined above), a key issue is the adequate assessment of needs and outcomes: to make sure that research focuses on what is relevant, and to assess how well this is being achieved, in terms of the benefits for immediate client communities and beyond. To this end, common evaluation tools are needed to provide a structured means of identifying needs, tracking activities and outputs, and measuring outcomes. Such tools would provide a support for learning and improvement to enhance outcomes and maximize impact.

Seeking sustainable solutions through collaboration and sharing

As in any applied science domain, maintaining the link between research and practice is vital. This is best served through solution-orientated applied research developed in partnership with end-users, which focuses on providing relevant information and tools to sustainably resolve priority challenges in heritage conservation. This requires a participatory approach to research that welcomes and encourages collaboration between different actors within cultural heritage conservation, and which also looks beyond the borders of the sector, to foster interdisciplinary working within research projects. In addition, creative partnerships, including citizen science and crowd-sourcing initiatives, can strengthen and expand the conservation community to become one that is more inclusive, capable and willing to reach out to engage with other communities.

On a practical level, mechanisms for sharing resources and expertise between institutions are much needed to increase efficiency, knowledge exchange, and reduce inequalities. This can be realized by creating international research infrastructures to foster scholarly exchanges, share equipment and experts, provide workshops, and facilitate internships.

Expanding and utilizing knowledge

It is important to recognize the multiplicity of knowledge systems that can contribute to the conservation of cultural heritage. In addition to diverse scientific disciplines, traditional knowledge and craft skills are a vital resource, with the potential to provide improved options for conservation practice that are better suited to context. Recognizing the value of these knowledge systems, and through the application of scientific methods to understand and assess traditional methods and materials, their potential application within heritage conservation can be optimized and enhanced.

However, knowledge is of little use unless it is effectively disseminated, and so providing ready access to knowledge is vitally important. Information should be shared in locations and formats such that it can be most easily accessed by target audiences, ideally using free, open access platforms. Knowledge infrastructures and interactive teaching tools adapted to audiences and context can help disseminate research findings and promote best practice at multiple levels from local groups to global networks.

Enhancing quality

To ensure delivery of high-quality science that is up to date and relevant to needs, conservation science professionals need to maintain strong links with scientific fields outside the sector. Moreover, outward looking research can lead to the discovery of new paths and applications of science for cultural heritage. Improving methods, minimizing errors in experimental processes and making use of standardized methodologies will also enhance the quality of scientific data.

A broader vision

Professional fields, regardless of whether they are well established or relatively new, either evolve or die out. Past developments in conservation science have followed those in science, cultural heritage, conservation, and beyond. The Forum findings are in line with a key change generally taking place within both the scientific and cultural sectors, which is the recognition that professional fields cannot work in isolation but rather must ally themselves with the rest of society.

In the scientific sector, this is evidenced by increasing numbers of initiatives both national and international which aim to foster communication and engagement between science and the wider society, an example at European level being that of *Science with and for Society* (SWAFS) (European Commission, 2015b). These initiatives are part of a systematic effort to build broad-based relationships through which scientific research goals are aligned to societal priorities. In addition, new terms such as 'citizen science' which have emerged through projects set up to involve the active participation of citizens and local communities in scientific research also evidence this movement.

Within the cultural sector, the role of heritage organizations has also changed to focus more on addressing societal needs. Museums, for example, in addition to being the custodians of cultural heritage through collecting, studying and preserving heritage assets, are now increasing their engagement with local communities, using their collections to educate and strengthen understanding of cultural identities.

Similarly, conservation practice has also evolved from a material-based to a people-centred approach. The demand for increased access to heritage sites and collections, the recognition of new emerging types of heritage and material culture to be preserved, and the need to reduce carbon footprints in museums are but a few examples of issues which indicate how general socio-political changes are driving a revision of the *status quo* within the field, and emphasize the need for conservation science to connect with societal priorities, in order to stay relevant.

A broader vision for conservation science is therefore demanded in terms of the contribution it should seek to make, which requires the field to reach out to other scientific domains in order to achieve this. The Forum recommendations also highlighted the need for the sector to become more strategic and to make evident the benefits that it delivers. This in many ways is in accord with the movement in some parts of the cultural heritage sector towards the establishment of 'heritage science' as an applied science domain. The term 'heritage science' is becoming increasingly adopted (particularly in Europe and North America) as a means to unify a number of interrelated applied science fields which focus on the study of cultural heritage — such as archaeological science, curatorial science (e.g. technical art history), and conservation science — under one umbrella to create a stronger, more cohesive and readily recognizable field with greater critical mass. Allying these various fields seeks to create a larger sector with shared goals, which can enhance its impact through the development of common strategy to align efforts and resources, and promote collaboration. Moreover the intent is to strategically position heritage science within policy and funding frameworks, and thereby make stronger arguments for investment to build capacity (Bell, 2015).

At the ICCROM Forum on Conservation Science, the term 'heritage science' was sometimes used in preference to that of 'conservation science', and indeed appears in some of the Forum papers collected in this volume. However, heritage science and conservation science although intrinsically connected are not synonymous terms. Heritage science is not solely limited to preservation issues and represents a larger domain of which conservation science (as it is currently practiced and understood) is a part. That said, while the findings of the Forum specifically related to conservation science, it is worth noting that many are equally applicable to heritage science.

Looking forward

Building upon the experience of the Forum and its recommendations, ICCROM together with the Forum partners have identified two key areas to progress: strategy development and demonstrating benefit.

Strategy development particularly at national and regional level is much needed not only to align efforts and address needs more effectively, but also as a means of creating greater cohesion within the heritage conservation community. In turn, this serves as an important communication tool which allows the community to speak with a stronger more united voice with government and other decision making bodies. However, the development and implementation of strategy requires adequate assessment of needs and available resources. Moreover, to determine if the strategy is working, also requires the evaluation of outcomes — which is directly linked to the issue of demonstrating benefit.

Demonstrating benefit is a high priority in many fields — especially those which rely on effective fundraising and public support for survival — and in recent years there has been increasing activity in this area with regard to culture and cultural heritage (for examples within Europe, see Cultural Heritage Counts for Europe Consortium, 2015; European Commission, 2015c). Conservation science, like many other specialized areas of applied research with limited funding resources, is under increasing pressure to make evident its relevance and delivery of benefit. However, while there is growing recognition of the importance of evaluating outcomes and impact, at the same time there are widespread difficulties in establishing common frameworks, language and methods. In other words, although it is easy to see the merits of the exercise, it remains difficult to apply in practice.

Accordingly, to enhance the relevance, visibility and strategic impact of conservation science, a structured and systematic approach to needs and impact assessment is required. An important advance would be the creation of shared tools for planning and implementing evaluation studies (e.g. survey questionnaires, data sets, and protocols). Common tools would also enable a 'big data' approach to the analysis of surveys, opening the way towards the collection of comparative data, benchmarking and the development of indicators for the field, and in turn provide a quantifiable basis to support strategy development.

As a first step, ICCROM has started an interdisciplinary dialogue between professionals from cultural heritage, cultural statistics, and social sciences to gain a clearer picture of evaluation methods used in the cultural heritage sector and other areas to assess needs and outcomes, and explore the possibilities for applying these in a systematic and structured way to heritage conservation science.

To this end, ICCROM is currently undertaking a study to collect data regarding current evaluation practices used in heritage organizations in relation to conservation science, and to identify methods used in other fields (in particular social sciences) which could be of

use. The goal is to work towards building a common tool for needs and outcome assessment for heritage conservation science, which could in turn serve as a model for further initiatives in the wider heritage science field. However, this will require participation and support at multiple levels, from grassroots to governments. We very much hope that the collaborative spirit of the Forum consortium will continue to sustain this effort.

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[2]Forum consortium partners (in alphabetical order of participating member state):

(1) Institut Royal du Patrimoine Artistique, Belgium
(2) Universidade Federal de Minas Gerais-CECOR, Brazil
(3) Canadian Conservation Institute, Canada
(4) National Heritage Center of Tsinghua University, China
(5) Centre de Recherche et de Restauration des Musées de France, France
(6) National Research Council, Italy
(7) National Research Institute of Cultural Heritage, Cultural Heritage Administration, Republic of Korea
(8) Cultural Heritage Agency, the Netherlands
(9) Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Portugal
(10) University College London Qatar, UK/Qatar
(11) AHRC/EPSRC Science and Heritage Programme, UK
(12) Getty Conservation Institute, USA
(13) Smithsonian Institution, USA
(14) National Heritage Board, Sweden
(15) Bern University of the Arts, Switzerland
(16) ICCROM

Position paper

How can science connect with and contribute to conservation? Recommendations and reflections

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This paper reports the conclusions and recommendations of the working group that synthesized the discussions on 'How can science connect with and be of greater benefit to conservation practice?' during the ICCROM Forum on Conservation Science. The author reflects on these findings from her own perspective and experiences, and places them in the context of two major shifts in heritage research: the first, a shift in focus from conserving materials to managing meaning. The second, a shift in organizational structures from single, centrally funded heritage institutions towards diffuse networks which include new players who have no direct responsibility towards heritage. Both shifts are taking place in an environment of decreased funding and increased accountability to society. Science and conservation connect and contribute to each other most effectively if they together contribute to the societal benefits of heritage. In this regard, heritage science strategies can stimulate collaboration, and direct science and conservation towards innovative, applicable outcomes. Moreover, they can promote a transdisciplinary approach which connects social, economic and business sciences and stakeholders. They should also ensure the creation of sustainable nodes for consolidating knowledge within these dynamic networks.

Keywords: Heritage, Conservation, Science, Strategy, ICCROM Forum, Research infrastructures, Capacity networks

A question, a working group, some reflections

On the first day of the ICCROM Forum on Conservation Science, the question 'How can science connect with and contribute to conservation?' was posed as a central point for discussion. On the last day a working group was formed to synthesize the results of two previous days of discussions, and to draft recommendations specifically in answer to this question. The presentation of their conclusions and recommendations can be viewed online (ICCROM Forum, 2013). This paper starts with a summary of the conclusions and recommendations of the working group. In the part that follows the author, who did not take part in the working group but discussed the question during the first day in a different group, reflects on the recommendations from her own perspective and experiences in the Netherlands, and places them in the context of other issues discussed at the Forum.

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What came out of the working group

The group's point of departure for their discussions was that the goal of cultural heritage conservation is to bring benefit to society. With this goal in mind, the group emphasized the need for strategies to expand and exploit scientific knowledge, to improve understanding of heritage (and thereby recognition of its values and significance), and to promote its sustainable welfare. The group emphasized that such strategies should be developed in collaboration with conservation practitioners, and used to promote creative research partnerships, undertake needs assessments, improve methods, and optimize access and dissemination of scientific knowledge and information.

The group diagrammatically represented science, heritage and its welfare, as having a symbiotic relationship in which science facilitates further understanding of heritage through humanities based research, disciplines such as archaeometry, and also through conservation practice (Figure 1).

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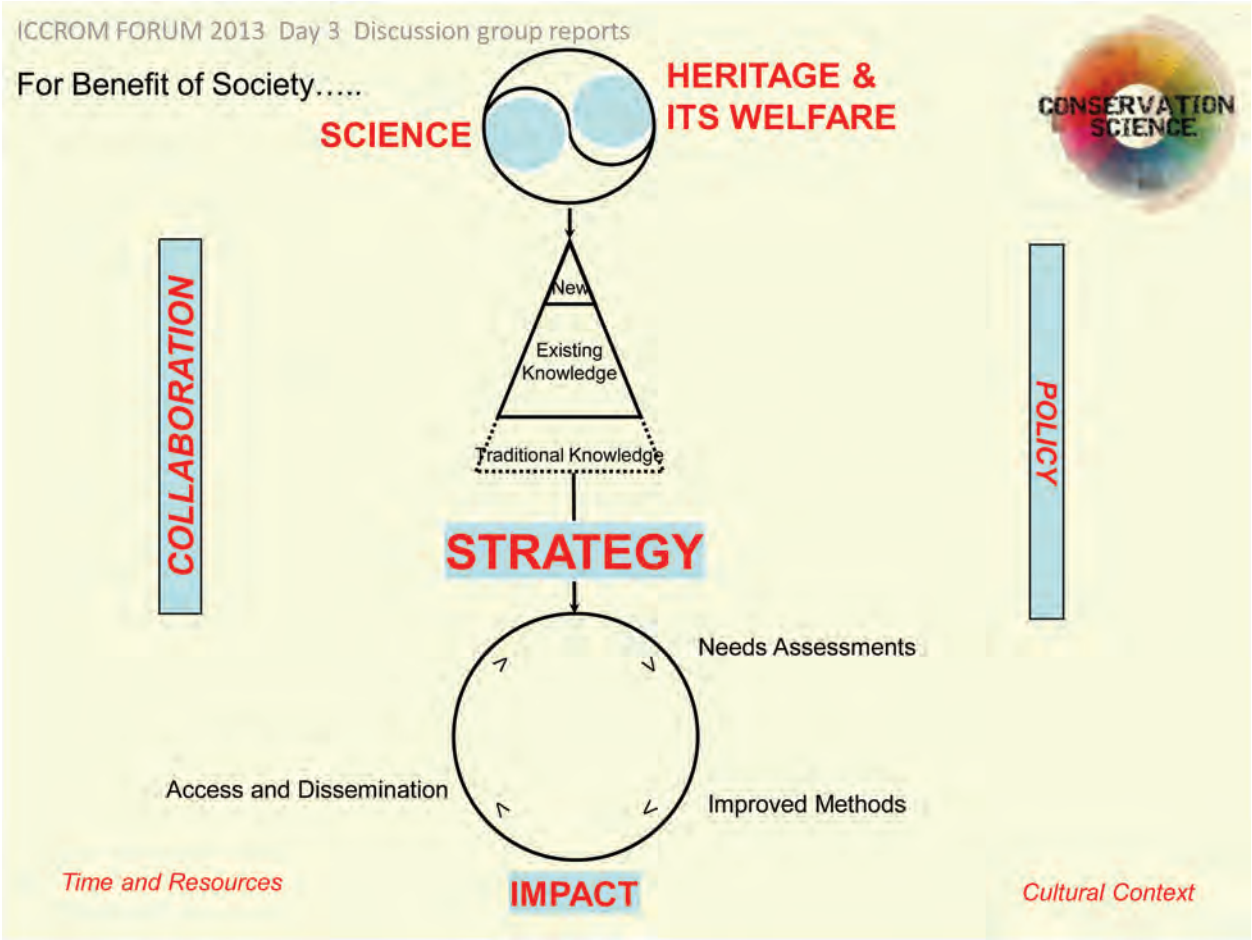

Figure 1 **Diagram representing the symbiotic relationship between science, heritage, and its welfare. © ICCROM 2013.**

In this context, the group identified three types of knowledge and outlined the role of science with regard to each of these:

- Traditional knowledge, of which little is written down but exists in oral and practice traditions, for example, in vernacular building techniques. Science can help understand and disseminate this knowledge.
- Existing scientific knowledge, which could benefit conservation practice if it were better known, disseminated, interpreted and understood. However, funding streams from academia tend to support new discoveries rather than the dissemination or application of existing knowledge.
- New scientific knowledge which can aid innovation within conservation practice.

The working group's proposal is based around a strategy for science in the support of conservation practice that stresses the need for interdisciplinary collaboration to ensure dissemination and applicability. Such a strategy will need to be supported by policies that enable it to proceed.

The conclusions of the working group are presented here, with some minor editing to improve legibility.

Scientists involved in heritage and conservation practitioners should collaborate and develop a heritage science strategy to:

- engage in creative partnerships,
- make assessments of need (and gaps),
- improve methods, and
- optimize access and dissemination.

Through implementing such a strategy, knowledge can be expanded and exploited, the understanding of heritage and its sustainable welfare can be improved and the recognition of its values and significance can be deepened. In these ways, science can contribute to the societal benefits from heritage.

Through the use of strategy, we recommend:

- To promote an interdisciplinary understanding which responds to the needs in practice, providing solutions to conservation problems, and optimizing conservation processes through the use of heuristic and sustainable methods.
- To develop interactive teaching tools and platforms based on science to meet needs in practice.
- To scientifically assess traditional knowledge (craftsmanship, ancient techniques) to better understand and optimize its use as an alternative in conservation practice.
- To tailor new approaches in scientific documentation that guarantees open access and co-conservation.
- To assure open and credible information, using common language and terminology, accessible for as

many end-users as possible, adapted to the level and context.
- To use impact assessments to assess the effectiveness and influence of science in support of conservation practice, by means of the ROAME methodology (Rationale, Objectives, Appraisal, Monitoring, and Evaluation).
  - For example, evaluating the quality of the science, its societal relevance, the access to and dissemination of the findings, and professional and public awareness and understanding of the results.
- To explore the narratives of conservation practice with scientific support, to demonstrate the applicability, use and benefits of scientific conservation knowledge.

To do all of the above, we need champions (who are well-known, respected, and dedicated), press coverage, and illustrated examples.

Reflections on a changing world

The working group recommended connecting science and conservation through a heritage science strategy. How does that fit in the bigger picture? The working group focussed on how to improve the relevance and impact of science to the conservation field, nevertheless, the bottom-line question for the ICCROM Forum was how should conservation science adjust to changes in society in order to stay relevant and have a sustainable future? This is an important question, because the world in which we, heritage professionals, do our work is rapidly transforming. The scientific world changes, the research infrastructure changes, the focus in conservation changes, and the interaction of society with heritage changes.

Shifts in the scientific world

Lidia Brito, UNESCO's director of the Division of Science Policy and Capacity-Building, in her opening keynote lecture in the Forum, sketched a globalized world in which the balance of global influences is shifting, as discussed some years earlier by UNESCO (2010). In terms of science development, continental Asia is growing rapidly and will overtake the old players Europe, North-America and Japan on many fronts within the next decade. Science is becoming increasingly internationalized. The distribution of research and development efforts between North and South is shifting with the emergence of new players in the global economy. A bipolar world in which science and technology were dominated by the European Union, Japan, and the USA is gradually giving way to a multipolar world, with an increasing number of public and private research hubs spreading across North and South. Newcomers, including the Republic of Korea, Brazil, China, and India, are creating a more competitive global environment by developing their capacities in the industrial, scientific, and technological spheres. While once these countries provided cheap labour, they now show a rapid increase in the number of researchers, combined with the automatic incorporation of knowledge and intellectual property through the acquisition of 'Western' companies.

Science is also becoming increasingly democratic. Thanks to modern technology and low-cost easy access, science comes to the people. People have access to scientific knowledge from all over the world and more people are able to get actively involved in science. Citizen science, or crowd-sourced science, makes use of amateur scientists and members of the general public to collect and analyse data. These initiatives drill into a huge resource of scientific enthusiasm. A successful example is the Galaxy Zoo, an astronomy project which invites people to assist in the morphological classification of galaxies on large numbers of telescope images collected in sky surveys (Zooniverse, 2013). Examples in our own domain are the *Your Paintings* tagging project in which the public is invited to describe what they see on the digitally available UK national collection of oil paintings (BBC, 2015) and the *Google Art Project* which enables anyone to study and use high resolution images of paintings (Google, 2011). Meanwhile, we live in times of uncertainty, under pressure on a planet at risk. Increasingly it is recognized that science can more effectively contribute to solutions through dialogue with stakeholders, through co-design and co-production with cross-cutting policies and through building bridges in and between networks. Accordingly, measuring the success of scientific research in these terms requires a shift from counting academic citations as evidence of peer regard to measuring impact on society and public engagement.

These changes and requirements in the scientific world at large are equally influencing science for heritage. An indicator of the changes taking place in our field is the plurality of terminologies used to describe it. This was reflected even in the title of the Forum itself, which when announced was 'the ICCROM Forum on Conservation Science'. However, at various stages of its preparations the phrase 'Science in Conservation' was used. Although the two phrases contain the same words, they do not convey the same meaning: in particular, 'conservation science' is more purposeful and focused than 'science in conservation'. Furthermore, during the three days of the meeting many participants, especially those from the UK, used the terms 'heritage science' and 'heritage research'. Heritage science 'is about managing change and risk and maximising social, cultural and economic benefit not just today, but in such a way that we can pass on to future generations that which we have inherited' (House of Lords, 2006, p. 15).

'In order to support the various aspects of heritage: conservation, access, research, interpretation and management, heritage science must be based on an interdisciplinary palette of knowledge, from fundamental sciences (chemistry, physics, mathematics, and biology) to arts and humanities (conservation, archaeology, philosophy, ethics, history, art history, etc.), including economics, sociology, computer sciences, and engineering' (Wikipedia, 2015). This illustrates the expansion of the playing field on which we do our work. It implies the need to take time and look at where we are and where we might go, to step outside our comfortable frames and reach out to other science disciplines and heritage domains.

Shifts in focus

The shift towards heritage science coincides with ongoing shifts in focus within the heritage field: from care and restoration, to conservation, preventive conservation, and risk management; from freezing to managing change; from preservation to access; from 'looking at' to experience. An example is the development in approaches to exhibiting objects of art, which has changed from 'looking at art' presented as a type of artistic wallpaper (as in the mid-nineteenth-century salons), to 'isolating' such as that described in *Inside the White Cube* (O'Doherty, 1976), 'feeling' or interaction with installation art, and 'experiencing' or immersion in, for example, Olafur Eliasson's *The Weather Project* (Eliasson, 2003).

There is also the shift from analogue to digital and from material to meaning. The emphasis is moving from preserving heritage as material culture, with a focus on 'stuff', to preserving its content and function and increasingly to preserving this relationship in a participatory society. This amounts to a change in focus from materials and things towards people and their interaction with heritage – a shift from the container; to content and concept; to context. Whereas traditionally keeping authentic material was the prime directive, digitization in archives and libraries has pushed a move towards preserving information or content. Contemporary art produces cultural expressions that are no longer self-explanatory and need understanding of the concept and the maker's intent. This becomes highly relevant when artworks contain media with limited life expectancy such as video and audio, which may need replacement to preserve the concept. With this shift in focus the topic of meaning, value, and significance has re-entered the debate. The conservation of contemporary art also includes preserving the social aspects of experience, interaction, and relationship with the beholder and stakeholders. The conservation of ethnographic objects has changed from keeping curiosities placed on a pedestal, towards understanding their meaning for both the original owners and the collectors and towards re-establishing and conserving the relationship with the original cultures. Thus, the tangible and the intangible aspects of culture and their mutual relationship need to be integrated into research. This shift in the focus of conservation has an impact on the contribution of science. With the recognition of cultural heritage as an anchor of identity at the heart of society, similarly conservation science needs to place itself within society as well. Hence, the material focus of conservation science and curatorial practice (technical art history and archaeometry), already interdisciplinarily connected with (art) history, needs to expand to include the social sciences. And as science democratizes, so does heritage. It is no longer the experts who solely determine importance and significance, the public has gained a voice in that process. Public participation, co-care and co-conservation require new approaches and understanding of the social interaction of heritage. The shift towards *The Object in Context* (Saunders *et al.*, 2006) is in full progress.

Shifts in research infrastructure: an example from the Netherlands

Throughout the twentieth century conservation science and curatorial study have been carried out mainly in single, centrally funded heritage institutions often supported by the state. In these institutions research matured from mono-disciplinary applications of science to multi- and interdisciplinary projects to find answers to questions about making, and solutions for problems with keeping. Curatorial study and conservation science have come together for the proper interpretation of objects and to understand the relationship between materials and meaning. This understanding is paramount for heritage management and for making well-founded decisions about its development, use, and preservation.

In the Netherlands, where the state took responsibility for the care and management of its national cultural heritage, this development is reflected in the institutes that have performed that support service. In the early 1960s, the 'Central Research Laboratory for Objects of Art and Science' was founded. It started out as a multi-disciplinary institution where scientists, (art) historians, and conservators came together to study the making, degradation and conservation of objects. The laboratory developed an interdisciplinary approach which expanded even further after the merger in the mid-1990s with the Fine Arts Bureau and the Training School for Conservators to create ICN, the 'Instituut Collectie Nederland'. The Dutch name of the Netherlands Institute for Cultural Heritage also reflects the development from studying objects to managing collections. Research

not only generated knowledge for conservation of materials and objects but also for determining significance of objects and collections and for their management. While ICN was widening its view and becoming more generalist, new research players entered the heritage science arena to deepen knowledge. Universities formed research groups that used high-tech equipment to study material change at a molecular level. ICN's conservation scientists had the task of bridging this 'fundamental' science with its application in practice, translating science into solutions for conservation, and conservation problems into scientific research questions. They also had a role in connecting the diversity of research initiatives in sciences and humanities. In 2011 ICN merged with the state services for built heritage, archaeology and landscape to form RCE, the 'Cultural Heritage Agency of the Netherlands', an organization in which all heritage domains have come together. While ICN aimed at an approach which integrated object, content and context, RCE aims to integrate knowledge, policy, and practice throughout all heritage domains.

