A Research Coordination Network: ArtSciConverge

Integrating the arts and humanities with long-term ecological research.

I. Introduction: Revitalizing the Integration of Arts, Humanities and Sciences

Human societies in the 21st century are faced with complex and interconnected social and ecological challenges in which humans are increasingly the drivers of environmental changes that jeopardize the well being of humans, societies and ecosystems. Examples include the burning of fossil fuels and land conversions contributing to a changing global climate, and the increasing and often competing needs to provide a growing world population with food, water, energy, and fiber, while at the same time maintaining the health and vitality of the natural ecosystems that provide these very services. Failure to address major social-ecological challenges in a timely fashion may result in consequences ranging from a disruptive and runaway climate; to degradation and loss of natural ecosystems; to increasing famine, social inequities and injustice; to social unrest, and even armed conflicts.

The *current paradigm* for addressing grand environmental challenges recognizes the need to bridge the biological, physical, social, and political sciences to tackle these complex problems, but often marginalizes or overlooks the role of the Arts (writ large to include the visual and performing arts, and other media) and Humanities (writ large to include creative writing, philosophy, ethics, etc.). However, there is a growing recognition that a *new paradigm* is needed, one in which authentic relationships among the Arts, Humanities, and Sciences (AHS) are revitalized to bring together the combined expertise and ways of knowing of these diverse disciplines to create a more unified approach to solving the ecological and social crises of the 21st century.

We propose to create the ArtSciConverge Research Coordination Network (RCN) to promote meaningful integration among the Arts, Humanities, and Sciences to advance ecological science and the ability of society to successfully address social-ecological challenges. Our primary focus is on creating synergy between AHS toward the goal of transformational primary inquiry (Intellectual Merit). Secondarily, we will also capitalize upon the unique power of AHS collaboration to promote successful public engagement for the goals of outreach, education, and enhancing the role of science in society (Broader Impacts).

The goals of this RCN are to 1) create a conceptual model for more fully integrating AHS into collaborative, primary inquiry aimed at major socio-ecological problems; 2) forge a strong network among existing and emerging place-based AHS integration programs and foster successful development of new AHS projects at long-term ecological research sites; 3) create a social infrastructure in which AHS researchers can thrive and share their work on this integration across sites and bioregions; 4) build diversity in AHS integration by actively engaging early-career participants from underrepresented groups and creating opportunities for educational and career advancement in the AHS; 5) increase the visibility and ensure long-term accessibility of the growing body of AHS work through peer-reviewed publications, websites, online databases, and museum archiving - blending the archiving cultures and capacities of different AHS disciplines; 6) assess and evaluate outcomes of the RCN, including impacts on participating students, scientists, artists, and communities; and 7) exchange strategies and methodologies for applying AHS integration to outreach and public education to better engage communities, policymakers, and under-represented members of the public with science.

The ArtSciConverge RCN will strengthen and cross-link relationships between an extraordinarily diverse and nascent community of artists, humanitarians, and scientists that is emerging organically from a recent groundswell in AH activities associated with NSF Long-Term Ecological Research (LTER) sites, Field Stations and Marine Labs (FSML), USDA Forest Service Experimental Forests and Rangelands (EFRs), and an expanding array of other organizations active in integrating art and science with outreach and education (Swanson, 2015). Through this ArtSciConverge RCN, we will expand the depth and breadth of these

interdisciplinary efforts in order to map a path forward in which AH activities contribute not only to outreach and education, but also to fundamental inquiry and analyses of the grand challenges facing social-ecological systems. We will also actively engage neuroscientists in the effort to connect shared dimensions of AHS (incuding creativity, perception and cognition), in the interest of enhancing the convergence of the disciplines. Outcomes of RCN engagement with artists, scientists and the public will be evaluated and assessed as part of our project. By integrating these different means of inquiry and observation, these challenges may be met in the future with greater power and insight than each discipline can offer in isolation.

II. Background and Rationale

Here we briefly recognize the historical integration between AHS, a recent trend to decouple these lines of inquiry, and emerging efforts to revitalize these relationships. By building on the growing body of works described here, and embracing the relatively new field of neuroscience, it is the goal of this ArtSciConverge RCN to encourage the growth of new line of transformational thinking, with a thematic focus of place-based, social-ecological inquiry.

The role of the Arts in western civilization has been intertwined with Science since at least the time of the ancient Greeks. Inquiry within AHS disciplines frequently differ in their processes and products, yet share many traits (e.g., creativity, keen observation), and have deeply resonated with one another historically, both by nature and necessity. Throughout most of the past two millennia, scientists were often either artists themselves (e.g. Leonardo da Vinci, Albert Einstein), or worked intimately with artists, with whom they freely exchanged ideas, and who often described and recorded the scientist's work (e.g., painter Conrad Martens on Darwin's voyages).

During the past 100+ years, the historic and cohesive roles of AHS have diverged, and a trend has emerged to increasingly rely heavily upon Science to provide the basis for technological solutions to global issues such as hunger, peace, health, and social welfare. Science indeed has radically changed societies at a breathtaking pace during this century. Examples include groundbreaking discoveries in agriculture, genetics, medicine, energy, transportation, and computing. These advances in science, technology, engineering and math (STEM) have benefited human societies, while also creating new challenges from the local to global scales in the 20th and 21st centuries.

In addition to contributing valuable lines of original and synergistic inquiry to Science (Intellectual Merit), the Arts and Humanities are also powerful means for education and outreach, and for engaging underrepresented groups in science (Broader Impacts). This RCN emphasizes the grand challenge of integrating AHS toward advancing science and addressing complex social-ecological problems. In doing so, we will also harness the power of AHS integration toward the mission of engaging, inspiring and involving diverse individuals and groups in Science, as well as connecting the public to Science in innovative, meaningful, and productive ways.

Why is this collaboration important?

BOX 1. "Any argument that leads to a conclusion about how we ought to act or what policies we ought to adopt must have two premises. The first premise is empirical, based on observation and experiment, often grounded in science. This is the way the world is, this is the way the world may soon be. The second premise is normative, based on cultural values and ethical norms. Here is the collected human wisdom about what is of value, an affirmation of what is worthy and worth doing. From this combination of facts and values, but from neither alone, we reach conclusions about what we ought to do. Collaborations between science and humanities are, in this respect, a logical as well as