These developments have taken place in a changing economic and political environment. While RCE integrates all the heritage domains, the Dutch state is withdrawing from the cultural arena. It prefers to take on the role of conductor or director, and encourages a participating society, and the development of private enterprise and entrepreneurship. Funding for culture is being reduced and its own heritage support agency has shrunk in size. This shift in politics requires RCE's conservation scientists to reposition themselves for a new role. As scientific research at RCE decreases in capacity and output, universities, and other research groups gain funding from the Netherlands Organisation for Scientific Research (NWO) and the European Union. NWO has a history of financing research programmes for art and heritage with the Molart, De Mayerne and Science4Arts programs. Over the coming years funding will be available for the virtual 'Netherlands Institute for Conservation, Art and Science' (NICAS) – a network initiative in which the Rijksmuseum and primary partners University of Amsterdam, Delft University of Technology and RCE have teamed up with a number of new players (NWO, 2015). The 'institute' aims to foster innovative research unifying three different disciplines: art history, conservation, and science. At this moment, it does not yet cover the full array of disciplines that heritage science encompasses, but nevertheless represents an interdisciplinary start with new players. In January 2015, a match-making day was organized where proposals could be pitched and matched with partners to initiate the design of proper research lines. The enthusiasm was overwhelming, with 51 proposals covering both curatorial study and conservation science. The day also showed that the government's laboratory, since its birth the leader of science for heritage in the Netherlands, may no longer be the central place where knowledge is generated, but rather the place where it comes together and from which it is disseminated. A network structure is growing that in due course may be able to take over this role.

The Netherlands is not unique in this development. As a result of stimulating innovative research through cooperation and crossing of boundaries, among others through national and international funding schemes such as the European frameworks, a large number of new players have entered the cultural heritage arena. Universities and research organizations have discovered cultural heritage as an interesting topic to apply their knowledge and generate funding to develop new knowledge and technology. These organizations are well equipped and can do 'fundamental' studies that the traditional heritage organizations cannot. Old questions are re-addressed with newly available techniques and our knowledge can be deepened. This represents the next jump in scientific progress. Concurrent with this deepening there is also a broadening. Heritage research has explored new disciplines, those of humanities, social sciences, and business studies, and these new disciplines have in turn discovered heritage as a subject of focus.

In today's world, research is increasingly being planned, organized, and developed in networks, which can receive funding that is unachievable for single institutions. Competition between single players is turned into enriching and more efficient co-operation, when the players organize their work together. The planning, co-ordination, and funding of such networks requires research agendas, science strategies, and joint programming initiatives. This happens at a large scale in Europe and at a smaller scale in the Netherlands, as sketched above. While the state institute used to take the lead in programming research, it is now increasingly becoming a partner in programming research together with heritage organizations and other partners. In the UK, reduced funding, disparate players, and a lack of political support have triggered a desire to align efforts, demonstrate value, and win recognition as a coherent field. The House of Lords sub-committee for Science and Technology's Science and Heritage report recommended the creation of a group to produce a National Heritage Science Strategy, to co-ordinate activity across the sector. A steering group of heritage scientists drawn from across the heritage sector was set up and in 2009 three reports were published which form the evidence base for this strategy (National Heritage Science Strategy Steering Group, 2010). Similarly, a number of other countries and

international networks have also drawn up heritage science strategies or research agendas. In preparation for the ICCROM Forum, a review was commissioned of such strategy documents, which covered eight national and three European documents (Ottens, 2013). In this report, it is interesting to observe that France, Spain, the USA, and Japan all have a strong focus on materials and their decay, aiming for interdisciplinarity; meanwhile the UK, the Netherlands, Australia, and New Zealand already focus more on heritage in society and are crossing boundaries, with an ambition to move towards transdisciplinary heritage science.

Opportunities and threats

Science organized in networks offers enormous opportunities for heritage science, benefitting society in the end. However, the question surrounding this type of organizational structure is whether dynamic and temporary networks are solid and persistent enough to consolidate knowledge and keep it available and applicable for the field. The networks need to prove they can avoid knowledge fragmentation when connections break and new ones are formed over time. Knowledge should not disappear once funding dries up. Somehow there needs to be a continuing critical mass in which knowledge comes together, is kept, and is further generated. The National Heritage Science Forum in the UK is an example of a semi-permanent structure that could fulfil this task. Alternatively in countries with national heritage organizations they may have to act as repositories, connectors, and relays of knowledge. They can form the nodes for the application of generated scientific knowledge in conservation practice and policymaking, for dissemination of knowledge, and to connect national and international heritage science initiatives. These institutions will need to be actively involved in drawing up national heritage science strategies, as facilitators, policy makers, and inspirers. This represents a new role, in line with governments' visions and society's demands, working within networks in which sharing is the new having. Yet, this is only possible if one has something to share. Accordingly, there needs to remain a basis and a critical mass in these institutions, if they are to continue as attractive network partners.

So how can science connect with conservation?

In the middle of all these changes, the heritage profession will need to create a new, enriched, more holistic approach. Conservation science may have successfully crossed disciplinary borders between the natural sciences, (art) history, and conservation. However, the societal changes that we are facing now ask for a broader perspective, yet more crossing of new borders and combining efforts at a higher level of innovation. Digitization and the generation of large datasets, increased involvement of the public and engagement with society, globalization, and economization, use and repurposing of heritage require crossing the borders of social, economic, business, computer, and other sciences alike. The challenge for the near future will be to integrate these disciplines, include stakeholders, and rise beyond interdisciplinary to transdisciplinary heritage science.

Simultaneously, the way in which we do our work is transforming. More and more, both science and conservation take place in environments that can be typified as large-capacity networks. Problem holders, stakeholders and knowledge holders organize themselves in temporary and diffuse networks to create new and innovative knowledge and solutions together. Creating sustainable heritage science networks requires not only dedication at champion level but at a whole level of scientists, conservators, and others who perform their work with a prime dedication to heritage be that in heritage organizations or semi-permanent structures such as fora. Only then can knowledge generated by enthusiastic scientists who see heritage as an opportunity for application of their own prime passion, be consolidated and continued. The future 'conservation scientists' will no longer be scientists who solely conduct research in support of conservation. They may still remain a main driver in support of conservation, but in the bigger picture of heritage science, will need to recognize their position as reliable and stable nodes within dynamic networks of players with diverse interests. To function effectively at those nodes scientific expertise will need to be complemented by people skills. They will have to adapt from scientist to knowledge manager, from reactive problem solver to proactive horizon scanner, and become an interpreter of material evidence in a social environment. Will they then have become 'heritage scientists'? Probably not. Perhaps heritage science is too broad for a single person. Indeed, it may only exist in a network where many minds come together, including scientists, conservators, and conservation scientists. This will be 'how' science and conservation can connect and contribute to the societal benefits from heritage. And those networks will need strategies to organize, direct, and fund themselves.

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Position paper

Shifting the focus to people: Global societal priorities and the contribution made by conservation science

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During the ICCROM Forum on Conservation Science in 2013, one of the main themes discussed was the ability for conservation science to contribute to global societal priorities. Today's world is in many ways globalized. Human actions have an impact at local as well as global level. Information travels fast, more or less in real time. To set up a framework for international interactions and cooperation, the majority of the recognized nations have joined the United Nations and signed the Universal Declaration on Human Rights. Global societal priorities are various and wide-ranging. This paper deals primarily with those that are referred to under the UN Millennium Development Goals and the term Sustainable Development. The first aims to fight extreme poverty, raise education levels, achieve gender equality, combat diseases, etc. The second deals with the interconnecting systems of social, economic, and environmental sustainability. A core aspect in the discussion is that culture and cultural heritage is integrated in all human activities, yet is diverse because culture holds various values, meanings, and functions for different groups in society. Cultural heritage is a powerful tool to reach and interact with people. It can be used for good and for ill. For conservation science as a discipline to take its professional responsibility seriously, it should contribute to the multi-, inter-, and transdisciplinary environment of conservation, and enhance its benefits for society. Through advanced research it can provide historical perspectives and raise awareness of traditional methods, transforming it into 'easily accessible' knowledge. It can also contribute by providing facts and information that can open up different narratives based on the same cultural historical *realia*. Examples of how that can be done are given under the headings: social, economic, and environmental sustainability. Finally, addressing the global conservation community, the following three areas are recommended for future development: the need for process managers and facilitators; the need for active participation in the global sustainability challenges, and the need for inspirational role models and case studies.

Keywords: Conservation science and society, Sustainable development, Sustainability, Societal priorities, Transdisciplinary approach, Participatory conservation science

Introduction

In 2011, the General Assembly of ICCROM (the International Centre for the Study of the Preservation and Restoration of Cultural Property) decided to set up a Forum to gather information and reflect upon the current state of conservation science and its capacity to serve the present and future needs of cultural heritage and by implication, heritage conservation. It was proposed that the meeting would consider all types of science, including the humanities and social sciences. The focus of the Forum was to scan the horizon and to revitalize the discussion on how to respond to current trends in cultural heritage studies as well as political and social priorities on a global level. The objectives of the Forum were outlined in terms of: building capacity, enhancing dissemination pathways, and promoting collaborative efforts in order to achieve better and more useful research outcomes for the field as a whole (ICCROM, 2012).

This paper summarizes the concluding discussion of the Forum and gives recommendations originating from the key question: 'How can conservation science connect with and contribute to world societal priorities?' The discussion followed two days of intense participation in several roundtable discussions

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and inspiring keynote lectures at the Forum on Conservation Science (ICCROM, 2013).

Global societal priorities

For over 60 years, countries of the world have been gathered together within the United Nations (UN), to discuss shared problems and create shared values. Through the UN, the international community has taken the initiative to work together to tackle important global issues. The Universal Declaration of Human Rights (UDHR) is the foundation on which these activities rest (United Nations, 1948).

In 2000, the majority of the UN's member states signed the Millennium Development Goals (MDGs) with the aim of dealing with specific social problems at global level (United Nations, 2000). The MDGs aim to eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower women, reduce child mortality, and improve maternal health. They also aim to combat diseases such as HIV/AIDS and malaria, ensure environmental sustainability, and to promote global partnership for development through measures such as fair trade, affordable medicines and by encouraging technology transfer. This is a 15-year programme due to end in 2015 (United Nations, 2000).

Although the challenge is overwhelming, the UN has already stated that significant progress has been made. To build on the momentum generated, steps to formulate a post-2015 sustainable development agenda are being taken. The UN together with civil society and other partners is working on a programme for the next 15 years: 'We can end poverty. Millennium Development Goals and beyond 2015'. The programme is expected to be launched in September 2015 (United Nations, 2014).

Many of the activities intended to address global societal challenges are now gathered together and referred to under the commonly used term 'sustainable development'. While origins and definitions of this term vary, it was most broadly introduced by the Brundtland report of 1987 (World Commission on Environment and Development, 1987) which also gives by far the best known and most often quoted definition of sustainable development as being development that

> '…meets the needs of the present without compromising the ability of future generations to meet their own needs.' (World Commission on Environment and Development, 1987, p. 41)

The objective of the Brundtland report (World Commission on Environment and Development, 1987) was to raise the importance of environmental issues on the political agenda and to discuss these together with development, as one overarching and interconnected issue. Accordingly, it considered three interacting perspectives on sustainability – social, economic, and environmental – with the view that effective and sustainable solutions to combat environmental issues also require action to similarly reduce negative impacts on human development. In relation to this, it is important to recognize that cultural and cultural heritage issues cut right across all three perspectives.

Cultural heritage: a powerful tool

Cultural heritage, archival sources, and other cultural expressions hold various values, meanings, and functions depending on when, how, and by whom they are interpreted.

Participation in a certain culture gives individuals and communities identity and stability. Cultural expressions and customs vary throughout the world at both micro and macro levels. In the document *Our Creative Diversity*, the authors choose to view culture as 'ways of living together' (UNESCO, 1996). The UDHR provides an important set of values for international respect. As heritage conservation professionals, we are obliged to attempt to understand both the historical and contemporary cultural expressions as parts of cultural heritage. On an individual level, this is sometimes complicated when dealing with human behaviour that is in conflict with the UDHR. An illustrative example is the tradition of villeinage and of keeping slaves which was common through history for most cultures. In *Our Creative Diversity*, development is defined and summarized as a process of enlarging people's choices, which includes the fostering of respect for all cultures, and the principles of cultural freedom.

Cultural heritage manifests itself through interpretations and narratives both written and oral. Narrative content is often confirmed using references to physical relics and there may be several parallel narratives. 'Owning' the narrative – giving precedence to one interpretation – is often used as an instrument of power. A common device used throughout history has been for the ruling power to write its own history in order to cement their right to exercise influence over other people. This has also resulted in the tactic of destroying their opponents' and competing groups' cultural heritage.

To break through reductive and censoring use of cultural heritage, contemporary theories of conservation are built on a democratic principle of negotiation between communities, groups, individuals, and other interests. The idea that a selection of representative cultural heritage is meaningful for everyone and that the role of heritage experts is to decide by themselves which cultural remains are worthy of preservation is

no longer seen as a relevant (Muñoz-Viñas, 2005; Australia ICOMOS Burra Charter, 2013).

When discussing global societal priorities, it is important to be aware of the significance of culture and cultural heritage to individuals and systems of power. By reflecting on the aims of, and actively working on, projects that support the good intentions that the nations of the world under the auspices of the UN have agreed, conservation science can contribute to efforts to level out social inequalities and demonstrate how people's individual range of choices can be expanded.

Global responsibility of science

At the Forum on Conservation Science, there was acceptance of the desire to understand global societal priorities and for the cultural heritage sector to step forward and take an active role in any way it can. To underline this responsibility, Article 27, Paragraph 1 of the UDHR was brought forward: 'Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits' (United Nations, 1948).

All scientists are thereby obliged to share their knowledge. In order to share its knowledge, conservation science needs to facilitate communication, connectivity, interaction, and understanding between conservation scientists and other stakeholders.

At the same time, it can be shown that the collective ability of different research areas to work together by multi-, inter- and, transdisciplinary means in order to solve common problems is rarely practiced. The natural sciences, social sciences, and the arts and humanities each have their own specific research traditions, vocabularies and methods. It is possible, perhaps even probable, that there are changes ahead of us that will see the discovery of new models of methodology because the problems humanity is currently faced with contain such complexity.

Heritage conservation is an applied discipline in which the natural, social, and formal sciences all play a part. It is by its nature multidisciplinary, and is often conducted by practitioners and skill-centred specialists independently working on the same problem. Among them we find conservation scientists who have the responsibility to support conservation practice and respond to the needs of society. To fulfil such a mission, a transdisciplinary holistic approach has to be adopted. This is based on inclusion of stakeholders in defining research objectives and strategies. Conservation science can thereby easily adapt to new approaches to science that open it up to transdisciplinary initiatives, collective design, and the collective production of knowledge.

Conservation science's contribution to global societal priorities

The responsibility of dealing with global societal challenges rests on us all, from the international community and individual countries, business, and organizations, all the way down to individuals. This also means that there needs to be active engagement in the global discussion at all levels. It may be regarded as naive to think that conservation science can contribute to solving global problems, but, from the perspective of the significance of many small initiatives, conservation science should, and must, actively contribute to this work in any way it can. A key starting point for those working in conservation is that cultural heritage plays a large role in people's identity and narratives. We must always be aware of the fact that this can be used for both good and ill. Cultural heritage can both unite and divide. However, the really crucial challenge is how this desire to contribute can be turned into action.

Together with other professions, conservation science can contribute by providing historical perspectives and, above all, by acting as a link to transfer scientific knowledge to professionals and stakeholders. Conservation practice needs to be further explored and enhanced using scientific support, and the applicability, use and benefits of scientific knowledge need to be demonstrated. Another important role is that of highlighting, from an impartial scientific perspective, facts that support or overturn different interpretations of cultural heritage.

To provide inspiration, some examples which demonstrate how conservation science can contribute are given in the section below. For the purposes of this discussion, they have been organized according to the three pillars of sustainability – social, economic, and environmental. However, it should be borne in mind that as culture is an integrated part of all human activities, it is difficult to compartmentalize cultural issues in precisely this way as they naturally extend across all of these perspectives.

These and many more, innovative and easily implemented initiatives can be discovered through adopting a transdisciplinary scientific approach which treats cultural heritage as a resource that has not only to be communicated, but also understood and embraced by society in order to support efforts to address global societal challenges.

Social sustainability

The global challenges of social sustainability affect communities and individuals' well-being and identity. Knowledge of history improves access to cultural heritage and increases our enjoyment of it by delivering an intellectual and emotional experience through the

sharing of deeper knowledge about our common history and multicultural world.

One of the greatest challenges for social sustainability is the work towards a world of mutual understanding, free from armed conflict and which supports the principles of dignity, equality, and mutual respect. Material cultural heritage often holds the keys to narratives that are of great significance in these processes. This can be of importance in healing processes following traumatic experiences such as natural disasters and after instable situations where different groups have threatened each other.

Cultural heritage has been targeted in conflicts for millennia, and this continues today. Conservation is a necessary aspect of the recovery process following armed conflicts, terror attacks, and riots. From the time it was set up, ICCROM with its global and politically neutral platform has worked in this area. These are extremely delicate and sensitive situations, and it is important to continue along this path of taking care of experience, building capacity, and working proactively (ICCROM, 2014).

Material cultural heritage can be used as a lever to facilitate social inclusion by breaking through complicated historical and sociological structures. Material cultural heritage and its narrative immaterial content might be of common interest to closed groups with a marginalized position in society and the mainstream community. Through dialogue and understanding of different, as well as common, stories, and perspectives, platforms for confidence and negotiation can be built. This dialogue-based method can successfully be used to bring awareness of different and common needs for different co-existing minority groups in society (Gustafsson, 2003).

Education and the long-term rearing of new generations of researchers in all disciplines is a factor in the success of the work relating to the global agenda for future sustainability. Cultural heritage and its enigmas and mysteries that can be solved through scientific investigations have a huge capacity to attract future young scientists into a career in research and development. Moreover, aspects of conservation science can be promoted as an interdisciplinary approach in education programmes.

Economic sustainability

The global challenges of economic sustainability are huge. In a just world everyone would have food, housing, and dignity. However, existing resources are finite and will have to suffice. The implication is that if this is to be achieved, we must all find sustainable systems.

Most current economic theories are based on the consumption of new products. At the same time, there is a growing understanding that natural resources are limited. This opens the way for a trend of conservation and reuse of both historic and contemporary objects and constructions. The conservation community has to take a lead in building capacity and training future generations to regain the knowledge of how to take care of and reuse the limited resources of the globe.

Cultural heritage knowledge can support this work by providing important historical knowledge. It is possible that perspectives on the traditional use of local materials, techniques, and economic systems for construction and the increased maintenance of existing buildings, for example, can reduce the pressure on local and global resources.

Old and new methods of producing energy and governing its use are one area to be further developed. The traditional use of wind power for mechanical devices and transport are well known and can be revitalized and used in contemporary society. Traditional methods of cooling interiors can be investigated and new low-cost photovoltaic cell technologies tested. The effects can be analysed by research projects, and the use of good examples encouraged through legislative instruments. The role of conservation science is to test knowledge from other scientific fields through research, so that it can be used in conservation. This spreads knowledge to a wider audience and gives it a new status.

Cultural heritage currently provides a livelihood for many people in the tourism industry, and heritage attractions often drive tourism. The significance of tourism is well-known and examined in, for example, work relating to the World Heritage Convention. In many cases, new and previously unknown narratives can be told about objects and places thanks to conservation science. However, cultural heritage attractions have to be looked after. This requires continuous maintenance and occasional conservation measures.

Environmental sustainability

The global environmental challenges are extensive and models indicating the expected development are many and uncertain. Changes to environmental systems will have immediate and marked consequences on the conditions needed to reach basic needs for living conditions for mankind.

Conservation science can contribute with information that demonstrates change, but also shows how humans have always been at the mercy of environmental changes and indicate positive examples of adaptation to new conditions. Written sources contain eyewitness accounts of natural disasters that occurred a long time ago. Meanwhile, archaeological and historical data can provide confirmation that these and other events actually took place.

Meteorology provides information based on everyday observations accumulated over centuries. By combining data from several sources, observations about environmental change can be analysed. The results allow emerging threats to cultural heritage to be detected and mitigated.

For example, Cultural heritage objects such as natural history specimens contain historical references showing the level of toxic substances in organisms that lived several hundred years ago. This data can be compared with samples from contemporary organisms. This was one of the methods used to demonstrate the accumulation of the pesticide DDT in the food chain.

The use of cultural heritage as indicators in long-term monitoring and data collection for scientific use can be increased and improved.

These examples show how historical facts and evidence can help to understand the present and to mitigate change. But, more important is the need to meet threats like global warming and to prevent an even more rapid change in our environment. The demand for energy and at the same time the need to reduce CO_2 levels is a priority on the international agenda. Energy efficiency is one pathway and again it is possible to learn from traditional building techniques involving passive houses and natural ventilation instead of high-tech solutions dependent on electricity. An example is when constructing permanent storage for collections.

Another evolving threat is the availability of fresh water. Water is necessary for all living organisms, and is a resource that needs to be handled efficiently. This is another important field where we need to regain traditional, and even lost, knowledge on irrigation, and combine it with the latest low-energy techniques.

Recommendations

The initiative to set up a Forum and discuss the relevance and future agenda of conservation science and its relation to cultural heritage studies is of significant importance. At the end of the 1950s, ICCROM was set up to provide training, information, research, cooperation, and advocacy in the field of cultural heritage conservation. ICCROM has succeeded in its mission and is a respected organization with influence on the global agenda for conservation. The Forum thereby wanted to address the following recommendations to ICCROM and all of its member states on how to meet and contribute to the global societal priorities in the future.

The need for process managers and facilitators

Cultural heritage can be used as a tool to help solve global societal challenges. There are currently many researchers, among them conservation scientists, who can contribute their knowledge towards this. The results can be harvested and refined and used in new applications. What is currently lacking are well-educated leaders with a broad knowledge of science, the humanities, social studies, and diplomacy who can cultivate an interdisciplinary approach. Their task will be to understand contemporary global political priorities and provide mechanisms for the development of inter- and transdisciplinary projects as part of relevant programmes established through the UN.

In this context, ICCROM, together with competent leaders, has forged a distinct role when it comes to certain aspects of the preservation of cultural heritage, in order to show how this can be used to achieve shared global goals and facilitate contacts between cultural heritage organizations all over the world.

The need for active participation in the global sustainability challenges

Cultural heritage can be both a help and a hindrance to bringing about the changes the world needs to make on a global level to cope with sustainability challenges. Our habitual ways of doing things, our ideals and attitudes can be changed. For example, the consumption patterns of developed nations in no way constitute a good example from a sustainability perspective. This can be contrasted with alternative ideals in which knowledge of the care and preservation of the objects around us are emphasized. It is important to dare to think innovatively; for example, to take active part in the development of the millennium goals beyond 2015, by contacting new collaborative partners such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) to introduce aspects of cultural heritage knowledge and processes as a tool to help achieve global goals.

ICCROM can be the partner that represents the perspective of cultural heritage conservation and conservation science. It can also conduct horizon scanning, analyses of trends and provide indicators in such development work.

The need for inspirational role models and case studies

Cultural heritage provides perspectives that stretch back over long periods of time and stimulate our thoughts about the future. Cultural heritage encapsulates narratives about people and societies. Successful case studies from around the world need to be made accessible to highlight the potential of cultural heritage and provide inspiration for future projects. Especially the mutual benefit from an extended cooperation with UNESCO needs to be explored. Aspects on conservation can be promoted in many existing programmes such as UNESCO's Education for Sustainable Development programme

(UNESCO, n.d. a), Local and Indigenous Knowledge Systems (LINKS) (UNESCO, n.d. b) or projects like Empowerment of Rural Women in Jordan through Heritage Conservation for Sustainable Development by UN Women and many more (UNESCO, 2014).

ICCROM can take on the role of an international clearinghouse to highlight innovative projects and initiate development of theoretical frameworks and methods for their performance.

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Position paper

How can we build an impactful future for science in conservation? Essential next steps

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This paper presents the outcomes of reflection and debate within the ICCROM Forum (2013) which explored how to build an impactful future for science in conservation. It sets out a number of recommendations to support a vibrant heritage science community with an impactful future. Key recommendations include: adopting the term heritage science as this reflects the growing use of the term in domains not exclusively conservation-focussed, positioning ICCROM as a leader in setting a vision for the heritage science community which would grow capacity, and support a high standard of academic research to underpin an impactful future for this growing discipline.

Keywords: Heritage science, Heritage science impact, Heritage science vision, Citizen science, Communicating value, Measuring benefit, ICCROM

Introduction

Heritage science applies scientific, engineering, and technology research to advance the understanding, the interpretation, conservation, authentication, and management of cultural heritage — both moveable and built. It is by definition cross-disciplinary, drawing from science in the broadest sense, as well as arts and humanities disciplines. Conservation science research, technical history research, and other areas of research including areas of digital and big data studies focussed on cultural heritage fit neatly within a larger frame of heritage science, which includes science that is not exclusively conservation-focussed. The term 'heritage science' is used in the UK and is being adopted internationally, for example by institutions such as the CNR, Italy, and the Library of Congress and the Museum Conservation Institute of the Smithsonian Institution, USA. At its best heritage science brings together expertise drawn from a range of disciplines, including both generators and end-users of research.

Heritage science does not happen in one place. Placing heritage — and arts and humanities (rather than conservation exclusively) questions centrally, we not only open up the possibilities of engaging research, higher education and cultural heritage institutions, but we also have the possibilities of engaging a wider range of participants, across geographies, as citizen scientists, or simply engaging the public more generally in the debates surrounding their local cultural heritage.

For these reasons, the term heritage science rather than conservation science is used here. The aim of this paper is to present the thinking and exchanges that took place within the group that discussed *How to build an impactful future for science in conservation*? at the ICCROM Forum (2013), and the key recommendations given by this group for future development.

To realise a more impactful future, three areas of focus were agreed:

- to establish a clear vision for building an impactful future that can sit comfortably within local, national, or international contexts;
- building heritage science research capacity;
- communicating the value of heritage science research.

A vision for heritage science

To grow a more impactful heritage science community, it is recommended that ICCROM takes a leading role in setting a vision for growing heritage science research globally

Given its global position, independence, and extended international networks, ICCROM is well placed, in collaboration with consortium partners, to take a lead in building a heritage science research community internationally. Defining a compelling vision, one that is ambitious, timely and achievable is an important first step. Such a vision should reflect that heritage science takes place locally, regionally and globally,

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and therefore sits within wider cultural frameworks. Such a vision should make explicit the potential for collaborating with partners internationally, to achieve the ultimate aim of realising an impactful future. Emphasis should be placed on demonstrating how the outcomes and relevance of heritage science can inform policies at all levels, as well as supporting practitioner needs.

Build capacity locally, nationally, internationally

Building capacity was considered imperative, and should extend beyond academia where possible. Encouraging active engagement between researchers and the public is an exciting way of demonstrating the benefits of heritage science research. Engaging the public in this way can build local support for heritage projects; it can bring economic benefit to local communities, and can be a means of encouraging long-term community participation.

How to build a heritage science community was considered in some detail. The development and publication of national heritage science research strategies was considered essential because the process of defining and publishing such strategies has shown to be a significant catalyst for galvanising support, for growing networks, and demonstrating the need for heritage science research to funders.

The *National Heritage Science Research Strategy* (available on The National Heritage Science Forum (NHSF) website www.heritagescienceforum.org.uk) published by the UK was a significant achievement and has been shown to be an important mechanism for growing and coalescing the heritage science community in the UK. Since its publication in 2010, the UK has established the NHSF a charity that brings together heritage scientists who carry out research, and practitioners in the arts, humanities, and sciences who apply research results to their own work. Member organisations include universities, heritage organisations, and professional bodies. Bringing the community together in this way enables the heritage science community to speak with one voice to government and to strategic and funding bodies, to influence policy and strengthen the position of heritage science nationally and internationally. Importantly, the forum will also lead the delivery of the National Heritage Research Strategy.

In addition to encouraging the drafting and publication of national research strategies, understanding and mapping end-users needs against available resources was also recommended. Identifying the broad spectrum of end-users of heritage science research within local contexts and understanding their interests is an important first step and an example of how the long-term goal of achieving a more impactful future can be realised through closer collaboration between generators and end-users of research.

Building capacity can be achieved through heritage citizen scientist programmes, where committed professionals working as volunteers can support heritage science projects that would not otherwise be possible without this resource. Trained volunteers, for example, have been used to mine large data sets with the view to making available to researchers much needed data to monitor changes within cultural heritage collections over time. Citizen heritage scientists have an important role to play in making this happen.

Developing a community of heritage science advocates could realise a huge resource. Conservative estimates suggest that there are some 5000 students internationally, enrolled in conservation courses on an annual basis. Just think of the potential this discrete group of committed professionals has in supporting heritage science research, disseminating the outcomes of their work to new audiences, while building a support base long term. Social media offer opportunities to engage audiences in heritage science projects and to connect more communities internationally.

Understanding the benefits of heritage science is a key if its value and impact is to be realised long term. Promoting resource and equipment sharing among institutions, and extending resources, for example skills and equipment, to organisations that would not have access to facilities enhances the impact of publicly funded research, and is effective in building capacity.

Communication and realising the impact of heritage science research

Communication and exploiting opportunities to promote heritage science through existing platforms, such as conferences and meetings, public engagement events, debates, or networking events could usefully be promoted by ICCROM in collaboration with other professional conservation bodies and the NHSF. If heritage science is to grow and be recognised beyond academia it needs to demonstrate the value of heritage science to policy makers, funding bodies, and the public in metrics and languages that have resonance with these audiences. How to measure the value and define the metrics for measuring economic, social, and political value, has been subject to some study, and will vary internationally. Regardless of how we 'sell' the benefits of heritage science research, the stories are rich, varied, and compelling.

There is a strong public appetite for learning more about cultural heritage. The work of heritage scientists, similar to that of forensic scientists, has already captured television audiences by revealing traces of the object's biography. Other steps toward a more impactful future could include:

- Promoting the richness of cross-disciplinary offer and cross pollination with other sciences and humanities. Promote valorisation of research to encourage research projects to deliver greater benefit for heritage and society, and thereby achieve higher impact.
- Quantification of research outputs and analysis to demonstrate the economic and social benefits of heritage science research is essential. It is important to move perceptions of heritage science beyond the too-often narrow scope of characterising cultural heritage materials to one that enriches the cultural experience and embraces a wider, impactful, domain.

Think the unthinkable

Heritage science is a growing international discipline supported by many outstanding centres of research globally. These centres could act as hubs for future development to extend the reach and to connect this fragmented community. ICCROM could usefully position itself as a facilitator and pollinator of research and ideas working with heritage science centres internationally to build heritage science locally, and in a way that meets local needs. These hubs could be beacons for local communities.

Heritage science has the potential to inform complex social problems, including climate adaptation strategies, moving beyond the understanding the value of cultural heritage to communities, to health and well-being, or the contribution to national economies, for example. Why not challenge existing centres of heritage science research to collaborate internationally and contribute to addressing social and economic challenges? Leveraging the value of heritage science globally would instantly bring the attention we need to our domain, and create the most impactful future.

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Position paper

Tools for assessing needs and impacts

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The results of the ICCROM Forum 2013 on Conservation Science working group on *Tools for assessing needs and impacts* is presented. It is used as a starting point for a fundamental study of tools in general, tangible and intangible. The phenomenon of scientists and their organizations becoming defined by their tools, and unable to change when the needs of those they serve change, was noted by Kaplan in 1964. Part of the mechanism is the human tendency to solve any disagreement between new facts (like client needs) and old beliefs (such as the importance of one's toolset) by twisting the facts rather than the beliefs. Collins' proposal of three kinds of tacit knowledge, with collective tacit knowledge as the most difficult to make explicit, can explain common problems of interpretation and communication of assessments, and guide strategies for reliable tools. Kaufmann's ideas on the structuring of needs assessment by levels, and the distinction between macro outputs and mega outcomes, is combined with Maslow's five basic human needs, as well as the three pillars of sustainability, to produce an overall map of where needs assessment tools operate, and where conservation science organizations fit into this structure.

Keywords: Needs assessment, Tools, Tacit knowledge, Conservation science, ICCROM

Introduction

There are two parts to this paper – firstly, a summary of the deliberations by the working group assigned to this topic during the ICCROM Conservation Science Forum (2013), and secondly, the chair's further thoughts and research on the topic. These working groups and topics were assigned after two full days of other structured discussions during the forum. Topics such as this one were based on themes that had emerged in the earlier discussions. As with all time-limited group work, our results that day were a little cryptic and a little fragmented, but they were, most importantly, representative of our field, and a good place to begin more solitary ruminations.

The results of the working group

Our group created a structured list of bullet points for presentation to the forum at the end of the day. Rather than subsume that raw material into polished text, it is presented here as 'exhibit A', important for its mix of individual and shared phrases.

What tools?

- Tools for assessing needs and impacts (and management strategies)

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Why are tools important?

- To get things done that meet our goals.
- To increase our efficiency, our effectiveness.
- To link beyond preservation issues to social and environmental needs and impact.

Recommended design principles for tools

Criteria to assess tools

- What costs to operate? (expertise x time)
- Is it accurate? (depends on algorithms, raw data)
- What communication effectiveness?
- Are results comparable, i.e., is there a sufficiently large group of users to share and compare results usefully?
- Is it integrated with macro/micro tools? Does it consider inter-sectorial integration (in terms of government sectors)?

Identify target groups for tools

1. Managers
2. Students (who can also contribute research)
3. Conservators
4. Scientists

Other design criteria

- Learn from other fields, their successes (and failures!)
- Make tools not only for analysis but also for communication.
- Make tools for intangible and tangible heritage.
- Include inter-sectorial clients and public in the early design phase of tools when necessary.

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Examples of tools and new building blocks

- Provide infrastructure for archived data sharing, i.e., museum data, research data.
- Use community 'polling'.
- Make tools for specific risk analysis (e.g., a scenario tool).
- Use mass communication technology.
- Use global satellite data.
- Provide needs and impact measuring tools for decision makers before they develop their own for us, i.e., be proactive in meeting the needs of decision makers!

Post-forum research

A working group of exceptional professionals tends to be both exhilarating and frustrating. As assigned chair of this working group and subsequently author of this paper, I will admit that I have worked my whole career on tools, most directed at assessing needs in terms of risk reduction in museums. Much of our working group's discussion felt familiar, and many previous readings came to mind. This article was an opportunity to build a fundamental understanding of tools in general, and to see how this could guide the discussion of needs assessment tools in particular. In the process, one will recognize many elements of our group's thoughts (Figure 1).

The need for professional tools is well known, so perhaps we are discontented

'Tool

1. A device or implement, especially one held in the hand, used to carry out a particular function.
   1.1 A thing used to help perform a job.

Example sentences:

Computers are an essential tool.

The ability to write clearly is a tool of the trade.

Models and monitored performance are essential management tools.

As with any occupation, professionals need the right tools to perform their jobs effectively' (Oxford Dictionaries, 2015).

It was both disheartening and reassuring to find the above definition in the dictionary. There it was – 'to help perform a job' – a concise and simple phrase that captured, undeniably, much of our deliberations on why tools are important. And up popped a string of example sentences that replicated much of our hard-won content – monitored performance as essential to management, need for communication tools, use of models as tools, and the fact that all professions, not just ours, need the 'right tools' to perform effectively.

Of course, the group did assemble other specific details relevant to our field, but in hindsight I think that the important discovery of the forum was not explicit but implicit – after so much effort to organize the collective wisdom of our field we seemed to have ended up simply identifying phrases that were already in the dictionary. Bear in mind that the task of our group – tools for assessing needs and impacts – was the distillation of two full days of forum working groups, and that these working groups had addressed topics designed by representatives of the consortium working months before over the course of two days. I believe that the emergence of our working group's topic as a recurring theme must be more than just recognition that such tools are necessary, which the dictionary notes is universal to all professions. It is a recurring theme because we are frustrated or discontented with the tools that we have, or more likely, that we do not have.

Since tools are extensions of the self, we become discontented with ourselves

'Artificial prostheses include of course tools, but also writing, as an external memory, can be considered a prosthetic extension. Thus, culture is by definition of the order of prosthetic extensions – a human stripped from everything prosthetic-like is a human stripped from culture' (De Preester & Tsakiris, 2009).

Tangible tools become extensions of our tangible 'self'. Intangible tools become extensions of our intangible 'self'. Although using the word tools in this sense might be considered only metaphorical, for a social and thinking animal these extensions of the mind – intangible tools – must be recognized as just as real and probably just as ancient as sticks and stones.

If we are discontented with our current 'tools' and if professional tools are extensions of our professional selves, then we are discontented with our professional 'selves', or more precisely with the relation of our professional selves to society.

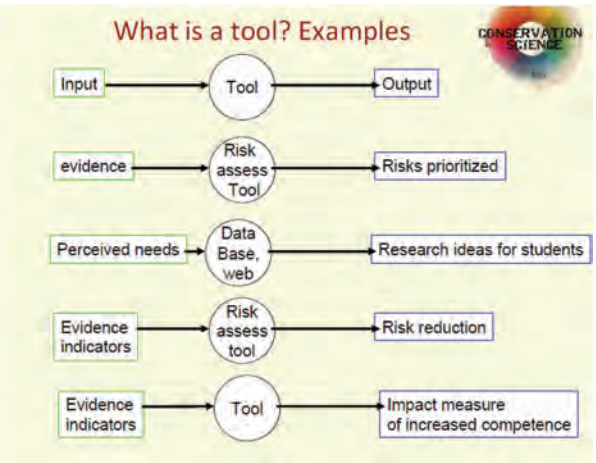

Figure 1 Examples of tools, developed and presented by the working group during the forum. © ICCROM 2013.

Tools bias what we think we can do

In notes from a preliminary brainstorm session for this forum, one participant wrote: 'The research direction and capacity of applied scientists and their institutions, are very difficult to change. To respond to change, an applied science must a) identify the current questions and b) answer them (and retool where necessary)'. One finds this to be a very common problem.

'I call it the law of the instrument, and it may be formulated as follows: Give a small boy a hammer, and he will find that everything he encounters needs pounding. It comes as no particular surprise to discover that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is especially skilled' (Kaplan, 1964).

For subsequent variations on this adage, such as the pithier 'To a man with a hammer, every problem is a nail' see http://quoteinvestigator.com/2014/05/08/hammer-nail/#note-8840-7.

'We shape our tools. And then our tools shape us' (Culkin, 1967).

'It's generally much easier to kill an organization than to change it substantially' (Kelly, n.d.).

I think we can all agree that a person who has developed great skills in the use of their tool, e.g., a violinist, a microscopist, is not just linked to their chosen tool, but defined by it. Our tools determine our sense of what we can do, and thus our sense of who we are. Similarly, a conservation science organization created with a particular set of experts and tools designed to meet the tasks assumed for a particular mandate will perceive itself in terms of that set of tools and expertise. When required to adapt to new tasks or even a new mandate, it may (for a time) avoid change rather than adapt. For a publicly funded organization, sticking to its old mandate when assigned a new one is bad enough, but perhaps even less justifiable is 'mandate drift', a situation where staff expertise and tools drift over time so task selection also drifts, thereby shaping a *de facto* (incorrect) mandate.

There are two parts to the mechanism behind Kaplan's 'law of the instrument'. The first part is just the unforgiving logic of availability, the second part is the way humans cope with this logic.

Availability has many poetic names – luck, fate, circumstance – but it is simply the fact that in the real world one can only use what is available, and what is available depends more on randomness than we ever want to admit. In decision-making theory, availability expands to become a principle called 'bounded rationalism' – the idea that rational decision-making is always imperfect because knowledge and time are always limited, i.e., bounded. What happens when it is very clear that we do not have the right tools at all?

Cognitive dissonance is a phrase from psychology that refers to the (unpleasant) state of mind that occurs when we take in new information that conflicts with a prior belief, e.g., a scientist (or an organization) accepts a project believing that they have the right tools, but it becomes increasingly apparent that they do not. Rationalization is the very human process of getting rid of any cognitive dissonance between new facts and old beliefs by modifying the facts rather than our beliefs, for example: my tools just need to be modified (the shoe almost fits); my tools are the best possible (denial that someone else has relevant tools); or, the task just is not important (trivializing the goal, and hence the conflict). It is not surprising that we have strong mechanisms to help us avoid feeling useless.

The difficulty of adaptation to changing needs by conservation science organizations is obviously not peculiar to us, but is it inevitable? Can it be fixed? There is a slew of management books on managing change, but it is only recently that some of the underlying phenomena have been studied, dare I say it, scientifically. Organizations trying to implement the single most important belief change that the world faces – that we are responsible for climate change and we better do something about it soon – have only recently studied the psychology of deniers (rather than just shaking their heads in frustration).

An important discovery has been the 'knowledge fallacy'. Experts had assumed that climate change denial can be overcome by piling up more scientific data, but studies have shown that the opposite is true: it makes denial more entrenched (Climate Outreach and Information Network, n.d.). Similar ideas had been emerging in studies of voting behaviour on many inflammatory topics. Our issues may be less important, but the mental mechanisms remain the same. One can understand the knowledge fallacy in terms of the current 'two part' model of our mind, work summarized well in Kahnemann's book *Thinking Fast Thinking Slow* (2011). We have two processors – one intuitive, fast to provide decisions, and most importantly, guardian of our beliefs, the other methodical, learned, but lazy, slow to provide decisions, and most important, only an advisor to our beliefs. The error of the knowledge fallacy is the hope that we can influence the deeply held beliefs of the fast intuitive part by piling up knowledge in the slow methodical part. Not so. But opinions, i.e., decisions on how to act, can be shifted, albeit slowly. Successful strategies discovered to date are not aimed at the slow logical part but at the fast intuitive part: one is 'framing', i.e., stating the decision, e.g., support for carbon footprint reduction, in terms of things that the denier values, such as job creation,

protection of wildlife, etc. The second strategy is 'trusted communicators', i.e., relaying the message through a leader from within the person's trusted affiliations. Of course, both strategies are more difficult to plan and implement than piling up facts, but they work better.

Conservation scientists and their management are human. If they rationalize that their skills and tools are relevant when clearly they are not, or if they rationalize that tasks suited to their skills and tools are important when clearly they are not, then we should not assume that piling up more facts such as might emerge from a good needs assessment will instantly lead to staff requests for retooling. Nor do we necessarily want a commercial model of the perfectly agile company – one with only project managers who hire and fire expertise on an *ad hoc* basis, since our field is much too small to maintain a stable pool of freelance experts. If we want the results of needs assessment tools to be implementable, we will need good framing of the new facts, and delivery by trusted individuals.

Tools that support reliability and therefore create trust

The primary function of a 'reliability tool' is to reduce errors, which in turn builds social trust in the profession. We as a society expect all professionals to exercise 'due diligence' – the competent use of the standard toolbox. I think game theory (balancing 'hits' and 'misses') can refine the issue further – professionals understand that the benefit of many good results ('hits') is often smaller than the cost of just one error (a 'miss'). Economists have also found that when making financial decisions about money already in hand, people tend to put more importance on avoiding losses than on creating gains (Kahneman, 2011) I think that in preservation this tendency is greatly magnified because we are not dealing with a replaceable commodity like money, but in things called 'irreplaceable', 'universal heritage' etc. Our anticipated loss of 'face' if something goes wrong with irreplaceable things is much stronger than the anticipated pride in a successful intervention. For example, the 10% chance that a stone treatment might accelerate erosion may outweigh the 90% chance that it will reduce erosion. Hence the recent tendency to favour 'minimal intervention' or even benign neglect. This phenomenon makes reliability tools of particular importance to our field, and if we are discontented with our current toolset, perhaps it is the lack of reliability tools in particular.

If needs assessment tools end up changing the direction of rare organizations such as ours, then the communities we serve will want them to be highly reliable too, which means they will have to buy in to the design of the tool as well as its implementation.

Tools depend on our collective tacit knowledge

'The calculator can only work as a *social prosthesis*, the deficiencies of which are made up for and repaired by the surrounding social organism … the human is repairing the deficiencies of the calculator by fitting its output in with social expectations' (Collins, 2010, p. 71).

Collins' book *Tacit and Explicit Knowledge* (2010) is a partitioning of three very different kinds of tacit knowledge which he calls relational, somatic, and collective. 'Relational' tacit knowledge can, in principle, be made explicit for all, but in practice it is distributed according to the relationships between groups, such as crafts, professions, or aptitudes. For example, it includes everything an experienced conservator could communicate to a neophyte about what they do, if they had the time, the self-awareness, the communication skills, and the inclination to reveal hard-earned trade secrets. 'Somatic' tacit knowledge rests in the body, and includes what a conservator or a scientist acquires when they become skilled in handling tangible tools. It can be communicated with medium difficulty, more by showing than talking, and is created in the individual primarily through practice. In the past, somatic tacit knowledge has been considered the mysterious core of tacit knowledge, anchored by the archetypal example of riding a bicycle, but Collins considers this to be a serious error. The inner core of tacit knowledge, the most difficult to extract and make explicit, is 'collective' tacit knowledge. It is, in Collins' words, 'located in society' (Collins, 2010, p. 85). Collective tacit knowledge can only be understood by accepting that the 'self' is more than just an individual body and individual mind. The self is something that knows how to 'act in concert with what other humans are doing, as a result of our mutual participation in the larger organism of society' (Collins, 2010, p. 165). One could use the drier terminology of complexity theory and say that whereas relational and somatic tacit knowledge can be meaningfully analyzed in terms of a single individual, collective tacit knowledge cannot. It is an emergent property of many individuals interacting with each other to form a collective.

Tangible tools – a hammer, a scalpel, a violin – are easy to fit into Collin's knowledge schema. They are tools reliant on tacit somatic knowledge, i.e., our physical selves. Of course, explicit knowledge helps but we all understand that a 'skilful' conservator or microscopist can 'do the job better' than someone who has no such skill but greater 'theoretical' knowledge. When we use 'theoretical' in this often disparaging sense, in Collin's terms we simply mean that the person has

more explicit knowledge but less somatic tacit knowledge than the skilled person. (We probably also mean that they lack social graces, i.e., collective tacit knowledge.)

Collin's purpose is to explain the misconception that tools, even the most elaborate, can 'do' what we say they do when we talk about them informally. For example, a calculator does not 'do' the calculation of the bill in a restaurant, what it does is take your inputs and choice of operations and applies the explicit logic coded into it by its maker, then shows the result. You supply not only the explicit knowledge such as the cost of each dish, but collective tacit knowledge such as whether to divide the bill equally or by individual items, and whether to assume a uniform tip or not (which can easily become a source of friction due to individual differences in collective tacit knowledge!). The calculator has a very powerful but very limited and precise function: rapid and reliable computation. The kind of tools discussed during the forum were not tangible tools but intangible tools. Like intangible heritage, they still have a tangible interface (a manual, a computer) but their function is communication and transformation of knowledge (a set of instructions, a database). If a simple tangible tool such as a calculator cannot be useful without collective tacit knowledge, imagine how much worse the situation will become for an intangible management tool like those for needs and impact assessment.

In other words, when we face the inevitable disagreements that we blame loosely on 'interpretation', for example, what might the word 'access' mean when assessing 'improved access to the object', then Collins warns us that despite the best efforts at transforming all relational tacit knowledge denoted by the word access, there remains an irreducible body of collective tacit knowledge around 'access' that is never explicit, and will vary across individuals in a way we cannot know. It varies less within a small community, and more across diverse communities – and languages. In our own field, Taylor & Watkinson (2007) have studied this issue in terms of collection survey judgements, and methods for measuring and reducing this variability (a reliability tool for the survey tool!).

Four paradigms (types of tool) in the history of scientific knowledge

'We now have terrible data management tools for most of the science disciplines. Commercial organizations like Walmart can afford to build their own data management software, but in science we do not have that luxury … When you go and look at what scientists are doing, day in and day out, in terms of data analysis, it is truly dreadful' (Gray, 2009).

Gray (2009) suggested four paradigms in the history of science. The first paradigm was organized observations, and the second was model building (using mathematics). Models are tools for prediction. Whereas a researcher builds models as a tool to explore theory, professionals want models as tools for reliable and accurate predictions of practical interest. Before computers, models were limited in complexity by the ability of one or two interested humans to calculate the equations in less than a few months. Such models only worked well for phenomena that were highly consistent and for which the controlling variables were all known. Those of us who have struggled to develop good damage 'functions' for the messy world of real materials in real environments, for example, usually find ourselves unable to derive the necessary mathematical functions, for the simple reason that they do not exist.

Information is organized by compiling explicit and relational tacit knowledge from experts. This knowledge is organized firstly at the level of sentences, tables, diagrams, and images, then secondly at the level of narratives or explanations, and thirdly at the level of thematic assemblies. Although as intellectuals or teachers we place the highest value on the highest level of organization, e.g., a thesis, a book, or an encyclopaedia, as day-to-day professionals we place more value on the lower levels, the individual building blocks of knowledge – *if we can find them*. In the past, one would search a library by its book indexing system, and then search the book by its index. Now we have computerized databases and web search engines. These are still just indexing tools, but they are so massively exhaustive and fast and custom designable that they have, as predicted, changed the way we act and perceive ourselves as knowledgeable beings. I think that much of our discontent with our professional toolbox is that while we have, as Internet surfers and 'app addicts', radically extended how our everyday self finds things we want to know, as professionals this extension of ourselves feels, as Gray stated above, 'truly dreadful'. That being said, more over-arching scientific disciplines and technologies are producing online databases, and a few good ones have appeared in our field, e.g., the *Conservation and Art Materials Encyclopedia Online (CAMEO)* developed by the Museum of Fine Arts, Boston, USA, see www.cameo.mfa.org, and *PreservArt* by the Centre de Conservation du Quebec, Quebec, Canada, see www.preservart.ccq.gouv.qc.ca. These information storage and search tools are still part of the first two paradigms – observations and models – but are just much easier to search.

Gray (2009) identifies computer simulations as the third paradigm – computational power far beyond all the graduate students ever born! For example, finite element modelling of mechanical response of

objects is slowly entering our field, and can be expected to answer many long-standing questions about climate control. My own work has moved towards simulations using widely available software such as Microsoft Excel™ (used as a static database by most users). For example, I have built a dynamic simulation of relative humidity (RH) inside an enclosure having complex cracks and subjected to a chaotic external climate. Ironically, simulations use much simpler equations than traditional models, because they do not need an equation for the final result, only equations which each piece of an interacting network that then 'runs' for thousands of time steps. My RH simulation only contains linear equations, and no exponential terms, but when one tests the model by entering a simple step in external RH that is known to cause an exponential decay inside the case, the simulation produces an exponential decay. Simulation tools are making big changes in science, but there is an even bigger change coming.

Gray is best known for coining his 'fourth paradigm' – the use of massively pooled and coherently organized data to discover phenomena unknowable by the three previous paradigms. Also called 'big data' or 'analytics', it is currently the preserve of big commerce and big physics, not so much due to the money but due to their 'born coherently digital' data. Sciences like ours must first transform legacy data into something both digital and coherent before we can do anything interesting. Other sciences – health, economics, biology – have started. Gray foresees big data becoming a fundamental tool for all sciences. The ARCHLAB project within the European Union CHARISMA project (www.charismaproject.eu) is a small step in this direction. Major museums do open up their conservation and scientific analysis archives to outside researchers to mine *in situ*, but that is a far cry from the CHARISMA goal of 'transnational virtual access to data by a large research community of professional users' (CHARISMA, n.d.). If such a portal does ever emerge, a conservator could, for example, ask for a map of pigment occurrence by date and location for every cultural object in the world that was ever analyzed. To enter the fourth paradigm, conservation science must, in Gray's terminology, do a lot of 'data curation'. The extension of the CIDOC Conceptual Reference Model (www.cidoc-crm.org) to scientific data (Forth *et al.*, 2014) seems a step in the right direction, inasmuch as a conceptual coding for conservation science data have been built to be coherent with the museological conceptual coding of the objects. If ever implemented, such a data pool would lead to an explosion of unexpected discoveries.

Needs (and impact) assessment: mega-, macro-, and micro- levels

'Critical Success Factor 5: Define 'need' as a gap between current and desired results (not as insufficient levels of resources, means, or methods)' (Kaufmann, 2005).

So far, I have discussed tools in general, and those used by scientists or conservators working on things or ideas. Now we can consider the tools used to 'assess needs and impacts (and management strategies)'. As with any management models and the tools they promote, needs assessment has a large, competitive, and often bombastic literature, but I think that the basic model by the so-called father of needs assessment, Roger Kaufmann, does help. Given Kaufmann's definition of needs (above), impact assessment is built into 'needs assessment'. That is, if you measure current results and specify desired results, then need is the difference between the two, and impact is the difference between last year's and this year's results, which you can demonstrate is due to your outputs.

The primary lesson from Kaufmann (and many others in his field, though not all) is that organizations should keep the needs of society (mega-level outcomes) firmly in mind when assessing their impacts and planning their outputs (macro-level). This becomes a bit more complicated for organizations such as conservation science institutes since most of our outputs are mediated first by the conservation community and then the heritage community, before influencing outcomes at society's level. Kaufmann's lesson to us becomes: do not expect to measure performance primarily, if at all, in terms of your outputs (number of publications, reports etc.) but instead measure it in terms of impact at the mega-level, starting with your intermediaries, and your client communities. I think this is well known by modern managers, but it is not so easy, and not inexpensive, to implement well. My own institute (the Canadian Conservation Institute) recently completed a year-long process of client surveys, interviews, plus compilation by a third party consultant, to inform strategic planning for the next several years.

Rather than select narrow societal needs and narrow notions of societal communities at the top level of Table 1, I thought it more helpful to blue-sky thinking not to presume particulars, but to use two well-established universal tools – Maslow's (1954) five basic human needs sitting as final outcomes, on top of the three pillars of sustainability. One of the notions that this juxtaposition immediately brought to mind was that while impact of the heritage sector within the economic pillar may be easy to trace, the final path to the five human needs will only ever be indirect

Table 1 A table for structuring needs assessment at various levels from the single scientist up to society

Level	Entities that produce results	Type of results	Specific results					Examples of tools for assessment of results due to conservation science output
Mega	Society	Outcomes: meeting the five basic human needs	*1 Physiological needs, e.g., food, shelter, etc.*	*2 Safety*	*3 Love and belonging, individual and communal*	*4 Esteem, individual and communal*	*5 Self-actualization, individual and communal*	Survey and analysis of: effects on public (immediate and over life-span) due to heritage use (life path, well-being, creative processes, i.e., *self-actualization*) and the relation of these impacts on the state of materials, amount accessible, added scientific knowledge. Public willingness to pay for maintenance of heritage assets even if unvisited (i.e., role in communal *belonging* and communal *esteem*) Measure the public's criteria for 'access' (minimum acceptable, and preferred) and their judgement of current situations
	The paths through the three pillars below and up to the five human needs above are complex and interacting. Politics can create a preference for assessment of our impact on the economic pillar, but our special path is via the social/cultural pillar up to the human needs 3, 4, and 5. Although Maslow (1954) structured these five needs as a hierarchy with the fifth as 'highest, they can be more usefully considered here as a set of parallel and interdependent needs.							
	Three pillars of sustainability	Outcomes within each pillar: in parentheses under each pillar	Economic pillar (employment, housing, goods, health services, etc.)	Environmental pillar (reduced carbon, healthy ecosystems, recycling, renewable energy, etc.)		Social/cultural pillar (cultural production, maintenance of tangible and intangible heritage, etc.)		Survey and analysis of: effect of heritage visits/use on economic activity, other economic activity, etc. Our behaviour in terms of environmental issues. Effect of our activity on new art production, e.g., more stable materials
	Heritage community	Outcomes	Improved care of heritage assets. Increased knowledge of heritage assets			The outcomes in each of these communities and in society can be due directly to our macro outputs, or mediated by one or both communities		Client surveys, interviews State of collections surveys Permanent stakeholder liaison committees
	Conservation community	Outcomes	Improved treatments of heritage assets. Increased knowledge of heritage assets					Client surveys, interviews Permanent stakeholder liaison committees Citation index of publications. Web page hits
Macro	Conservation science Institutes, universities	Outputs: results delivered by the organization to the outside	Publications, websites, official reports, verbal advice, training courses, development of new experts					Content analysis of extant publications. Audits of other activity such as reports, telephone advice, etc. (e.g., business management database)
Micro	Institute sections or individual expert staff	Products: results from each building block	New data, compiled data, draft texts, edited texts, verbal exchanges.					

Tools for assessment at each level shown in the last column. The structure of mega, macro, micro entities, and the idea that outputs from an organization are not what should drive its planning, but rather the outcomes at higher levels, is from Kaufmann (2005). The five primary human needs in italics are from Maslow (1954). The 'three pillars of sustainability' are drawn from numerous sources. Examples of tools compiled from various sources, as well as the author's speculation, and are only examples, and are not exhaustive.

and difficult to assign, whereas activity in the social/cultural pillar will often provide a clear path from the heritage community to three big human needs – belonging, esteem, and self-actualization – especially if one recognizes that all three have both communal and individual expression.

The literature on measuring results or outcomes or impact, however one calls it, is also large and controversial, but one of the generally accepted ideas is that societal outcomes (mega-level) are somewhere between difficult and impossible to measure, and that metrics, while more feasible, just opens up a new debate about the link between indicator and outcome. I think that if conservation science were to focus on assessment of outcomes within the conservation and museum communities, we will probably be doing well enough, and if we allowed economic arguments to be made where substantial, we will be more politic. But we should not be afraid to explore paths via the social and cultural pillar directly to the three basic needs (3, 4, 5 in Table 1) that actually make us human.

Romantic serendipity or planned resilience

As I was finishing this text, news services were covering the discovery of human tools plus human markings much older than any previously known, made by *Homo erectus* 500 000 years ago (Joordens *et al.*, 2015). Even more *à propos* our field, the discovery was made on shells collected 120 years ago and resting unknown in a natural history museum. A visiting researcher pressed for time made photographs of the shells and did not notice the human markings until he looked at digitally enhanced images back home. The oldest human tools had waited in a museum for over a century, to be finally 'seen' when a scientist's eyes were extended by the latest tools. This 'big news story' confirms the reality about which of our field's results are noticed – the press loves a story about big finds or dramatic restoration of a precious object, not the hard-earned, hidden, but I believe more substantive outcomes due to the heritage community's shift to preventive conservation and risk management.

This news incident also supports those who believe that science, or at least important science, cannot, should not, be planned, so our fretting over tools for needs and impact assessment is a waste of time! I am content to agree with this view for the purposes of 'fundamental research' but not for applied research, which is what we do. That said, Orrell (2007), a mathematician specializing in complex systems and predictive modelling, writes convincingly of our overemphasis on prediction of any kind for long-term planning purposes. He concludes that organizations, especially those mandated to serve the public good, should limit predictions to short-term planning, and plan for resilience in the long term. I do not think this should be reduced to the paradoxical homily of 'plan for the unexpected' but perhaps more the one about 'Don't think of planning as aiming an arrow, think of it as launching a missile in the general direction. You can always steer it if the target moves'. The trick is to create the steerable organization, which may mean a few moderately steerable scientists.

Conclusions

For individuals as well as organizations, chosen tools begin as extensions of the self but turn around and define our capacities and our sense of who we are. Unlike individuals, organizations cannot choose to switch employers, they are obliged to change their outputs if asked to do so by those they serve. To that end, we must assess current and desired results at the levels above our organizations, *which will not resemble our outputs* – no client will say 'my desired outcome is that you produce 50% more publications than last year' (they would at least say which kind of publications). Any needs assessment tools must balance reliability with the awareness that collective tacit knowledge is always in play. Face-to-face discussions with permanent advisory committees or stakeholders allows the collective tacit knowledge of each group to be shared gradually (phrased literally as 'getting to know each other'), so that communication becomes more reliably accurate. When making 'objective' needs assessment tools, one must define outcomes in a way that requires as little interpretation as possible, which tends to favour economic measures. Recent examples with promise are the impact of new conservation science advice on life-cycle energy savings, and carbon footprint reduction.

Our organizations and we ourselves must be wary of the all too human tendency to rationalize any unpleasant evidence. It seems to me that the only long-term strategy for maintaining the relevance of an organization's outputs is a culture of honest, effective, and regular needs assessment (monitoring) combined with planned resilience. Fortunately, I think our field serves a very stable long-term societal outcome – three of the five basic human needs as defined by Maslow (1954). And since we scientists and our managers are human too, it is worth noting that belonging and esteem are useful things to keep in mind when framing the results of a threatening needs assessment. Human resources studies have long shown that peer esteem has greater importance to a scientist's job satisfaction than increased salary.

I think ICCROM can provide several key functions, starting small and building upwards. Although our organizations' outputs are not the end game, we should at least know what they have been. Our most

vaunted as well as easiest-to-measure output is publications – this was the scope of the literature survey carried out by ICCROM for this forum. I think much valuable insight will emerge from its detailed inspection. I think the next step would be the creation of shared tools for assessing outcomes at the level of the conservation community and the museum community. ICCROM could shepherd development of a common survey questionnaire and protocol. A common tool would enable a 'big data' approach to the analysis of the surveys. The Forum Consortium, led by ICCROM, is a logical group to do this task. Finally, needs assessment needs a meta-tool within which to understand the role of any individual tools noted, i.e., ICCROM could shepherd agreement on a structure such as Table 1, if agreement exists. The needs at levels above the heritage community can remain vague, but we must try to imagine how some of our outputs connect to the top, and through which pillars of sustainability.

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Position paper

Conservation institutions as agents of change

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Key messages to conservation institutions were drafted during the ICCROM Forum 2013 on Conservation Science so they could, in turn, influence the profession. The first message is a general statement of the fact that conservation science is an essential part of conservation. The other messages provide guidance to conservation institutions so that they can achieve maximum impact. Conservation institutions should engage in research and development that anticipate issues, provide sustainable solutions and guidelines, and are conducted in a transdisciplinary way; share resources and expertise to be more efficient, increase access and reduce inequalities; and assume a leadership role, promote conservation, and ensure knowledge is made available. The key messages, five altogether, are reproduced in their entirety in this article, which provides further elaboration and development of each message as well as avenues for making positive changes in strategic areas.

Keywords: Conservation science, Conservation institutions, Conservation science community, Transdisciplinarity, Participative research, Leadership, Sustainable solutions, Research, Knowledge dissemination

Introduction

During the ICCROM Forum 2013 on Conservation Science, a discussion group was given the mandate to draft key recommendations to conservation institutions. For the purpose of the exercise, conservation institutions were defined as independent institutions (governmental and non-governmental) that were created to ensure the proper care and long-term conservation of national or regional heritage. While conservation is conducted in other types of institutions (e.g. conservation departments in museums, universities, etc.), the particular focus of the discussion group was on conservation institutions because they are in a key position to influence decisions and policies that will have an impact on the conservation of cultural heritage. This is because their mandate is focused solely on conservation, and many of them are government agencies. The group was composed primarily of people having experience of working in such institutions, and was moderated by the author.

Conservation institutions are found in many countries; many employ conservators and conservation scientists, while some also employ other heritage professionals such as art historians, architects, archivists, etc. The institutions are typically engaged in a broad range of activities such as research, expert services to national or regional heritage communities, and knowledge dissemination that often includes training and publishing.

As key players at the national or regional level, it was only natural that many conservation institutions such as the Canadian Conservation Institute (CCI), the Centre de recherche et de restauration des musées de France, and the Republic of Korea's National Research Institute of Cultural Heritage, to name just a few, joined with ICCROM to organize the Forum on Conservation Science and that other conservation institutions later participated in the event. Their objective was not only to contribute to the discussion, but also to become agents of change, bringing back recommendations made at the Forum and working towards implementing them in their communities.

Key messages to conservation institutions were drafted during the Forum so they could, in turn, influence the profession. The group responsible for this work took into account the results of the deliberations of the Forum to develop messages that contain important principles and capture what the group saw as the most important roles conservation institutions should play. This involved intense discussions and, at times, lively debates, as well as carefully choosing and weighing of each word. The results, five key messages altogether, are reproduced below.

- Conservation science is an essential part of conservation. We need a conservation science community with

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critical mass, credibility, relevance, and influence, that is well connected both within the science field and with other disciplines (transdisciplinarity).
- Research and development projects must include all concerned (i.e. scientists, conservators, and other heritage experts) who together will define the issues and objectives.
- Conservation institutions should engage in research and development that anticipate issues and provide sustainable solutions and guidelines.
- Conservation institutions should share resources and expertise to be more efficient, increase access and reduce inequalities.
- Conservation institutions must assume a leadership role, promote conservation, and ensure knowledge (including knowledge produced by others) is made available at all levels.

This article provides further elaboration and development of each message, drawing from the author's professional experience in the context of the CCI and her knowledge of the profession, as well as outlines avenues for making positive changes in strategic areas. It must be noted that whereas the first recommendation makes direct reference to conservation science, the others do not; having been prepared in the context of the Forum on Conservation Science, they must be understood as referring to conservation science, as is this article in general.

Conservation science as a discipline and a community

Conservation science is an integral and essential part of conservation. It provides a sound basis for informing conservation activities, and contributes to the development of the profession. In some conservation institutions, conservation scientists have reached a critical mass, i.e. the number needed for a specific result or action to occur, which translates into impact and influence. On a global scale, however, progress has yet to be made, principally on two related key issues: cohesion and recognition.

Critical mass, cohesion, and recognition

There are no precise data available on the increase in the number of conservation scientists over the years. One difficulty in compiling data on this is that the title itself, 'conservation scientist', is not uniformly adopted; nevertheless, the growth in the number of conservation facilities, especially in recent years in Asia and the Middle East, all of which employ conservation scientists,[1] implies that the number of conservation scientists has also grown. The specialty has reached a number large enough to justify having special groups in many national and international conservation associations as well as user groups (for example, IRUG and MaSC)[2] composed primarily of conservation scientists.

Although this community is large enough to support networks at the international level, its capacity at the national level varies greatly. While in some countries national networks of conservation scientists do exist through the existence of multiple conservation institutions and museums with scientific laboratories, in others there may be only a single conservation institution in which conservation scientists are employed. Consequently, in general, the community is rather scattered, which makes efficient linkages and communication difficult to establish and maintain. Another factor contributing to the scattering of the conservation science community is that conservation scientists are often highly specialized and as a result primarily communicate and operate within small sub-specialist groups. The disparate nature of conservation science is further heightened by the fact that in order to adequately fulfil their role in conservation, conservation scientists also need to participate in areas of specialization within mainstream science relevant to their work. This is necessary so they can grow and develop as scientists, transfer and adapt new concepts and technologies to conservation and establish partnerships to help with these transfers and adaptations. This is not a one-way street, however, as conservation scientists also develop solutions that can be transferred to or adopted in other fields of science.

In order for conservation science to contribute effectively to the profession, we need to find ways to strengthen this community and improve cohesion by recognizing conservation science as a discipline in its own right, by improving its visibility within conservation, and by improving linkages and communication between conservation scientists. This should be done with the goal of enhancing the visibility of cultural heritage in general and conservation in particular, so that these efforts contribute to the development and promotion of the larger sectors of which conservation science is a part.

Credibility, relevance, and influence

Conservation scientists often find themselves sitting between two worlds, the world of conservation and the world of science, trying to belong effectively to both.

Conservation as a discipline is still very much defined by the work of conservators, and conservation science is often perceived as an activity somewhat peripheral to conservation. To the question 'what is conservation?', the answer relates often rather to the question 'what does a conservator do?', a solution

[1] As an example, the Heritage Conservation Centre of the National Heritage Board in Singapore that opened in 2000 includes a laboratory designed to conduct scientific analysis, material testing, and research.

[2] Infrared & Raman Users Group (IRUG); Users' Group for Mass Spectroscopy and Chromatography (MaSC).

often adopted for the sake of simplicity, in an attempt to be understood by as wide an audience as possible. A clear definition of conservation should recognize the fact that not only conservators carry out conservation actions, which are not limited to interventions on objects. Conservation scientists, like conservators, participate in all aspects of conservation as defined by ICOM-CC (ICOM-CC, 2015): preventive conservation, remedial conservation, and restoration. Examples of their actions include, to name just a few: for preventive conservation, monitoring of pollutants, and research on packing methods; for remedial conservation, development of new treatment methods, and research on conservation products; for restoration, analysis of degradation products, and identification of non-original materials.

Conversely, within mainstream science, perceptions of conservation science vary from an interesting and valuable scientific discipline in its own right, a curiosity, or, to the other extreme, a sub-discipline with lower scientific standards. In the latter case, one factor that may contribute to such a negative impression is that very few conservation publications, in which conservation scientists need to publish to reach the conservation community, are indexed in the *Journal Citation Reports* (*JCR*). *JCR* provides information about academic journals in the sciences and social sciences, including impact factors, which are a measure reflecting the average number of citations to recent articles published in the journals. Impact factors are frequently used to evaluate the relative importance of a journal within its field. Journals having higher impact factors are deemed to be more important than those with lower ones. The credibility of scientists (i.e. the quality of their work) can be measured by the number of articles they publish in journals with high impact factors. The impact and influence of their work can be measured, to some extent, by the number of times their articles are cited in articles written by others.

More conservation journals should be indexed in the *JCR* and have impact factors, so that important indicators such as impact factors and number of citations are accessible to measure the work of conservation scientists using the same standards applied to and by mainstream scientists.

However, a more important quality for conservation research is relevance, i.e. how well conservation research answers the needs of the community. While tools such as impact factors and citation reports can contribute to measuring impact and influence, we need to find ways to measure relevance, for example, by assessing how solutions, tools, and methods are effectively transferred into conservation practice.

Participation in conservation research

Although the term 'transdisciplinarity' was mentioned in the first key message in relation to conservation science being connected with the science field and other disciplines, it is in the context of the second key message that it is the most relevant.

The term 'multidisciplinary' is often used in conservation when referring to approaches, teams, and projects. The term, most of the time, is used to mean that participants from different disciplines are involved in an activity or in an approach to a topic or problem. This is in agreement with most definitions of the adjective that one can find in dictionaries.

In the popular online source Wikipedia, one can find the following statement about the multidisciplinary approach, which well describes what conservation is often about: 'A multidisciplinary approach involves drawing appropriately from multiple disciplines to redefine problems outside of normal boundaries and reach solutions based on a new understanding of complex situations' (Wikipedia, 2015a).

In the field of cultural heritage and conservation, the adjective 'multidisciplinary' or 'interdisciplinary' is used to describe many different things. A search in the Art and Archaeological Technical Abstracts (AATA Online) at the time of writing this article found 425 results when looking for 'multidisciplinary' in the abstract and 700 when looking for 'interdisciplinary' (Getty Conservation Institute, 2015). Based on these figures, it seems that multidisciplinary or interdisciplinary is what conservation has been aiming for, and succeeding in achieving. A closer look at what the concept entails shows that purely scientific studies of cultural heritage using different techniques (e.g. imaging and spectroscopy) are labelled multidisciplinary or interdisciplinary. A group composed of an art historian (or curator), a conservator and a conservation scientist working together to gain knowledge about an artwork will be identified as a multidisciplinary or interdisciplinary team because the disciplines involved are art history, conservation, and science. As mentioned in the previous section, in this case it seems that conservation is the discipline of the conservator, not of the conservation scientist, who remains firmly associated with the scientific discipline they specialized in (e.g. chemistry, engineering, etc.).

So is multidisciplinary or interdisciplinary good enough? Is it really what we should strive for?

Lidia Brito, Director of the Division of Science Policy and Capacity Building at UNESCO and keynote speaker at the Forum on Conservation Science, mentioned two important points during her keynote lecture: science is moving from curiosity and creation of new knowledge to problem-solving addressing development issues; and in order to foster and

provide solutions for sustainable development, we need to adopt a 'transdisciplinary' approach.

Looking again at Wikipedia, one finds the following entry under 'transdisciplinarity' (Wikipedia, 2015b):

> As the prefix 'trans' indicates, transdisciplinarity concerns that which is at once between the disciplines, across the different disciplines, and beyond each individual discipline. Its goal is the understanding of the present world, of which one of the imperatives is the overarching unity of knowledge.
>
> Another critical defining characteristic of transdisciplinary research is the inclusion of stakeholders in defining research objectives and strategies in order to better incorporate the diffusion of learning produced by the research. Collaboration between stakeholders is deemed essential – not merely at an academic or disciplinary collaboration level, but through active collaboration with people affected by the research and community-based stakeholders. In such a way, transdisciplinary collaboration becomes uniquely capable of engaging with different ways of knowing the world, generating new knowledge, and helping stakeholders understand and incorporate the results or lessons learned by the research.

This last part of the text is actually very relevant to conservation research as defined in the second key message to conservation institutions. Too many times conservation is perceived as imposing rigid solutions that go against the will of other heritage professionals and that prevent them from accomplishing their projects. A good example is the recent debate about the museum environment and the need to reduce operating costs of expensive air-conditioning systems required to maintain temperature and relative humidity at specific levels.[3] Clearly, it is necessary to provide solid data on which to base decisions. However, involving stakeholders in defining research objectives and strategies, and also in a discussion of the impact of changes in environmental guidelines on collections, would ensure a common understanding of the results of the research and contribute to practical solutions.

Proactive research leading to sustainable solutions

Currently, in many countries, resources (both human and financial) are scarce and problems, numerous. Therefore, research plans are usually established through some type of consultation with the community to determine which problems need to be addressed as a priority. Owing to the time required for these consultations and for confirming that there is a consensus on which topics or problems deserve research, the actual research work may in the end focus on issues that the community has been facing for many years. Also, while research is being conducted, new issues keep emerging. For example, recent objects made of polymeric materials now require attention, and the preservation of digital heritage pose new challenges to institutions. At the same time, traditional materials still require research. In painting conservation, a large body of research is now devoted to the more recently created acrylic paintings while there are still unanswered questions related to traditional oil paintings, such as how to prevent the formation of disfiguring metal soap protrusions, and how to treat paintings affected by this problem. Research requires time and it is not an activity that can accommodate shifting priorities very well. As a result, research, as good as it can be, is often out of phase with the reality the community is facing. Most importantly, some excellent research may end up providing solutions that are only accessible to a few because of the complexity or cost involved. Powerful technologies such as multispectral imaging and investigations using national facilities for synchrotron radiation studies, to name just a few, are not currently commonly available. However, the tendency for sophisticated technologies is to become more affordable and user-friendly as usage becomes more widespread – a good example being Raman spectroscopy instrumentation, which used to be complex and, for that reason, confined to research facilities. In the area of treatment, the same 'democratization' phenomenon applies: laser cleaning is much more commonly done, and nanoparticles (some types being available commercially)[4] are now used in a variety of applications. Nevertheless, we need to ensure that conservation research results will be useful to as many people as possible. One way to make results more widely applicable is to embrace transdisciplinarity.

Can research be proactive in order to provide solutions to problems we do not yet recognise? The answer is yes. Researchers who are aware of global trends, in their specialty or at a broader level, can recognize that the conservation community will be impacted, and take on a leadership role to find solutions. A good example is the gradual ban on fumigants and pesticides that triggered research on treatments to combat pests that would not resort to the use of chemicals (Strang, 2012).

[3]Since the 'Dialogue for the New Century' on this topic by IIC in 2008 (IIC, 2008), several workshops and conferences have taken place and a declaration was recently signed jointly by ICOM-CC and IIC (ICOM-CC & IIC, 2015). A review of the situation was published recently by Kirby Atkinson (2014).

[4]One example is the product Nanorestore© used for the consolidation of wall paintings and calcareous stone (Baglioni *et al.*, 2014) distributed by CTS (http://www.ctseurope.com/en/scheda-prodotto.php?id=232).

The current emphasis on sustainability and greening provides opportunities to find solutions that not only would be in line with these concepts but that could also ensure greater accessibility to research results, especially in developing countries. For example, it could be beneficial to replace a specific treatment involving dissolution in solvents, that works very well, with one that uses greener products, or to replace the method altogether with one that does not resort to dissolution but to another action. Similarly, traditional techniques, that were deemed less efficient than methods developed more recently, may be worth researching because, although less efficient, they would provide greener and more sustainable solutions.

Another area to which conservation science research is expected to contribute significantly over in coming years is the assessment of changes in environmental guidelines in order to allow museums to operate in a more sustainable way. This will require a transdisciplinary approach so that stakeholders take part in finding solutions, as stated previously.

Sharing of resources and expertise

As mentioned above, resources are scarce in many countries. Conservation institutions that are often the principal resource for the conservation community in a given country are often not in a better position than the community they are meant to serve, and struggle to maintain their capacity. Many have found ways to counteract diminishing resources by establishing partnerships and collaborations with other institutions, universities, or the private sector. However, this is not the case everywhere and much could be achieved if conservation institutions engaged in a more coordinated effort that would result in the sharing of resources and expertise. Increased sharing would have a beneficial impact on many aspects of the operations of conservation institutions, an obvious one being the training of scientific staff.

Educational programs in conservation science remain rare and graduates in conservation science (at the M.Sc. or Ph.D. level) number only a few. Often conservation institutions will hire scientists with no conservation experience, particularly if they are part of the government and have to follow government rules promoting employment of citizens of the country. Conservation scientists will often learn on the job. Depending on the particular speciality they were hired to work in, they may end up being the only one of their kind in the institution they work for. Beginners in the field, even though they have considerable experience in science, would benefit from working alongside experienced conservation scientists. This could be achieved through short, intensive training, such as attending workshops, or long-term solutions like internships or distance mentoring.

Scholarly exchanges could be another way to share resources in cases where an institution faces a particular problem that requires expertise on a short-term basis only. This could be expertise in a particular type of cultural object or material, or in instrumentation, methods, or techniques. The sharing of instrumentation is also a possibility.

There are of course obstacles to such sharing initiatives, not the least financial. It is not always possible for staff to travel to other institutions, because of logistical implications on both the professional and personal life of the individuals involved. Nevertheless, such initiatives should be encouraged and we should find ways to make them possible.

The profession would also benefit from scholarly exchanges that would go beyond exchange at conferences. Although conferences are extremely useful in making others aware of progresses and achievements, they may have more or less success in providing a forum where issues and ideas can be exchanged and debated in a climate of trust, with the aim of solving problems and achieving results. Researchers, quite legitimately, may want to protect the research that is often a key performance indicator for their institution, until it is published. Formal collaborative agreements between institutions would provide a means for a more trusting exchange of information between researchers while at the same time being recognized as an appropriate performance indicator in itself by the authorities responsible for the funding and management of the institutions.

Conservation institutions could also share resources and expertise for the purpose of benchmarking. This would promote efficiency and effectiveness.

Leadership

In countries, where there is a national, governmental conservation institute, the conservation community expects that institution to be the main provider of information and to play an advocacy and leadership role. This presents many challenges.

National conservation communities often expect that the national conservation institution should not only effectively disseminate information created by the institution itself, but also be a conduit for information produced elsewhere. Conservation experts at the institution are expected to have up-to-date knowledge in their area of specialization, which in itself is a challenge given the massive amount of information being produced in conservation nowadays. Because of diminishing resources, institutions tend to move away from one-on-one conversations to more efficient means of communication like web postings. This creates new sets of challenges related to the ongoing

requirement for up-to-date information. This problem could be alleviated if conservation institutions were organized as a network to direct people to the relevant conservation resources. There is also a requirement for interactivity, so there could be two-way communication between institutions and the communities they work with. For example, a recent evaluation of the CCI demonstrated how much the Canadian conservation community appreciates and values direct contact with CCI specialists to discuss issues and obtain solutions.

For conservation institutions to play an advocacy and leadership role, they need to reach beyond their main audience, which is the conservation community. To actively promote conservation in closely related circles (e.g. museum professionals, archaeologists, archivists, etc.) and among non-specialists (e.g. politicians, policy-makers, and the general public) means that information needs to be disseminated at various levels of complexity or that different information needs to be directed to different audiences. Conservation institutions should also be integrated into the professional life of the first group, and this happens naturally when transdisciplinarity is adopted. This ensures that other heritage professionals are not only aware of conservation activities but actively engage in them and, as a result, participate in advocacy efforts. To reach a broader audience, participation in events such as conferences of museums or archives associations, archaeological societies, etc. provides not only networking that is essential for conservation institutions to play their role effectively, but also a forum to demonstrate leadership and play an advocacy role. Engaging local media for high-profile stories or highlighting case studies to convey the results of research can be effective ways to engage non-specialists such as politicians, policy-makers, and the general public.

The conservation community itself can be further divided into two main groups when considering the dissemination of conservation science information: users and peers. Users are primarily conservation practitioners who want to use the information in their work without necessarily being interested in the intricate details of the science; peers are primarily other conservation scientists who, on the contrary, are deeply interested in all details of the science. This means that the same research results may end up being disseminated to the two groups in different forms: very detailed for peers and less detailed and more practical for users. If conservation science is to be recognized as an important scientific field, conservation science articles should not attempt such a degree of scientific popularization that would jeopardize their scientific profile. Instead, multiple communication inside and outside the conservation community using different levels of language and different vehicles is required.

Effectively communicating with such varied audiences may take many forms, such as publications, conferences, web platforms, interactive discussions, formal submissions to government authorities, press releases, etc. It requires different approaches and strategies depending on the goals one wants to achieve. This could be to increase conservation expertise among practitioners or to convince decision-makers to increase funding to conservation. Conservation institutions are often fortunate enough to have specialists outside the field (e.g. people specialized in training or communication) who contribute to make scientific information understood by a wider audience. Such expertise should be sought if not already available.

Communication to advocate and promote of conservation would also benefit from more coordination at the international level, so that a unified voice can be heard.

Conclusion

The Forum on Conservation Science recognized that conservation science is an essential part of conservation. We need a conservation science community that is well connected and has critical mass, credibility, relevance, and influence. Conservation institutions play a crucial role building this community because they employ a large number of conservation scientists and they must ensure that conservation science achieves maximum impact in activities such as research and knowledge dissemination.

In doing so, conservation institutions should engage in research and development that anticipate issues and provide sustainable solutions and guidelines and are conducted in a transdisciplinary way. They should share resources and expertise to be more efficient, increase access and reduce inequalities; and last but not least, assume a leadership role, promote conservation, and ensure knowledge is made available.

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Position paper

Educating future professionals in conservation science: The challenges of an interdisciplinary field

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Training and education paths in conservation science have been the subject of ongoing debate over the last two decades. A key issue is that conservation science, although not a new field, is not adequately defined, which leads to a lack of consensus regarding the competencies needed. During the ICCROM Forum 2013 on Conservation Science, education for conservation scientists was discussed, with a particular focus on those necessary competencies which exceed the scientific domain. This paper reflects on the outcomes of these discussions as well as the results of surveys carried out by ICCROM in preparation for the Forum on education, job advertisements, and the relationship between conservation professionals and science. Challenges identified included current professional paths, dissemination of scientific findings, use of specialized terminology, and the need for professionals who serve more than one area of specialization. These challenges could be viewed as an opportunity to revise and modify educational programmes. New interactive platforms could be used to facilitate participative science projects, and could change the way projects are carried out in the near future.

Keywords: Conservation science, Education, Interdisciplinary research, Transdisciplinarity, Participative science, ICCROM

Introduction

While conservation science is considered by many as a relatively new field, science has played a major part in the development of cultural heritage conservation for over a century – as evidenced by the early establishment of laboratories in museums such as the Rathgen Laboratory, Berlin, Germany; the British Museum, London, UK; and the Louvre, Paris, France, in the late nineteenth and the first half of the twentieth centuries. Considering the variety of scientists who work within the sector, and the diversity of scientific research undertaken, it is safe to say that conservation science as a field is neither new nor has it been the outcome of a specific educational system. Science became part of conservation and following this, conservation science became a field in its own right. However, the recognition of conservation science as a profession is still ongoing.

The definition and the role of conservation scientists have been the subject of several debates over the last two decades (see, for example, Mazzeo & Tabasso, 2000). In 1997, an ICCROM survey on conservation science showed that conservation scientists were primarily professionals trained in one of the natural sciences who entered the field directly through employment (Mazzeo & Tabasso, 2000, p. 4). In the subsequent 1999 ICCROM meeting regarding education and university curricula for conservation scientists, much attention was placed on the definition of the professional and his/her educational background and skills, rather than the aims and operational domain of the profession.

During the ICCROM Forum 2013 on Conservation Science, education and the desired attributes of conservation scientists were discussed extensively. On the final day of the Forum, a discussion group was formed to focus on this topic, chaired by the author. The group comprised diverse professionals from different educational and cultural backgrounds, who provided very different perspectives of education in conservation science. The recommendations arising from this group form the starting point for this paper, which were then combined with reflections from the author's own experience (both as a graduate student and as an educator in conservation), and the results of a number of surveys undertaken by ICCROM in September 2013 in preparation for the

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Forum. These surveys were intended to capture current views regarding educational pathways for conservation scientists, the use of science by conservators, and the skills sets employers are looking for when employing conservation scientists.

With these considerations in mind, this paper then moves to discuss some of the underlying issues related to the definition of conservation science as an operational domain, issues in defining competences in interdisciplinary studies and the use of terminology which in theory improves communication but in practice can complicate matters. Regarding terminology, in this paper the word 'educator' refers to anyone involved in the training of conservation scientists.

Findings of the Forum discussion group on education

The diversity of the members of the discussion group lead to thought-provoking and enlightening debates, however, selecting the main points to be given as recommendations to educators was quite challenging. The recommendations and findings on messages to educators are reproduced unedited here below.

Key messages to educators

Why? Education is the future of our profession

- Educators should have a clear understanding of the vast array of necessary sciences that contribute to conservation to ensure graduates can bridge these different disciplines.
- Educators should value traditional knowledge systems as part of the cultural heritage in their own right. Conservation science could be used as a means of better understanding this traditional knowledge.
- Conservation education should consider the social and political dimensions of conservation in addition to technical and scientific aspects. This should include how conservation can contribute positively to societal priorities.
- Education should empower students with skills that could be adapted to meet local needs.
- Education should foster solution-oriented learning attitudes that seek cost-efficient outcomes.
- Conservation education should expand beyond concern for material culture to consider emerging issues such as intangible heritage and sustainability.
- Educational programmes should respond to the needs of the profession as well as ensuring that graduates have the skills necessary to be employed.
- Educational programmes must provide communication skills so that students may participate in effective dialogue with a variety of audiences (political, community, professional, etc.) and be strong advocates for conservation.
- Conservation education should foster collaboration at the university, professional, governmental, and community levels.
- Educational frameworks should be developed to be flexible enough to take into account local, governmental, and social conditions.

Exploring the issues

Despite the fact that a significant proportion of current conservation scientists first trained as chemists, there is no single scientific discipline that could serve as the sole foundation of an educational programme for conservation science. The complexity and range of issues encountered in conservation require inputs from many different disciplines and specializations. There is, however, general agreement that conservation scientists should be trained in 'a science' and use their knowledge for the conservation of cultural heritage (Corbeil, 2000). Price (2000) suggests that conservation scientists in addition to their scientific background need to be acquainted with the ethos and the principles of conservation, suggesting that scientists need further training in conservation to understand the constraints but also the broader research horizons under which conservation professionals operate. Inevitably, the definition of conservation science surfaces in the discussion, which in turn raises a number of questions regarding educational pathways. More often than not the focus has been on who the conservation scientist is rather than defining what the field of operation should be. However, it would perhaps be more pragmatic to focus more on the latter rather than the former, as this would help establish conservation science as an independent scientific domain, set professional goals and thereby assist educational institutes in their training of future conservation scientists. This particular challenge is by no means unique to conservation science, but rather is common to all interdisciplinary fields, where the lack of definition of the specific operational domain hinders the specification of required competencies, and consequently the development of relevant training programmes.

In lieu of a definition, for the purposes of this paper the author would like to attempt a short description of the operational domain of conservation science, in order to provide a starting point for the subsequent discussion regarding conservation science education and its links to the different facts of cultural heritage conservation. Conservation is considered here as an overarching field that seeks to preserve cultural heritage both in terms of the physical object itself, and the diverse values and information it carries. To this end, in addition to technical issues concerning the material composition, construction and properties of objects, conservation also considers why and how objects become cultural heritage from the perspectives of different interest groups, and how perceptions of value can change over time due to physical alterations

(e.g. through ageing and interventions) or through societal and cultural changes. Within this context, conservation science is a scientific domain where diverse scientific knowledge and methodologies are applied to understand, characterize, and preserve not only the component materials, but also the values of the heritage. Consequently, the operational domain of conservation science cannot be limited solely to materials science, but must encompass diverse disciplines, from natural sciences to social sciences and humanities, each contributing towards the same goal that is promoting the understanding, preservation, and management of cultural heritage, its values and its sustainable use.

Training and educational pathways in conservation science

There are very few undergraduate or postgraduate programmes dedicated to conservation science, as opposed to those for conservators. Moreover, education in conservation science is highly variable and complicated to evaluate. To better understand training pathways for conservation scientists, in preparation for the ICCROM Forum 2013 on Conservation Science, ICCROM together with the support of the ICCROM Forum consortium partners undertook an online survey of educational programmes in conservation and ostensibly conservation science in September 2013 (Heritage *et al.*, 2014). The results of the survey offer some interesting insights.

The majority of the educational programmes surveyed offer postgraduate courses (at masters and doctoral level) focusing primarily on museum collections and site-based conservation (73% and 56% respectively). The percentage of the student intake with a degree in a scientific discipline varied greatly: from less than 10% (for 54% of training programmes) to more than 90% (for 22% of training programmes). Interestingly, the percentage of students undertaking research generating scientific information through their studies are somewhat higher with the majority of students in around 40% of training programmes carrying out science-based research. The above indicates that scientific research in training programmes is strongly linked to the objectives of the programme. Additionally, it is worth mentioning that the research interests of the academic staff in an educational department as well as the facilities available strongly influence the research undertaken by students. The survey also revealed that little of this student research is published – which is not altogether a surprising finding as this is known to be a common issue in most tertiary education institutions (Cather, 2013, personal communication; Pye 2013, personal communication).

The survey results are less clear when it comes to what qualifications are needed for a career in conservation science. It was clear from the responses that there are several possible paths, however, the majority (87%) of the educators agreed that both science and conservation qualifications are necessary, with a first degree in science and a masters in conservation being the most favoured combination. Moreover, the general consensus was that training in conservation science should be pursued at postgraduate level, either as a doctorate (60%) or a master's degree (44%), with only a small percentage supporting the need for a specialized bachelor (first) degree (14%). A number of educators commented on the employability of graduates with doctorates in conservation science, compared to doctorates carried out in a 'mainstream' science discipline which they considered to offer more employment possibilities. Employability is linked to needs and opportunities within the sector at the time of graduation; however, the skills acquired are transferable and not limited to the cultural heritage field.

What are employers looking for?

To understand what employers typically require from conservation scientists, ICCROM undertook a survey of posts advertised for conservation scientists on the website of ICCROM and the *Conservation DistList* between 2008 and 2013 (Heritage *et al.*, 2014). In total, 89 job advertisements were surveyed, the majority of which were for positions in North America and Europe (93%). However, jobs advertised at national level and in languages other than English were not traced and these results are discussed with these limitations in mind.

Within the adverts surveyed museums and academic institutions appear as the main employers for conservation scientists with only few positions advertised in the private sector. The majority of these posts were for mid-career professionals with only a small number at entry level, indicating the difficulties new professionals face when attempting to enter the field. Moreover, the lack of entry level positions might in part explain the increasing take-up of post-doctoral positions which offer graduates an opportunity to gain expertise and experience in the field prior to obtaining a job. Interestingly, less than half of the job positions advertised in conservation science listed a Doctorate as an essential qualification. Very few senior positions were advertised.

In general, only 45% of the adverts highlighted experience in the sector as a pre-requisite, even though the positions advertised were for conservation scientists. Contrary to the opinions polled during the educators' survey, the adverts often did not specify whether the required academic qualifications should

be in science or conservation, with the exception of Doctorates which, when requested, 68% of the adverts specified it should be in natural sciences or engineering.

Conservation and science: an affair to remember

Educational programmes in conservation and restoration are highly varied, ranging from vocational courses to Bachelor's and postgraduate degrees, such that the training offered differs from one country to another, and often within the same country. Similarly, the level of science required to enter conservation programmes also ranges dramatically (e.g. from intermediate and advanced certificates in science to college level science courses). As a result, even though established training programmes have been in existence for several decades there is no conformity in conservation training, and the related science entry requirements.

One of the key themes of the Forum was how to improve the relevance and impact of science within conservation. It is logical that at least part of the answer to this question lies in the effectiveness of interdisciplinary collaboration within the field – i.e. in what ways, and how effectively different professionals communicate and work together. In regard to this, education and training plays a crucial role. While discussions regarding education for conservation scientists have highlighted the need for scientists to be educated in conservation ethics and principles, similarly, conservation training also needs to focus on improving science literacy, and in particular the application of scientific principles and methods to conservation.

To better understand the relationship between conservators and scientists and in particular the access to and use of scientific information and services by conservators, an online survey of conservators was undertaken by ICCROM during September 2013. More than one thousand two hundred conservators from around the world participated in the ICCROM survey which was advertised through professional conservation websites and social media (see Heritage *et al*., 2014, for more information). Similar to findings of the survey of job advertisements, the majority of the conservators who responded were employed in museums (55%) with site-based conservators being the second largest group (43%). Of the conservators surveyed, the majority cited their academic training as the primary source of scientific knowledge used for their work (69%), in comparison to conservation science literature (11%) and direct exchange with scientists (9%). This highlights the importance of training programmes as a fundamental resource – and sends a clear signal to educators that this is a vital window of opportunity for enhancing levels of scientific literacy. Moreover, while conservation science publications, seminars, and workshops are also significant resources for knowledge exchange, nevertheless financial constraints and lack of accessibility were reported as significant barriers, particularly for operators in private practice who, for example, do not have access to subscription-based publications through an institution.

While in general terms, communication and collaboration with scientists was reported in the survey as being good, nevertheless, from the respondents' qualitative comments the precise terms of these collaborations warrant closer examination. Increasing scientific literacy without doubt facilitates communication and understanding at the intersection between different disciplines, and improves levels of collaboration. Indeed, academic programmes already deliver syllabi with this in mind at different training levels. While the degree of scientific literacy and competence of conservators need not match that of conservation scientists since the professional objectives of each are different, conservators with an advanced understanding of science can and do lead research projects in conservation, particularly where the focus is on applied practical aspects. As a result, this bridges the gap between conservators and academics as well as conservation scientists, leading to more effective co-working and ultimately projects of greater practical relevance to conservators.

The paradigm shift from the craftsmen and artisans who characterized the field 40–50 years ago, to current day science-based conservators, is quite significant. While the modern scientific approach without doubt has led to many advances, it is important not to lose these vital practical roots which are an essential knowledge resource. Conservation is as much linked to arts and crafts traditions as it is to science – and this traditional knowledge base should be acknowledged and incorporated within conservation science research as a means to enrich understanding, and enhance conservation methods.

The use of surveys

Surveys are helpful to get a snapshot of the field at a specific moment in time. However, they do have significant limitations, since the outcomes of a survey depend on the objectives and the design of the questions and, in the case of quantitative surveys, the pre-selected options for answers. In quantitative surveys one expects to reveal some of the general tendencies that are influenced by personal experiences, rather than a more in-depth analysis that is afforded by qualitative methods using for example in depth interviews (Creswell, 2014). While it is understandable that a primarily quantitative approach was adopted for the Forum surveys – given the short space of

time available for their design and execution, and the ease of analysis that these afford, nevertheless further qualitative research would help to elucidate some of the results obtained.

Comparative analysis of the data collected during the different surveys yields further insights. For example, the relationship between conservators and conservation scientists, and also the access to scientific information and services, is conditioned by the working environment. From the survey data gathered, it is possible to see some clear similarities, and also some dissimilarities, between the various groups. While the primary areas of employment for both conservators and conservation scientists were museums and site-based organizations, nevertheless almost half of the conservators surveyed reported themselves as working freelance or in private practices. In contrast, this is rarely the case for conservation scientists, the vast majority of whom are institutionally based, in museums, universities, and cultural heritage organizations. Indeed, the extent to which shared working environments influences the effectiveness of interdisciplinary collaboration between scientists and conservators is worth investigating further.

Another important issue highlighted by the surveys is the degree of access to new knowledge and scientific advances, which at present is often limited by journal subscription costs. Again this is an issue that affects the various groups differently depending on their work context (i.e. whether institutionally based or in private practice). Although a number of organizations and educational institutions support open-access publications, the majority of scientific papers are still published in subscription-based journals. These issues cannot be overlooked as the field expands far beyond the universities and museums of developed countries. As open access journals become more established and the benefits of delayed open access publications (papers of subscription-based journals which become open access by the publisher after a predefined period of 'embargo' time) are better understood (Laakso & Björk, 2013), such obstacles to the dissemination of new information should diminish. In particular, research carried out to understand better the benefits of open access has highlighted a number of advantages to publishers, which in addition to the more obvious, also include an increase in citations and accordingly an increase in the journal impact factor (see Bernius *et al*., 2013).

Interdisciplinary, multidisciplinary, and transdisciplinary research

A strong message of the Forum was that conservation science will benefit from a more inclusive attitude towards other scientific disciplines, including humanities and social sciences. Conservation science is traditionally linked to natural sciences such as chemistry, physics, biology, geology, and materials science. However, an increasing number of disciplines are now becoming included in conservation research, and in particular the adoption of a value-based approach has led to the incorporation of disciplines such as anthropology, psychology, and sociology as a necessary component in scientific research projects (see Dillon *et al*., 2013).

Conservation science has for a long time been described as 'multidisciplinary'; however, increasingly the term 'interdisciplinary' is used. While multidisciplinary research involves the collaboration of several disciplines working towards a common goal, nevertheless, each remains distinct, producing results which are typically published separately in journals relevant to the disciplines involved (Aboelela *et al*., 2007). Conversely, interdisciplinary research is associated with the use and integration of theories, concepts, tools, methods, models, data and paradigms of two or more disciplines to solve a problem (Porter *et al*., 2006), and results of findings in jointly authored publications. Interdisciplinary research not only borrows from different disciplines but also integrates them, and is characterized as an 'intellectual landscape of knowledge, not disciplines per se' (Huutoniemi *et al*., 2010). In view of these considerations, the term 'interdisciplinary' would seem the better fit since conservation science research starts from a question, and through the synthesis and integration of sciences and humanities, results in the production of new knowledge.

The interdisciplinary nature of conservation science is also evident in the use of specialized terminology borrowed from disciplines both in humanities and mainstream science. The language and the methods used to communicate research findings merits further investigation, as a significant proportion of conservation science findings are published in mainstream scientific journals, with little or no dissemination in the conservation literature. This trend is largely dictated by university requirements and departmental priorities, which are often ranked in terms of their publication outputs for which the journal's impact factor is a key criterion.

Nevertheless, the use of language and the factors that influence its selection is significant as a key determinant for communication and hence interdisciplinary collaboration. The breadth of knowledge needed for conservation research has required the integration of an increasing number of scientific disciplines within conservation science: from natural sciences and engineering to mathematics, computer sciences, statistics, and social sciences. This leads to an increasing multivocality within the field. Moreover, the significance of language comes to the fore as the field transitions

from interdisciplinary towards transdisciplinary research. Transdisciplinary is described as a problem-oriented research that requires cooperation between researchers and practitioners, bridges science with society, and ultimately results in mutual conceptual and methodological frameworks (Jahn *et al*., 2012). Consequently, with roots both in the crafts and the sciences, conservation science has developed to a large degree along the lines of transdisciplinary research.

Communication, politics, and conservation science

The lack of effective communication among different professionals within and outside the field, as well as between different interest groups, was a recurring theme highlighted during the Forum. Scientists need to have a broad understanding of the extended field and to be able to make connections between the different professionals. Communication should include institutional communication with the public, interdisciplinary exchange, communication between different professionals within an institution and transmission of scientific concepts to different interest groups. The last few years have witnessed a number of conservation professionals including scientists advancing in key managerial roles in various cultural heritage institutions. This facilitates the dialogue between different experts and stakeholders, and more importantly adds cultural heritage to the general agenda focusing on societal needs. Cultural heritage is often marginalized outside the field and it is apparent that the significance and the stability it brings to society is not communicated properly at higher levels of leadership. The reasons behind this are far too complex to discuss in this paper, however, part of the issue is related to the methods, terminology, and language used in specialized fields such as conservation science, which make communication with the general public, policy-makers and other professionals difficult. It is worth learning to corroborate the value of our work using common language and nomenclature to communicate competently and effectively. Communication skills that could help advocate for cultural heritage should be acquired via educational programmes and further professional training.

Another dimension to the above is the use of Internet sources and interactive platforms to design and communicate scientific projects in cultural heritage. Participative science projects could be developed in conjunction with different citizen groups. A number of crowd sourcing projects are currently online; a successful example of this is the MicroPasts project (see Bonacchi *et al*., 2014). Apart from the benefit that this type of projects brings to data sourcing and analysis, they are beneficial for the society as citizens become part of a larger scientific community. A number of platforms are currently available (see Zooniverse, CrowdCrafting, PyBossa, Thinkable, Marblar, and Ushahidi)[1] and can also be used to design projects with the public. Interactive platforms like these and many more that are not mentioned here can provide data and evidence, which in addition to informing processes and standards, can act as an indispensable communication tool for the field of conservation science.

Towards a new paradigm for conservation science education

There are very few programmes in conservation science around the world. An example of a dedicated project in training conservation scientists was the European PhD in Science for Conservation (EPISCON). The project was funded by the European Union in 2004 and was concluded in 2009. Another noteworthy current example is the Centre for Doctoral Training in Science and Engineering in Arts Heritage and Archaeology (CDT-SEAHA), based in University College London (UCL), London, UK, which is designed to address issues in heritage in collaboration with heritage organizations and industry partners (www.seaha-cdt.ac.uk). This programme envisages career paths which are not limited to heritage organizations, but which will extend to industry and policy making, multiplying employment options as well as addressing wider communication issues. The initiative is remarkable because of its outward-looking approach and the involvement of new partners in heritage science. This model of studies is worth exploring further, as it provides a larger framework within which heritage scientists could operate.

However, due to the heterogeneous nature and breadth of knowledge required in the field, designing a degree in conservation science is challenging (Golfomitsou *et al*., 2015). The multifaceted nature of conservation science demands creative solutions within educational programmes to further advance the field. The lack of definition regarding conservation science makes the design of any syllabus complex, because any degree programme must have clearly defined learning outcomes. Educational programmes are designed following tested and conventionally

[1]CrowdCrafting. 2015 [accessed 15 February 2015]. Available at: <http://crowdcrafting.org/>.
Marblar. 2015. [accessed 15 February 2015]. Available at: <http://marblar.com>.
PyBossa. 2015 [accessed 15 February 2015]. Available at: <http://pybossa.com/>.
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Ushahidi. 2015. [accessed 15 February 2015]. Available at: <http://www.ushahidi.com/>.
Zooniverse. 2015 [accessed 15 February 2015]. Available at: <https://www.zooniverse.org>.

accepted methodologies. The professional reality, however, would be best suited to flexible programmes both in terms of student profile intake and specializations offered. The focus of such a programme should be on the diverse range of competences required, which go over and above scientific expertise (see the findings of the Forum discussion group above). The breadth of these skills require the exploration of new pedagogical approaches both within and outside the discipline. For example, research-based teaching linked to workplace training could contribute to translating research findings into practice. Similar to conservation science, a number of professions require theoretical understanding of processes combined with development of motor skills and critical thinking (Sadideen & Kneebone, 2012 ; Papp *et al.*, 2014). The integration of theory, research and practice should be encouraged, and models used in other fields can assist in developing suitable training paths.

Inquiry-based learning (IBL) is a pedagogical approach which is based on problem-solving, research and real-life projects, and scenarios (Aditomo *et al.*, 2013). Students participate actively, and teaching can take place outside the classroom, e.g. in a museum laboratory. This model is used to a certain extent by several university programmes, where students carry out practical work in museums/sites affiliated to the programme. Conservation science in its complexity and interdisciplinarity makes inquiry-based learning imperative. IBL increases awareness of real-life problems and contributes to the development of professionals who can think and act critically.

The latter is immensely important, as conservation scientists, like all cultural heritage professionals, should be communicating with broader society in matters that affect our understanding of the past. The value of heritage is not necessarily evident to a lay person, and specialists often fail to communicate its worth due to the assumption that its value is self-evident. The complexity of conservation science lies in the preconception that it is a scientific discipline; however, it is based in a field that has numerous socio-cultural consequences. Enhanced partnerships among educational institutions, museums, and relevant organizations can bring academic programmes forward, as they should not only respond to present needs, but also predict the requirements and predicaments of the near future. The latter cannot be done in isolation but only within a wider context where scientific developments as well as general scientific and societal trends are considered, assessed, and incorporated into the training.

In addition to research and analytical skills, education in conservation science should equally cover the intangible values of cultural heritage. Transfer of craftsmanship knowledge, sustainable conservation methods as well as emerging forms of cultural heritage should be included. Facilitating access to information at both local and global levels is imperative and luckily there are many available platforms that can be used for this purpose. Participating in projects linking local and global knowledge, questioning existing knowledge systems and creating interactive platforms for sharing knowledge should be in the immediate priorities of any educational programme in an ideal world.

In view of this, it is clear that all conservation scientists should be well-versed in more than just conservation principles. They also need to understand the field and the stakeholders to be able to communicate with different interest groups at different levels, and to participate in effective interdisciplinary projects. Conservation scientists cannot be isolated from the cultural heritage sector and the cultural heritage sector cannot be isolated from the rest of the society. In particular, critical and reflective thinking are needed to develop context-specific research projects that will inform decisions in different sectors. Accordingly, communication skills are quintessential in these multi-, inter-, or trans-disciplinary studies, and more emphasis should be given to them. This way programmes can ensure that future professionals are not only connected with the advances in their respected scientific field, but also they also learn to operate in an inclusive fashion.

Yet the role of educational institutes and academics in conversation science is not merely limited to the training of future professionals. Educational institutes in addition to their role of educating future professionals and producing knowledge through research have a key role to play in the development and promotion of the discipline. This includes a necessity for well-founded public outreach activities to positively influence public perception in relation to heritage, the importance of preserving it and the role it plays within a community. Academic institutions should identify future research tendencies and drive developments in the field. They should also in collaboration with partners such as ICCROM offer mid-career continuing professional development which can result in real-life solution-oriented training. ICCROM provides a link to practitioners and the challenges encountered around the world; both are essential to academic institutes. Apart from continuous training in new pedagogical methods, educators need to maintain a connection with the field and its challenges, which can lead to new creative ways of delivering problem-based teaching.

An additional concern in relation to education is the lack of dedicated conservation science textbooks (Tennent, 2013). Didactic resources in a variety of forms are needed to match different modalities of learning. For example, online platforms with case

studies could provide an alternative and stimulating way of learning and also act as a communication channel for students and professionals around the world.

Conclusion

Societal changes, scientific developments, and new challenges across the field require the implementation of a more pragmatic approach to the education of conservation and heritage scientists. Definition of the operational field will allow educators to define professional competences and learning outcomes required for future conservation scientists. A programme aimed at educating conservation scientists should include training in the intangible values of cultural heritage and should be inquiry-based with strong links to museums, heritage organizations and institutions, as well as covering communication skills, and an appreciation of the craft roots of the profession. It should encourage communication with stakeholders and the planning of projects that benefit wider society. It should allow specialization and encourage dissemination of research findings to a variety of audiences and through different channels. Educational programmes should accept students from a wide range of scientific backgrounds and build upon their strengths following a student-centred approach. Research-based learning allows students to participate actively in research projects.

Effective interdisciplinary collaboration requires effective communication, which rests upon all parties being sufficiently literate in both conservation and science. Emphasis on key transferable skills related to communication, adaptation, flexibility in methodological approach, and innovation will allow graduates to establish efficacious partnerships which will go above and beyond traditional research pathways, and will contribute in moving the field forward.

Finally, education of conservation scientists should be based on programmes designed to train a diverse body of students in distinct specializations both in science and conservation. This would break restrictive barriers between the distinctive fields, raise awareness of the mutually complementary roles various professionals have in the field, and contribute towards building future effective partnerships. Flexibility in academic curricula will allow the formation of professionals that can 'think globally, act locally' and work at different local, governmental, and institutional levels.

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Position paper

Working with policy-makers for integrating heritage science research into political priorities

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This paper draws upon the deliberations and outcomes of a discussion group at the ICCROM Forum 2013 on Conservation Science which focussed on the role of policy-makers within conservation science as important agents who can determine the future of this field, and how to strengthen the relationship between heritage professionals and policy-makers. In developing recommendations, five key areas were considered: identifying policy-makers; the actors involved in drafting and deciding a policy; what policy-makers require from conservation scientists; what conservation scientists require from policy-makers; and the ways to develop common interest between conservation scientists and policy-makers for efficient policy-making. This report summarizes the findings from each area concluding with two parts: key messages to policy-makers; and recommendations to conservation scientists to ensure that the key messages are included in policy-making.

Keywords: Policy-making, Effective communication, Policy-making actors, Quality of policy, Evidence-based, Political agenda, Heritage science research prioritization, ICCROM

Introduction: key questions

Policy-makers are important stakeholders in the field of cultural heritage conservation, and therefore also conservation science, not only as decision-makers but also as individuals who are both politically and personally benefited by heritage and its conservation. However, within the conservation profession, little attention is paid to communicating and working with this group of stakeholders, in order to raise awareness, lobby and actively contribute towards heritage policy development. This is a missed opportunity. As a large proportion of cultural heritage and its conservation rest in the public sphere, as does the majority of research funding for science, conservation science is acutely affected by governmental policy-making with regard to heritage and science. In turn, this sector should be acutely aware of the importance of good communication, developing strong relationships and actively contributing at policy-making level.

This paper draws upon the deliberations and outcomes of a discussion group at the ICCROM Forum on Conservation Science (2013) which focussed on the role of policy-makers within conservation science as important agents for the future of this field, and what recommendations can be made to strengthen the relationship between the conservation profession and policy-makers.

To facilitate the discussion, this paper is structured around the following five key questions:

- Who are the policy-makers?
- What are the factors that influence the decision-making process?
- What do policy-makers require from conservation scientists?
- What do conservation scientists require from policy-makers?
- How do conservation scientists and policy-makers develop common interests?

However, before moving on to these key questions, a first basic question to ask is why is it important to convince policy-makers of the value of conservation science? Perhaps the primary reason, even before that of resource allocation is that policy-makers have the capacity to make heritage and its conservation a priority within political agendas, in connection with contemporary issues and challenges. For example, through the recognition that heritage is a fundamental element of exercising human rights, it becomes important for policy-makers to place value on heritage conservation (and thereby also conservation science) as an

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important activity through which heritage can be protected for contemporary and future generations.

Following the establishment of cultural heritage conservation as a political priority, policy-makers then have the capacity to make or at least influence decisions to allocate resources, such as funding, to heritage and its conservation, which if successful would ensure long-term sustainable heritage policies.

Generally speaking, policy-makers prefer to base their decision-making on evidence. Therefore, it is important for conservation science research to provide evidence regarding the benefits it brings to heritage conservation. If it can also provide useful information that demonstrates the capacity of cultural heritage conservation to contribute to economic growth, social issues, and other cultural benefits through integrated approaches, this will provide yet more reasons for moving cultural heritage conservation up the political agenda.

In order for conservation scientists and other heritage conservation professionals to effectively communicate with and influence policy-makers, it is necessary to have a good understanding of who the policy-makers are, and the nature of their work. This will allow heritage professionals to know who to talk to, and how to approach policy-makers in order for their needs to be listened to. This raises two questions:

- Who directly or indirectly participates in policy-making?
- What are the factors that influence the decision-making process?

Policy-makers not only include conventional groups such as politicians, but also a whole range of people, including opinion-makers, and institutes which are involved in forming political ideas and influencing policy-making. These are not only local people but also experts and politicians working in international organizations, foreign institutes and non-governmental organizations (NGOs). The process of policy-making and the people involved vary from culture to culture and nation to nation. Moreover, policy is set out not only at local but also at international level.

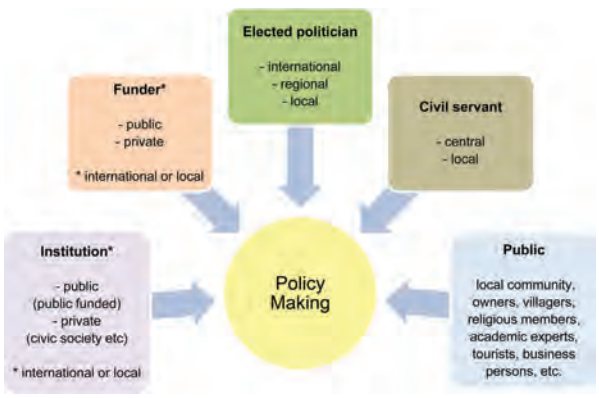

Figure 1 Types of policy-makers.

The decisions at these two different levels can be interactive and complementary to each other; or they may not correspond at all. A consideration of these aspects is given below in the section entitled 'Policy-makers'. Another important element in understanding policy-making is the knowledge of the factors that influence the decision-making process. This is needed in order to develop strategies to lobby policy-makers for constructive policies. Accordingly, a discussion on these factors is given in the section entitled 'Factors that influence policy-making'.

Once policy-makers have been identified, it is important to think about what conservation scientists and policy-makers might want from each other. In order for both parties to collaborate it is important to clarify the demands of each party and to identify what their common interests are and in what aspects they can help each other to pursue common goals. The needs of policy-makers towards conservation scientists are addressed in the section entitled 'What policy-makers require from conservation scientists' and those of the conservation scientists towards policy-makers are presented in 'What conservation scientist require from policy-makers'.

On the basis of an understanding of both policy-makers and policy-making processes, as well as the needs of conservation scientists and policy-makers, a list of recommendations for taking action in policy-making and the practical ways of how it can be developed is given as 'Recommendation and action: a way forward'.

Policy-makers

The literal meaning of policy is '*a course or principle of action adopted or proposed by a government, party, business, or individual etc.*' (Concise Oxford Dictionary, 1990, p. 921). The role of a policy-maker is to formulate, debate, and enact policy. A policy-maker may be a governmental body, political parties, public or private institutes, interest groups, and people who set a direction and priority for an action to benefit a society, a nation, or community.

Policy-making processes for cultural heritage are highly variable, given that the types of policy-makers in heritage and the ways of setting out and implementing policy vary from culture to culture and nation to nation. Moreover, policy development and implementation processes take place at many different levels from local to international. Therefore, the individuals or groups involved in policy-making for cultural heritage are equally diverse, depending on the process of initiating, discussing, drafting, adopting, and making a decision. While it is difficult to comprehensively list all types of policy-makers, common types of policy-makers can be categorized as shown in Fig. 1.

Elected politicians are arguably the most influential policy-makers. They are appointed to take responsibility for policy development for a certain period of time at the local, national, or international level. However, other types of heritage policy-makers are also influential at international level. A case in point is the ICCROM Council, the governing body of ICCROM, an intergovernmental organization dedicated to the conservation of cultural heritage. The ICCROM Council is an international expert group and is responsible for deciding and advising on the activities of the organization, from setting out an annual or long-term plan to the financial management of income and expenditure. For example, the idea for the ICCROM Forum on Conservation Science (2013) came from a proposal by the council members. This recognized the important role the organization has played in the past in conservation science and its potential to facilitate the international heritage conservation community in establishing constructive future directions for the sector. The work of international policy-makers, in some cases, is also closely related to and influenced by the policy of local government. The CHA-ICCROM fund, established by the Cultural Heritage Administration of Korea for building regional capacity in heritage conservation in Asia, is an example of such a case. The changing of the Korean government's attitude to its role as a financial contributor, increasing its overseas project budget and expanding its interest in cultural activities, played an important role in setting up the CHA-ICCROM fund in 2012. The fund project has directly contributed to the improvement of the conservation skills of local experts and conservation infrastructure.

Another example is the European Union parliament whose members decide on an extensive range of different issues and activities shared by member nations. However, unlike ICCROM, its scope of interest is of course not solely limited to cultural heritage, but covers all human-related issues from economic and political to cultural, academic and scientific matters. Considering such differences, when working from a heritage conservation perspective, it is important to understand that conservation science is a part of a larger pool of science and cultural issues, among which it has to strive for priority. Such circumstances mean that the way of approaching policy-makers and providing them with the necessary information should be tailored to their needs.

Civil servants, both in central and local governments, often work closely with the heritage sector and so are witnesses to the reality of heritage problems. They play an important role not only in policy development but also in its implementation. In many countries, such as Korea and other Asian countries where heritage conservation is led by government, civil servants are a key group in policy-making. They are involved in preparing the necessary information, enacting, and applying policy in a given area. However, as in the case of politicians who have a limited mandate, civil servants in many countries have a certain period of time in one position. While this is not universally the case, in countries such as Korea, Bhutan, Sri Lanka, and many others, civil servants in all central and local governments move from one department to another after approximately two to three years. It is also important to understand that one of their key duties in the financial management of state funds is to estimate the budget for a new or existing policy, and then to distribute or subsidize the funds to implement it. As in the case of international politicians, central and local governments prioritize their needs so that they can subsidize limited state or local funds. In Fig. 2, the case of the Korean government is taken as an example to illustrate the funding allocation process.

In addition to knowing who the policy-makers are, and the mechanics of the policy-making process, it is also important to have an up-to-date awareness of the strategic directions of the funding body, as this will influence not only the allocation of funds, but also policy development. The Heritage Lottery Fund (HLF), for example, one of the major UK funding organizations in heritage, drafted new strategic frameworks in 2011 for the operation of the Fund from 2013 onwards (Heritage Lottery Fund, 2011a, pp. 32–35). One of the changes, although it received a negative response during consultation (Heritage Lottery Fund, 2011b, p. 18), was that the HLF would increase funding for identified strategic needs, whereas funding to open programmes would be decreased.

A further important group that influences policy-making is the general public, which through interest groups works as an important opinion provider in setting out policies which contribute to understanding the significance of conservation science, as well as decisions regarding which research directions in conservation science should be supported. They are both contributors to conservation and at the same time beneficiaries of conservation through their use of heritage. The general public is of course extremely diverse in its membership, including interest groups such as scholars, owners, religious communities, and the inhabitants of historic villages. There are also tourists and business people who contribute to and generate financial benefits. However, it is useful to reflect that in most cases these interest groups have a similar role to that of institutions, as both groups influence the process of policy-making as an opinion provider rather than as a decision-maker, insisting on a required policy to funders, governments, and elected politicians.

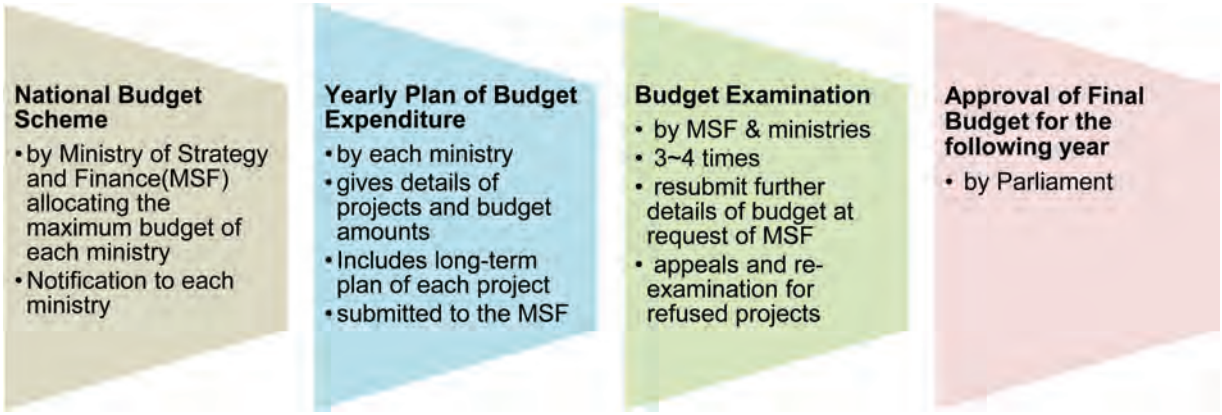

Figure 2 Process of budget allocation (Korean case).

Factors that influence policy-making

There are many different factors which can influence initiation and decision-making regarding a policy. These differ from culture to culture and case by case. However, in Table 1 the major factors are categorized into four groups: known factors within the heritage field affecting policy set-up or change; factors generated from non-heritage fields, which can be expected; factors within the heritage field, which have not been foreseen or expected; factors originated from non-heritage fields, which have not been predicted.

Arguably the most important factor influencing policy-making is the availability of information regarding the benefits of heritage and the problems in conserving what is valued. This is because this type of information provides a useable rationale for the need of policy. In most cases, such aspects need to be identified through research to establish, for example, known or newly recognized heritage values, potential and existing risks, the state of conservation, new developments in related science fields, and problems in heritage management.

Policy-makers can prioritize actions based on the balance of the public benefit to be gained and the urgency of the problem to be solved. Therefore, it is very important for a policy-maker to have evidence supported by scientific and statistical data to address the benefits and problems in order to draft a policy based on relevant information and knowledge. For this it is necessary for conservation scientists to provide clear and accurate information so that a policy-maker can set out evidence-based annual and long-term policies. In particular, the provision of timely research outcomes is an important factor because a policy should respond to a social need as soon as possible once the issue has been raised. Moreover, in the case of governmental policy-making it is important to adhere to parliamentary timeframes – there is a fixed schedule according to which parliamentary members follow a certain process, such as to review, draft and submit for a decision, and to approve/refuse a policy within a fiscal year. For example, Korean Parliamentary members need all supporting information for a new policy and funding by the end of June at the latest if it is to be adopted and implemented in the following year.

Another crucial factor is 'unexpected problems', such as a disaster resulting in rapid destruction of heritage. Disasters which affect well-recognized heritage sites attract huge public attention, requiring an immediate response to provide funds and establish an infrastructure to prevent similar problems from happening again. It also leads to the drafting of a new policy. The destruction of heritage by fire is a good example, as shown in the case of the steam clipper the *Cutty Sark* in England (2007), the Sungnyemun gate in Korea (2008) and the Wangdue Phodrang Dzong, a royal palace of Bhutan (2012). The investigation of all of these cases revealed the lack of sufficient on-site monitoring systems and adequate fire extinguishing equipment that could have prevented such extensive damage to the heritage and avoided the large cost of the subsequent restoration works. These experiences have encouraged policy-

Table 1 Types of factors influencing policy-making

	Internal factor	External factor
Usual	Availability of information concerning the benefit of heritage and its conservation	Political or social issues related to heritage
	Known risks and problems (based on past and ongoing research)	New appointment of decision-maker or politician
	Availability of funding and resources	
Unexpected	Disasters and accidents to heritage	New heritage issues caused by social or cultural interest
	New evidence or new issues	

makers to set out new policies and to provide emergency funds for recovering heritage values. In turn this also triggers new challenges for conservation science concerning the study of ancient construction techniques and materials, and the development of new contemporary conservation methods to respond adequately to such emergency situations.

The fire and reconstruction of the Sungnyemun gate, also known as National Treasure No 1, which was the south gate of the old capital city of the Joseon Dynasty (1392–1910) in Korea, illustrates all of the above-mentioned consequences. The loss of National Treasure No 1 through fire provided an indisputable reason for establishing a new 'Department of Risk Management' in the Cultural Heritage Administration of Korea. It secured the allocation of state funds for research on risk and disaster management of architectural heritage in Korea, thus expanding the field of conservation science research. In addition the decision to reconstruct the extensively damaged stone and wood structure of National Treasure No 1 raised new challenges for conservation science concerning the appropriate materials and techniques to be used. Roof tiles, metal components and mineral pigments applied to wood surfaces for decoration and protection from insects were particularly problematic areas on account of the lack of available information regarding the original materials and the selection of new materials to be used for reconstruction. The allocation of funding and human resources have revitalized the study and reproduction of discontinued ancient techniques, and the value of conservation received significant public attention. However, the mineral pigments applied to the new wood structure started to peel off within a few months of the completion of the restoration. The problem was connected to the difficulties associated with rediscovering lost traditional techniques for producing and applying pigment to wood surfaces. As a result, government authorities, artisans, and the public have realized a previously unanticipated need for long-term research. The strong criticism directed against the Cultural Heritage Administration of Korea focussed on the lack of scientific research, and has requested the establishment of a long-term policy for the study and development of traditional painting materials and techniques. The case has resulted in new opportunities for conservation science and extended the role of scientists in heritage conservation.

The conventional role of conservation scientists has been limited mainly to the analysis of materials and techniques which were applied to objects for conservation treatment. This is because modern conservation principles have stressed the preservation of an object to retard the process of deterioration rather than the restoration of missing parts. However, the public in many developing countries, such as Korea, China, and other Asian countries, demand that heritage policies and principles affirm existing values, create new ones and bring benefit through the promotion and use of heritage. Therefore, reconstruction and restoration have been approved when a certain heritage has great public value or has played an important role in shaping national identity. In such cases the role of conservation scientists can range, for example, from scientific analysis to developing new materials of the same quality as traditional materials. After the problems of the Sungnyemun gate reconstruction, the Cultural Heritage Administration of Korea has appointed two institutes to meet the demand for new pigments in the restoration and repair of timber buildings: the National Research Institute of Cultural Heritage (NRICH) to analyse traditional pigments and to produce alternative pigments which can replace the lost pigments; and the National University of Cultural Heritage to produce commercial pigments as soon as the NRICH prototype pigments are ready. Conservation scientists in the Conservation Science Division of NRICH have set up a five-year project to collect information on pigments in old documents, analyse traditional pigments in ancient timber buildings and existing commercial pigments on the market, and produce a prototype of the same quality as traditional pigments.

What policy-makers require from conservation scientists

First, policy-makers need resources to draft a policy which reflects contemporary social needs and demonstrate the impact of political decisions. Moreover, a quick response to such needs is important. An effective policy must have a positive impact on the targeted issues. In order for policy-makers to do this, they need conservation scientists to provide relevant information and reliable data to display the positive change on the condition of heritage before and after implementing a new policy. A good example is if conservation scientists, by monitoring a timber structure over time, can indicate to a site manager or a decision-maker when a regular repair should be executed. Furthermore, if they can work with a quantity surveyor to compare the cost of regular maintenance to that of emergency repairs and restoration when a heritage collapses, then policy-makers can establish a new policy or legal framework to oblige site managers and owners to conduct regular monitoring and repair work as a mandatory process. Policy-makers would welcome such a situation because it can provide an opportunity to generate economic revenue by fostering private sector structural stability monitoring.

Second, the quality of a policy, in terms of its relevance, adequacy, and consistency, is a crucial way

for policy-makers to demonstrate their competence and secure re-appointment or re-election. In many cases, heritage issues appear to be an important tool to satisfy voters and stakeholders. Therefore politicians are interested in integrating heritage into the priorities of political projects, education, and social welfare. In addition, for many developing countries, heritage is becoming a useful political mediator in strengthening cultural association or reaffirming national identity. Research on manufacturing techniques of metal objects by the Joongwon regional office of NRICH shows how conservation scientists have played an important role in reaffirming local identity. Since the office was established in 2007, they have conducted multidisciplinary research in archaeological excavation and conservation science to understand the advanced skills used to produce ancient metal objects in Korea, which has shaped local distinctiveness for centuries. The outcome of their research has attracted the attention of local politicians and people and influenced the setting up of a conservation laboratory in the regional office.

Third, rather than 'wishful thinking', policy-makers prefer to work on the basis of clear evidence, sound arguments and scientific data. Funds and resources are already limited. Therefore, the reasons for, and the impact of, a new policy have to be clearly explained to the public. The quality of a policy is dependent on the relevant information provided by academic experts and institutes, and balanced judgement between different issues both within and outside the heritage field. Policy-makers expect conservation scientists to provide useful resources in order to facilitate their role in policy-making. It is very difficult for a policy-maker to go through all of the steps of collecting, reviewing, and interpreting scattered information because they are not specialized in heritage matters. Therefore, it is inevitable that they depend on experts who can understand the problem, select and examine relevant information and synthesize this into a useable resource. Policy-makers want information which is directly relevant to contemporary issues and easy to understand.

Considering the three aspects mentioned above, the two important things that policy-makers want from conservation scientists are timely submission of information to respond to contemporary needs; sound data; and information to draft efficient and competitive policies.

What conservation scientists require from policy-makers

Conservation scientists conduct research not just for the interests of their institution but for it to be usefully applied in practice to benefit society. Scientific research in cultural heritage conservation is of no use if the research outcome does not provide useful information such as understanding an issue or constructive solutions to tackle problems in practice, but rather remains buried in papers as a theory or academic reference. In order to convert heritage-related research into a useful resource to be applied in practice, there are several things that conservation scientists require from policy-makers.

First, heritage is a resource to generate economic benefit and social solutions so, conservation scientists want heritage matters to be integrated into political priorities. Considering that heritage has been a useful resource in education, tourism, urban planning, and many other important social activities, heritage policy should be taken as an important issue in setting out policies of social, cultural, and economic activities.

Second, heritage-related policy requires consistency and continuity in legislation and policy based on a long-term vision and commitment. Policy-makers need to understand the important nature of heritage, which is that it is an irreplaceable resource; it is not possible to recover its value and authenticity once it is damaged or lost. Accordingly, heritage policies should be drafted and decided upon while reflecting on these aspects. Policy-makers should understand that the conservation of heritage is a long-term process which includes various types of activities; heritage needs to be regularly monitored, repaired in a timely manner and properly maintained, and evaluated with regard to its significance. Therefore, sufficient funds for the implementation of a policy should be secured so that the full cycle of all necessary related works can be undertaken without risk of termination due to lack of funding at a later date. In reality, it is difficult for policy-makers to allow conservation scientists enough time and funds to establish a depth of knowledge. However, this can lead to shortcomings and sometimes quite high-profile failures – as demonstrated by the example of the Sungyemun reconstruction project-mentioned above where problems encountered in the reproduction of traditional painting techniques were in part caused by a lack of time allocated for research and development. Therefore, policy-makers should bear in mind that a policy to solve a problem quickly is not always an efficient one in the long run.

Third, conservation scientists would like policy-makers to provide efficient and constructive opportunities to exchange ideas and information between them. Feedback on the effect of a policy that policy-makers has drafted and implemented, for example, or information on changing national strategy in social and cultural field can provide useful information to conservation scientists to integrate a certain theme of their research into social issues.

Recommendations and action: a way forward

At the ICCROM Forum 2013 on Conservation Science, it was recognized that conservation scientists are currently facing a particularly challenging period in terms of the survival, development and expansion of their role and responsibilities in the heritage field. The challenges differ from culture to culture. Many Western countries, which have developed advanced techniques and research capacity in conservation science over the last few decades, have been faced with a constraint in funds in recent years. Conversely, many Asian countries, which need to build capacity in conservation science to meet the increased demands of heritage issues in society, face the problem of a lack of infrastructure and knowledge to develop the necessary skills.[1] However a lack of understanding about the societal significance of heritage in the modern era and the need to insert heritage into political priorities are problems shared in both Western and Asian countries. To solve these problems, the following fundamental messages need to be acknowledged and understood by policy-makers:

- Heritage is a key element to sustain cultural and social identity and enrich the quality of life of the people belonging to that society. Its role in a society can only be secured by a carefully designed heritage-based policy.
- Heritage is a resource that can generate economic benefit and provide solutions to social problems. Heritage, therefore, should be integrated into contemporary political priorities.
- Research on heritage, both in scientific and humanistic aspects, plays an important role in all processes of heritage-related activities: in understanding, conserving, and appreciating both the tangible and intangible values of heritage. Research activities, therefore, should be promptly supported and promoted so they can play their role in providing a constructive platform for heritage-related activities.
- Considering that heritage is living legacy, with the imprint of myriad layers of human activities over centuries, has been valued, used and conserved for many years since it was created, and will be a useful asset to benefit future generations, heritage-related activities should be managed as a long-term process. This means that long-term policies and legal frameworks to support the activities should be developed.
- Heritage conservation is a social process of understanding tangible and intangible values, finding various options of conserving it, making a decision on the best way to conserve it and benefit the public and delivering it to future generations. There is no set of universal solutions for such a social process; therefore, continuous research to make better decisions should be carried out.
- Effective policy can be set out when it takes an evidence-based, value-based, and people-based approach. Policy-makers, therefore, should effectively collaborate with experts in the various areas of heritage so that they can provide prompt and useful information to improve the quality of a policy. In order for heritage professionals to bring useful research outcomes to the discussion, it is important that policy-makers share information and ideas on political agendas and national strategy with heritage professionals. This will allow the experts to provide relevant knowledge and participate in and contribute to the establishment of effective policies.

In order for the above messages to be emphasized and acknowledged by policy-makers, a number of actions are needed to improve the working relationship between heritage professionals and policy-makers in terms of the manner and content of communication. At present conservation science is insufficiently integrated with political or social sciences. Moreover, the number of conservation scientists – or indeed any other heritage professionals – who work directly or indirectly with policy-makers, or who are involved in policy-making is very small. As a result, there is insufficient awareness within the heritage conservation field of the processes and people involved in policy-making, as well as a lack of capacity and emphasis on research topics needed to provide specific evidence for setting out strategic statements to policy-makers. In addition, the information exchanged between policy-makers and heritage professionals is not always useful enough to support each other's work.

First, it is necessary to establish constructive and efficient communication channels, such as regular or occasional workshops and parliamentary hearing sessions, between policy-makers and heritage professionals including conservation scientists, and to make good use of existing ones. Parliamentary hearing sessions, in particular, are an efficient communication channel to discuss specific problems and projects with policy-makers. Therefore, conservation scientists need to have a prepared audience-focussed strategy to attract the targeted policy-maker's attention. Two important bodies making decisions on the national budget in many countries are central government and the Ministry of Finance. National budget processes orchestrated by these two bodies include several hearing sessions on the budget requested for

[1]The Asian Cooperation Program on Conservation Science (ACPCS) run by the National Research Institute of Cultural Heritage of Korea and CollAsia and by ICCROM as a CHA-ICCROM funded project on behalf of the Korean government reflects the growing demand of such initiatives in the Asian region. In addition, the project strategy of Korea International Cooperation Agency (KOICA) has changed in recent years from building tangible infrastructure such as road construction into capacity building in heritage conservation. Their project in Cambodia, for example, started with road and hospital construction in 2005 and extended to restoration of the world heritage site in Ankor Wat in 2011. The government of Bangladesh requested KOICA in 2014 to provide funds to establish a conservation laboratory in the National Museum and a training programme, and the examination into the request is ongoing.

an individual project from government sectors. The hearings take place at each phase of the budgetary process, such as reviewing the rationale of each project and appropriateness of the requested budget, or adjusting the budget between all projects and deciding a final budget for each project for the upcoming year. The perspective of reviewing and criteria of finalizing budget for these bodies can be slightly different. For example, in Korea, parliament is influenced by party political interests which tend to favour projects with short-term benefits for the public just before elections rather than those needing long-term funding, whereas the Ministry judges the significance of projects according to different types of social problems rather than outcomes visible to the public. Therefore, conservation scientists need to understand the aim and perspective of the different decision-makers and use the relevant strategy for each communication opportunity. The Korean parliament has a Committee of Cultural Affairs to review heritage projects (including that of conservation science) and the Ministry has the National Committee of Science and Technology to review a part of the heritage budget. Therefore, in parliamentary hearing session's conservation scientists need to explain in what way heritage projects can visibly benefit the public whereas in ministry hearings they need to emphasize why conservation science projects should be funded rather than other scientific projects.

Second, for the above message to be delivered to policy-makers, conservation scientists should produce and provide different types of information for each step of the process; from preparing, drafting and implementing a policy as shown in Table 2. It considers the three different stages of policy-making and gives a list of aspects for each stage to be clarified, studied, analysed, and prepared by conservation scientists and other heritage professionals involved in policy-making.

The role of conservation scientists in preparing, drafting, and implementing a policy is to provide relevant information and scientific data on time. Therefore, understanding the ways in which the process works and what actors influence each stage is key for them to play their role well. Given the lack of awareness in the heritage field regarding policy-making, further studies on heritage policy-making processes should be conducted at local and international level.

In addition to understanding the process, conservation professionals also have to understand the criteria policy-makers use for prioritizing which issues should be tackled with limited funds. Accordingly, it would be helpful if conservation science can integrate with political science to better understand these criteria, and produce the relevant information for deciding on priority in policy-making.

The value of heritage in terms of its benefit to society cannot be justified by unsupported statements; it should be demonstrated through evidence and examples. Therefore, it is necessary for conservation scientists, together with other heritage professionals, to examine heritage issues from the standpoint of social science to evaluate heritage from a new perspective, as a resource to generate economic benefits and social solutions which can be integrated into contemporary political priorities. The benefit of heritage then should be outlined in statements drafted for different audiences including different types of policy-makers. Conservation scientists need to speak to policy-makers in a clear understandable language rather than using impenetrable technical terminology. One of the mistakes conservation scientists make is to provide complex diagrams and charts to show accurate data and evidence. Policy-makers, however, prefer simple and clear statements on what is the direct impact of a project on the life of the public. The Cultural Heritage Administration of Korea use

Table 2 Recommended actions to support heritage policy development

	Preparing stage	Drafting stage	Implementing stage
What to clarify	What do we want from policy-makers	Method of decision-making	Research priority
What to research	1. Benefits of heritage	Actors in decision-making	1. Practical information by topics
	2. Identification of contemporary issues and problems		2. Instruments to evaluate the quality of a policy
What to prepare	Strategic documents	List of priorities (action plan)	Relevant information by topic for implementing a policy
	Benefit of heritage / Nature of heritage and conservation	With statistical data / With scientific evidence	
Guiding principles	Must be easy to understand	Political science + conservation research	
For whom	Policy-maker	Policy-maker	Site manager
			Contractor
	Public		Public
			Heritage experts

caricatures, flowcharts, cartoons, or videos to attract the public's attention when advertising new policy in websites or posting it on the social network service. Conservation scientists need to get away from conventional ways of making statements from their own perspectives and develop new and effective tools for delivering information.

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Position paper

Communicating conservation science

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What are the key messages conservation science should communicate to the public? Although the profile of conservation science itself can be raised by talking about the process, most feel that the messages should concern what conservation science brings to the focus of its work – cultural heritage. However, it is no longer enough to focus on the needs of heritage in isolation. Demonstrating public benefit is crucial to persuade decision-makers to invest not only in the conservation of cultural heritage but also in the science that informs its care. Conservation science can research the significance of cultural heritage and how to enable access to it, but it now also needs to engage the public actively in its activities. This means continuing to use the traditional 'hard' sciences of physics and chemistry but also learning from and collaborating more with less familiar partners such as the social sciences, the medical sciences, and natural heritage to demonstrate how conservation science is good for people, and developing new methods of communication to do this. Conservation science needs to engage with the public not only as a subject for research but also as a means of doing the research, so the end also becomes the means. Public impact should be factored into conservation science projects, with training in communication and the principles of interpretation provided to those involved. A more fundamental shift may be required in the sector however, that puts people's benefit at the heart of conservation science as much as the benefit of the cultural heritage it engages with.

Keywords: Conservation science, Public benefit, Public value, Public engagement, People-centred approach

On bending a piece of tin. 'It's not wondrous straight off [but by holding and bending it] I felt it crackle between my fingers … and heard it [shriek], and suddenly a ductile bendy material started to feel that it was splintering and cracking and sounded like glass. Mark explained that this was because of the crystal structure inside the metal and the crystals sliding over each other. Suddenly what was opened up to me was the world inside stuff, and that through understanding that stuff I can now imagine differently, I can now think better about the things that I make and the world which I inhabit.'[1]

Introduction

Is conservation about people or about heritage? Increasingly, there is a view that conservation should focus on how people benefit from its work as much as the heritage asset. The ICCROM Forum 2013 on Conservation Science agreed that conservation science does not exist for its own benefit but for the benefit it brings to cultural heritage. Conservation science must also, by extension, focus on how it can investigate and demonstrate the value of cultural heritage for people. Therefore, the question of how conservation science can demonstrate this value is crucial for the future of both heritage and conservation science.

People-centred conservation science

The development of the scientific paradigm of conservation into a model that embraces the interests of people can be traced through many examples and references. Most of the following are from a UK perspective as this is the main area of the author's experience. In the twentieth century, in the west, the damage to the cultural heritage caused by war and subsequent rebuilding led to codes of practice such as the 1964 Venice Charter (ICOMOS, 1965). These ethical guidelines developed an objective, scientifically based paradigm of conservation whose focus was the well-being of authentic cultural heritage assets. Threats of damage by warfare and injudicious development continue world-wide as Europe tries to build its way out of recession, developing countries attempt to enhance their standards of living through building and redevelopment, and conflict

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[1]Zoe Laughlin, Co-Founder of the Institute of Making, UCL, on 'The Life Scientific: Mark Miodownik'. Broadcast on BBC Radio 4 Tuesday 11 March 2014, MP3 available at <http://www.bbc.co.uk/programmes/b03xdmz8> [accessed 25 August 2015].

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persists. By the end of the twentieth century, people and the intangible qualities of heritage that they value have been placed increasingly at the heart of the conservation process, as exemplified by the Burra Charter (Australia ICOMOS, 2013). The beneficiaries of conservation are now felt to be people as much as, if not more than, the heritage asset itself. Conservation science needs to address this change of emphasis.

Cultural heritage conservation arguably lags behind other heritage sectors in demonstrating its value and relevance to society. In the world of nature conservation, the concept of eco-system services and the benefits that they bring to mankind has proved persuasive in leveraging support from governments and institutions.[2] The benefits of cultural heritage tend to be measured as economic benefits principally in terms of tourism and development (Mason, 1999; De la Torre, 2002; Cassar, 2006). Whilst other benefits are recognized as being delivered by cultural heritage (Jones & Holden, 2008), they do not have the same impact, especially during economic recession or where there is a desire to improve standards of living such as housing, services, and infrastructure (Rypkema, 2008).

Even before the most recent economic recession began in 2007, cultural heritage conservation had begun to tackle the need to justify the public funding of heritage by demonstrating the benefit it provided to the public, not least because public funders such as government and its agencies, for example in the UK the Heritage Lottery Fund, demanded it. The public benefit of conservation is increasingly addressed in conferences such as those mounted by IIC (*Conservation and Access*, London 2008), ICOMOS (*Le Patrimoine*, *Moteur de Développement*, Paris 2011; *Heritage and Landscape as Human Values*, Florence 2014), DEMHIST (*The Artifact, its Context and their Narrative*, Los Angeles 2012), and ICOM-CC (*Building Strong Culture through Conservation*, Melbourne 2014). The need to make this case is demonstrated by the concerted lobbying that was necessary to reinsert 'Cultural Heritage' as a theme in the EU's Horizon 2020 €78 bn research and innovation grants programme.

What are the key messages that conservation science should communicate to the public

Communicating the full significance of heritage

Scientific analysis and research help to reveal the meaning and significance of cultural heritage, in tandem with other disciplines such as history. In addition to providing understanding of deterioration processes and developing preservation treatments, conservation science can assist in understanding how heritage has changed over time, by revealing its history (technical art history), authenticating heritage assets, and informing conservation and presentation decisions such as cleaning techniques and levels. Conservation science can make connections between cultural heritage artefacts and history, such as identifying trade routes that shaped human society. The application of the social sciences and techniques such as demographics to the conservation science field of activity shows how people benefit from cultural heritage, what they themselves value about their heritage and how they wish to use it. New technologies can be investigated and developed by conservation science to communicate the significance and values of heritage to the public; for example, through digitization, scanning and computer modelling, giving alternative views, and virtual access where the original is too fragile or physically distant to be directly enjoyed.

Communicating current threats to cultural heritage and their management through conservation science

Conservation science addresses big issues. Climate change and extreme weather are today considered amongst the principal threats to cultural heritage. Conservation science is crucial to understanding building physics and material response, often rediscovering the lessons of the past in designing sensible and economic adaptations that are applicable not only to cultural heritage assets but also to the wider fabric of people's lives. Rates of decay caused by agents already studied by conservation science may be accelerated through warmer, wetter weather promoting mould and insect attack, or shrinkage and embrittlement through drought, or elevated temperatures in cities. Extreme weather exposes building weaknesses in domestic as well as historic buildings, such as damaged roofs and inadequate drainage, and causes direct damage such as flooding, subsidence, and collapse. Conservation science can reveal how ill-considered adaptation risks sacrificing heritage values to no good 'green' purpose, for example destroying long-lasting historic windows in favour of short-lived, visually inappropriate, uPVC double glazed units, when the issue is the seals, not single glazing; and demonstrate how everyday measures such as curtains and shutters can improve insulation effectively.[3]

Nevertheless, cultural heritage is still threatened by the forces of social change, war, and redevelopment to which the Venice Charter responded. Keynesian strategies of building out of recession through infrastructure and housing projects still prevail in the West. Such strategies threaten not only natural

[2]See for example <www.gov.uk/ecosystems-services> and <www.epa.gov/research/ecoscience/> [accessed 25 August 2015].

[3]See <http://www.historic-scotland.gov.uk/gcu-technical-_thermal-efficiency-traditional-windows.pdf. [accessed 21 August 2015].

landscape, but also built heritage, as heritage buildings and neighbourhoods are demolished to make way for, or are submerged by, new high-rise glass and concrete structures such as The Shard in London and the waterfront redevelopment in Shanghai. At the same time, some of these buildings may be the heritage of the future. Cultural heritage is also threatened by an increasingly competitive market place for public support which means its presentation must be refreshed constantly to remain relevant.

In these threats lie opportunities for conservation science to contribute to an increasing appetite for content, real experience and a desire for value that is not just financial. Conservation science must continue to deal with the physical issues of decay and their control, but must also develop ways of establishing and delivering the social benefit of cultural heritage, and how best to communicate these issues and benefits to the public.

Communicating how conservation science enables the physical accessibility of cultural heritage to the public

Conservation science enables access. The hard sciences such as physics and chemistry study the tolerances of heritage material to agents of deterioration such as light exposure which people need in order to see, and the impact of relative humidity (RH) levels and fluctuations from comfort heating and cooling. This informs environmental control strategies which ensure heritage remains accessible to the public for as long as possible. Conservation science also investigates the risks associated with public access, so that they can be managed, such as a Leverhulme Trust funded joint research project by the University of East Anglia, Historic Royal Palaces, and the National Trust and English Heritage. This studied visitor-related dust in historic house collections on open display. It showed that regular housekeeping and RH control is needed to prevent dust cementation (through the formation of calcite and sticky exo-polymers by microbiological growths), which requires removal through remedial conservation. Acceptable soiling rates and associated management strategies were identified such as the design of visitor routes, protection, and the arrangement of displays.[4] The ever increasing demand for access means all research needs regular review, to enable managers and practitioners to move away from generic rules to site-specific measures: local assessments of risk enable public access to be maximized within acceptable rates of deterioration rather than reduced to a minimum. Statistical approaches used in the medical world such as epidemiology and demographics can be applied to bulk collections such as libraries to understand decay mechanisms, as investigated by the Collection Demography project, UK.[5]

How conservation science can help understand how people value cultural heritage and its conservation and what they want from it

Conservation science helps understand people's needs. The social sciences have been used extensively in marketing to understand what customers want, applying statistical analyses to quantitative and qualitative data collected through surveys, observation, and social experiments (Lithgow et al., 2012a). As well as being applied to the marketing of museums and historic houses, these methods are now used to evaluate the public benefit of conservation activities and influence the design of the work (Lithgow *et al*., 2012b).

In the National Trust for England and Wales, UK, methods derived from the social sciences have been used to show that whilst people think that the organization is objectively a good thing, they may not choose to support it personally. The development of the participatory model of museums, of using happiness as a measure, and of museums as social enterprises with a community focus, all evidence the trend for cultural heritage to demonstrate its benefit for people at all levels, not just the intellectual.[6] Conservation science can research these benefits and help design ways to enhance the delivery of these benefits through cultural heritage conservation.

How conservation science can help understand and develop effective means of communication

Conservation science can investigate and develop the ways in which cultural heritage and its conservation can be communicated most effectively to the public. The general science community takes communication extremely seriously, with an ambition to enable people to become as literate in science as they are in culture. There are organizations and events dedicated to promoting science; with training courses ranging from masters courses to workshops to help scientists develop communication skills.[7] These skills make conservation science interesting and entertaining, but through skilled messaging avoid over-simplifying science in the interests of popularization.

It is no coincidence therefore, that the UK's National Heritage Science Strategy puts public benefit as the first of its two aims: 'to demonstrate the public benefit of heritage science and to increase public engagement and support for it' (NHSS Steering Group, 2010).

[4]See <http://www.nationaltrust.org.uk/article-1356397219282/for> a bibliography [accessed 25 August 2015].

[5]See <http://www.bartlett.ucl.ac.uk/heritage/research/research-projects/projects/collections-demography> [accessed 25 August 2015].

[6]Participatory museums (<http://www.participatorymuseum.org/>), happiness measures (Fujiwara 2013), and the model of community-based social enterprises (<http://www.choicesforchange.info/wp-content/uploads/2011/03/Social-enterprise-and-museums-II.pdf>) [accessed 25 August 2015].

[7]See, for example, <http://www.sciencecabaret.org/ and http://www.cheltenhamfestivals.com/science> [accessed 25 August 2015].

Vision

Where should conservation science aspire to be in 5 years' time? It should be connecting with people emotionally as well as intellectually, inspiring them through cultural heritage and its conservation, so that their quality of life is improved now and for the future. Put in the vernacular, 'conservation science makes me, my neighbourhood, and my planet feel good'.[8]

The ICCROM Forum defined the public benefits of conservation science as helping tell the story of humanity through cultural heritage at the global and the local level. It allows the diversity of society and its many communities to be appreciated, and encourages people's sense of personal ownership for cultural heritage. Conservation science forms a crucial meeting place for people and cultural heritage through the examination, understanding and care of heritage assets by scientists, conservators, owners and the multitude of stakeholders. Conservation science helps heritage to change as people and society change, by enabling what is important about the past to be handed on to future generations. Understanding these processes of change through conservation science reveals their historic scale and puts today's challenges in context as well as reviving solutions from the past that are relevant to the future. Therefore conservation science is a positive and constructive force which improves people's quality of life. It can help the healing of damaged communities through helping their spirit of place to be understood and recovered, and through telling the stories of their heritage.

Themes that emerged during the ICCROM Forum to guide conservation science's communications with the public included:

- *Building the future*: conservation science connects people in time and place through conserving heritage. Conserving cultural heritage is the starting point for a sustainable future, forming our children's legacy.
- *Making connections*: conservation science connects the future with the past by enabling the survival of cultural heritage. It connects people by identifying and understanding the diversity of publics engaged with heritage through in-depth and multi-disciplinary studies that include both hard and social sciences such as sociology and psychology. Conservation science enables links to be made between people and heritage, revealing their past and designing their futures at both the macro and the micro level, whether dealing with the impacts of global climate change or of dust.
- *Benefitting people*: conservation science benefits people by preserving their cultural heritage enabling the various interests of the diverse publics that create and use heritage to be taken into account and securing this heritage for children's future. Thus conservation science enables people's fundamental human right of access to their cultural heritage.[9]
- *It's personal*: cultural heritage is created and owned by people and looked after by people through conservation science. Conservation science asks people what they value about their heritage, reveals their heritage, and helps people discover things for themselves.
- *Promotes caring*: conservation science enables cultures to care for culture through the restoration and conservation of cultural heritage, sustaining it for the future.
- *Is a human resource*: conservation science preserves cultural heritage so that it is available as a treasure house of possibilities to enrich and sustain our future.

Messages that arose from these themes were tested with visitors to the Trevi Fountain, located beside the ICCROM Forum meeting venue. Although the sample could be considered self-selecting, and with 19 votes in total was evidently not at all statistically significant, the message about conservation science enabling 'cultures to care for culture' was substantially more popular than ones about giving access to cultural heritage, restoration and conservation, and connecting the past with the future. This illustrates the value that people put on people – which may be a truism, but is forgotten at our peril. If we, the conservation community, are not enthused and passionate about conservation science, how can we expect this response from anyone else.

Steps to the future: how to communicate conservation science messages to the public

Things that need to be done to achieve this vision were identified as follows.

- *Developing capability within the conservation science community*. We have some star performers and communicators within the scientific community but we need more in conservation science. Capability can be developed by engaging with interpretation and communication professionals, and participating in the communication programmes of the wider science community, but should also be built into training. Those involved in the work should become able to communicate effectively not only what conservation science discovers and the story of how it does this, but also to engage people in doing conservation science, and use that experience to enable understanding of conservation science beyond the exchange of information.
- *Devising measures*. On the well-established principle that 'what gets measured gets done', to drive this shift in focus forward, conservation science and the

[8]Training in communication skills has also recently been called for as a means of ensuring better collaboration within heritage and conservation science, let alone beyond it. See <www.nationalarchives.gov.uk/about/mind-the-gap.htm> [accessed 25 August 2015].

[9]See the UNESCO declaration on cultural diversity <http://unesdoc.unesco.org/images/0012/001271/127160m.pdf> [accessed 25 August 2015].

projects in which it is involved should include public impact in their success measures. This is, in any case, increasingly frequently required by funders, for example the UK Research Councils.[10]

- *Understanding the needs of diverse publics.* Effective communication and interpretation of conservation science requires a clear understanding of audiences and their needs, to enable messages and their media to be designed appropriately. Research needs to establish what people currently value about cultural heritage, what they could value in the future, and how the gap might be filled.
- *Define what needs to be communicated.* Do people value things because of facts or because of feelings? Today there seems to be agreement that feelings drive value but they need to be built on sound evidence. There is guidance already available on interpreting heritage which is being, and can be more, developed to aid communication of conservation science. These include six interpretation principles by Freeman Tilden, commonly regarded as the founder of the interpretation of all heritage, natural or cultural (Tilden, 1957),[11] and sector guidance (UNESCO, 2007) as well as principles specific to particular organizations. These principles address the need for layered information, presented in different ways to meet the needs of the audience; using evidence to drive content, whether scholarly, scientific or living tradition; taking account of the perspectives of all stakeholders; ensuring every detail of the activity creates a coherent whole; provoking and stretching people to create an emotional and not just an intellectual connection, so that they are inspired to care for and revisit the heritage; and regularly evaluating the activity through clear and measurable objectives to ensure that the content is refreshed and thus remains relevant and inspiring.
- *Develop methods of communicating conservation science*
  - Our comfort zone should be stretched beyond traditional formal print media that convey information, such as display panels, published papers and lectures. Every contemporary means at our disposal should be used, such as informal social media and new communication platforms including the web, smartphones, and tablets, as well as TV and radio. Imagination, inventiveness, and many contributors (artists, mediators, pedagogues, etc.) will be needed to adapt communication to diverse publics. Putting this together will need a communications strategy.
  - Conservation science should be done with the public, not at or to them. The medium might be the message, especially where the research is relevant to the stakeholders themselves. Surveys and questionnaires were used in the dust project discussed earlier; contingent valuation through survey by the London School of Economics, UK, for the *Climate for Culture* research project (how much more people would be willing to pay to protect cultural heritage from the impacts of climate change); and observation and experiment as in the *Collection Demographies* project.
  - Conservation science should also learn from how other scientists have engaged people directly with their work, harnessing the public's computer power to process astronomical observations and observe wild life, collecting and analyzing data as citizen scientists.[12] Conservation science is beginning to doing this, as seen in how scientists, archaeologists and conservators have had to learn how to accommodate metal detectorists (English Heritage, 2014). However, such activities will need to increase, for example working with volunteers.
  - By becoming the show, conservation science can make more emotional connections with people. Conservation science is an element of 'conservation in action', celebrated since 1994 by the IIC Keck Award. Recent recipients of this award include the Lunder Conservation Centre, Washington, USA, where the conservation of cultural heritage forms the visitor attraction[13]; the Acropolis Museum in Athens, Greece, for the laser cleaning of the Caryatids in front of the public[14]; and CSI Sittingbourne for the conservation of Anglo-Saxon burial finds in a high street store by volunteers trained and supervised by a conservator.[15] Increasingly conservation galleries are included in museums such as the Ashmolean Museum, Oxford, UK, which illustrate scientific methods used to understand and conserve cultural heritage. However, they have proved vulnerable to budget cuts, as was the case with the Conservation Centre of National Museums, National Museums of Liverpool, Liverpool, UK,[16] and the British Library's Preservation Advisory Centre in London, UK.[17] These last have both closed as visitor attractions, although they still carry out conservation, and provide advice. The reasons for this vulnerability might be because of

[10]See <www.rcuk.ac.uk/pe/>, and <www.rcuk.ac.uk/ke/>, [both accessed 25 August 2015].
[11]See <http://thesciencepresenter.wordpress.com/2011/01/24/6-principles-of-heritage-interpretation/> [accessed 25 August 2015].
[12]See <http://citizencyberlab.eu/2012/11/learning-by-doing-citizen-science/> [accessed 25 August 2015].
[13]See <http://americanart.si.edu/lunder/>.
[14]<http://www.iesl.forth.gr/research/project.aspx?id=131> and *News in Conservation*, Issue 34, 2013, available online only at <https://www.iiconservation.org/system/files/publications/journal/2013/b2013_1.pdf> [both accessed 25 August 2015].
[15]For CSI Sittingbourne, Kent, UK, see <https://www.facebook.com/pages/Anglo-Saxon-CSI-Sittingbourne/247290788632730?ref=hl&ref_type=bookmark, http://hc.english-heritage.org.uk/content/pub/2011/cs-csi-sittingbourne.pdf> and *News in Conservation*, Issue 34, 2013, available online only at <https://www.iiconservation.org/system/files/publications/journal/2013/b2013_1.pdf> [both accessed 25 August 2015]. *CSI* is a popular British television series depicting forensic scientists who undertake crime scene investigations.
[16]See <http://webarchive.nationalarchives.gov.uk/20080609144937/liverpoolmuseums.org.uk/conservation/>, and <http://www.museumsassociation.org/museums-journal/news/10122010-nml-conservation-centre?c=SUB227819> for the Conservation Centre in Liverpool.
[17]See <http://www.bl.uk/blpac/about.html> for the British Library [all accessed 25 August 2015].

management perception that their visitor appeal was a 'good' rather than an 'essential' thing, because of a lack of public profile and support. Can conservation science provoke experiences which change people's perceptions and understanding by using all of their senses as well as their intellects, in the same way that experiential methods of learning are being explored in medical science research at Imperial College, London, UK, by Professor Roger Kneebone?[18]

Conclusion

Conservation science needs to put people at its heart to enable 'cultures to care for culture'. It has to appeal to people's hearts as well as their minds so that people are inspired to care for heritage.

Conservation science enables cultural systems to provide services to people. It gives people access to heritage by revealing its meaning and caring for it, so that it survives for future generations to enjoy it. It unites young and old, local and global communities through being a place where people and heritage meet. By enabling people to enjoy heritage, conservation science helps people to care for it, so that they can continue to use it.

Through revealing the meanings and value of cultural heritage, conservation science allows us to understand each other and ourselves. By taking care of heritage in the face of threats from conflict, the undesirable impacts of development, or climate change, conservation science helps us to take care of ourselves, promoting respect and trust of others, whilst demonstrating the value of the long term view that enables people to rebuild and heal their society.

Conservation science can learn from the experience of other scientists and other disciplines to acquire the skills and techniques it needs to move the public from being audiences to participants in its work, so they become co-creators and narrators of the messages communicated by conservation science. By so doing, conservation science will show that it can 'make me, my neighbourhood, and my planet feel good'.

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Appendix: Interpretation principles

Freeman Tilden, interpreting our heritage (1957)

1. Interpretation that does not somehow relate what is being displayed or described to something within the personality or experience of the visitor will be sterile. Interpretation should be personal to the audience.
2. Information, as such, is not interpretation. Interpretation is revelation based upon information. Successful interpretation must do more than present facts.
3. Interpretation is an art, which combines many arts. Any art is in some degree teachable.
4. The chief aim of interpretation is not instruction, but provocation. Interpretation should stimulate people into a form of action.
5. Interpretation should aim to present a whole rather than a part. Interpretation is conceptual and should explain the relationships between things.
6. Interpretation addressed to children should not be a dilution of the presentation to adults, but should follow a fundamentally different approach. Different age groups have different needs and require different interpretive programmes.

The ICOMOS Charter for the interpretation and presentation of cultural heritage sites (Enamecharter) (UNESCO 2007)

Principle 1: access and understanding (of the public should be facilitated by interpretation and presentation);
Principle 2: information sources (base interpretation and presentation on scientific and scholarly methods as well as living cultural traditions);
Principle 3: attention to setting and context (of cultural heritage sites should be respected);
Principle 4: preservation of authenticity (see ICOMOS 1994, The Nara Document);
Principle 5: planning for sustainability (should factor social, financial and environmental sustainability into the interpretation plan for a cultural heritage site);
Principle 6: concern for inclusiveness (interpretation and presentation should arise from collaboration between heritage professionals, the site's host and associated communities and other stakeholders);
Principle 7: importance of research, training, and evaluation (for and by heritage professionals to ensure interpretation and presentation remains fresh and relevant).

[18]An example of such emotional connection is the surgical re-enactment portrayed at <http://www.youtube.com/watch?v=dWtILWOYwpQ> [accessed 21 August 2015].

The National Trust, England and Wales, UK

This organization is an example of developing the communication of heritage from 'telling' facts to an 'emotional experience', demonstrated by the move from a rules based approach of 2007 which focusses on content to a principles-based approach based on creating feeling (see also Ingram 2011).

Five Golden Rules of Interpretation 2007

1. Know your audience;
2. Decide on your general topic and the theme/message you will use to communicate your topic;
3. Set clear and measurable objectives;
4. Try different techniques;
5. Evaluate the impact, and make changes.

In 2014, a principles-based approach which articulates the 'what' interpretation should achieve, but leaves the 'how' to the interpreter. Still under development, this approach is based on research and understanding but aims to engage with audiences on all levels, as well as the intellectual.

Seven principles of interpretation 2013 — which combine the principles of service delivery and welcoming visitors with interpretation principles:

1. Create the right first impression;
2. Let the spirit of place shine through;
3. The visit should appeal at different levels (multi layered offer);
4. Every detail counts;
5. Allow the place to speak for itself if it can;
6. Provide reasons to return;
7. Stretch and surprise people – using scholarly, technical, and emotional keys.

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Appendix

ICCROM Forum 2013 on Conservation Science

ICCROM Forum 2013 group photo

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2. Universidade Federal de Minas Gerais-CECOR, Brazil (*Luiz A. C. Souza; João Antonio de Paula*)
3. Canadian Conservation Institute, Canada (*Charlie Costain; Marie-Claude Corbeil*)
4. National Heritage Center of Tsinghua University, China (*Wei Qing; Li Jianyun*)
5. Centre de Recherche et de Restauration des Musées de France, France (*François Mirambet; Philippe Goergen*)
6. National Research Council, Italy (*Daniele Malfitana; Luca Pezzati*)
7. National Research Institute of Cultural Heritage, Cultural Heritage Administration, Republic of Korea (*Sujeong Lee; Lee Yena; Jeong Eun-seon*)
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11. AHRC/EPSRC Science and Heritage Programme, United Kingdom (*May Cassar; Simon Cane*)
12. National Heritage Board, Sweden (*Gunilla Lagnesjö; Christian Runeby*)
13. Bern University of the Arts, Switzerland (*Sebastian Dobrusskin; Stefan Wülfert*)
14. The Getty Conservation Institute, United States (*Jeanne Marie Teutonico; Leslie Friedman*)
15. Smithsonian Institution, United States (*Sharon C. Park; Carol Grissom*)
16. ICCROM (The International Centre for the Study of the Preservation and Restoration of Cultural Property) (*Catherine Antomarchi; Alison Heritage; Alberto de Tagle*).

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Day 1

How can science connect with and be of greater benefit to conservation practice?

- Needs and Strategies

Group A, members: *Alberto de Tagle*[1], *Marie Lavandier*, *Sujeong Lee*, *Marco Leona*, *Stefan Michalski*, *Webber Ndoro*[3], *Janneke Ottens*[2], *Luca Pezzati*.

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- Dissemination

Group A, members: *Marie-Claude Corbeil*[1], *Hilde De Clercq*[3], *Fatima Fall*, *Linda Lindblad*, *Katy Lithgow*, *François Mirambet*, *Anupam Sah*[2], *Min Seok Seo*.

Group B, members*: Mandana Barkeshli*, *Giacomo Chiari*[1], *Veerle Meul*[2], *Salvador Muñoz-Viñas*[3], *David Saunders*, *Katriina Similä*, *Xingling Tian*, *Stefan Wülfert*.

- Research Projects

Members: *Łukasz Bratasz*, *Bruno Brunetti*[1], *Marjolijn Debulpaep*, *Bertrand Lavédrine*, *Valerie Magar Meurs*[2], *Yoshinori Sato*, *Jan Van't Hof*[3], *Yong-Jae Chung*.

- Research & Practice

Members: *Gunnar Almevik*[1], *Nancy Bell*[2], *Kenza Dufourmantelle*, *Nia Naelul Hasanah Ridwan*, *Pallot-Frossard Isabelle*[3], *Fernando Pina*, *Andrew Thorn*, *Qing Wei*.

Day 2

How can science in conservation connect with and contribute to the wider societal priorities?

- Science for Access

Group A, members: *Hilde De Clercq*, *Alberto de Tagle*, *Marián Del Egido*, *Philippe Goergen*, *Marco Leona*[3], *Katy Lithgow*[2], *Yoshinori Sato*, *Katriina Similä*[1], *Yu Zheng*.

Group B, members: *Mandana Barkeshli*[2], *Kenza Dufourmantelle*[3], *Kyeong Soon Han*, *Luca Pezzati*[1], *Fernando Pina*, *Jan Van't Hof*, *Stefan Wülfert*.

- Science for Green Conservation

Group A, members: *Gerhard Banik*, *Giacomo Chiari*, *Stavroula Golfomitsou*, *Maria João Melo*[1], *Joseph King*[3], *Gunilla Lagnesjö*, *Navin Piplani*, *David Saunders*[2], *Yong-Jae Chung*.

Group B, members: *Bruno Brunetti*, *Zani Cajueiro*, *Nia N. Hasanah Ridwan*, *Marcella Ioele Bertrand Lavédrine*[1], *Linda Lindblad*[3], *Stefan Michalski*[2], *Norman Tennent*.

- Science for Diversity

Group A, members: *Tharron Bloomfield*[1], *Łukasz Bratasz*[3], *Marjolijn Debulpaep*, *Sebastian Dobrusskin*, *Fatima Fall*, *Marie Lavandier*[2], *Salvador Muñoz-Viñas*, *Min Seok Seo*, *Gamini Wijesuriya*.

Group B, members: *Gunnar Almevik*, *Marc Jacobs*[3], *Yohei Kiyonaga*, *Valerie Magar*[1], *François Mirambet*, *Janneke Ottens*, *Dean Sully*, *Andrew Thorn*[2].

- Science for Emerging Heritage

Members: *Nancy Bell*, *Marie Berducou*[2], *Agnes Brokerhof*[3], *Marie-Claude Corbeil*, *Leslie Johnston*, *Sujeong Lee*[1], *Luiz A C Souza*, *Xingling Tian*.

- Science for the Macro Scale

Members: *Zaki Aslan*, *John Fidler*, *Veerle Meul*, *Eduardo Muñoz Gonzales*, *Webber Ndoro*[1], *Isabelle Pallot-Frossard*[3], *Anupam Sah*, *Qing Wei*[2].

Day 3: Looking ahead

How can we build an integrated and impactful future for conservation science?

- Connecting In: How Can Science Connect with and be of Greater Benefit to Conservation Practice?

Members: *Gunnar Almevik*, *Hilde De Clerq*, *John Fidler*[1], *Valerie Magar*, *Navin Piplani*, *Wei Qing*, *Luis Souza*, *Jan Van't Hof*.

- Connecting Out: How Can Conservation Science Connect with and Contribute to World Societal Priorities?

Members: *Isabelle Pallot-Frossard*, *Gunilla Lagnesjö*[1], *Marc Jacobs*, *Marco Leona*, *Janneke Ottens*, *Yoshinori Sato*, *Andrew Thorn*, *Xingling Tian*.

- Building the Future: How Can We Build an Integrated and Impactful Future for Science in Conservation?

Members: *Catherine Antomarchi*, *Nancy Bell*[1], *Agnes Brokerhof*, *Bertrand Lavedrine*, *Webber Ndoro*, *Luca Pezzati*, *Anupam Sah*, *Min Seok Seo*.

- Tools: Tools for Assessing Needs and Impacts (and management strategies)

Members: *Zaki Aslan*, *Bruno Brunetti*, *Łukasz Bratasz*, *Marjolijn Debulpaep*, *Philippe Georgen*, *Leslie Johnston*, *Stefan Michalski*[1].

- Key Messages to Conservation Institutions

Members: *Giacomo Chiari*, *Marie-Claude Corbeil*[1], *Yong-Jae Chung*, *Sebastian Dubrusskin*, *Marie Lavandier*, *Maria-Joao Melo*, *Francois Mirambet*, *Yu Zheng*.

- Key Messages to Educators

Members: *Tharron Bloomfield*, *Kenza Dufourmantelle*, *Stavroula Golfomitsou*[1], *Eduardo Muñoz Gonzales*, *Joe King*, *Salvador Muñoz-Viñas*, *Kyeong Soon Han*, *Stefan Wulfert*.

- Key Messages to the Public

Members: *Marie Berducou*, *Linda Lindblad*, *Yohei Kiyonaga*, *Kathy Lithgow*[1], *Nia N. Hasanah Ridwan*, *Katriina Simila*.

- Key Messages to Policy Makers

Members: *Zani Cajueiro*, *Marian Delegidoi*, *Fatima Fall*, *Sujeong Lee*[1], *Veerle Meule*, *Fernando Pina*, *Dean Sully*.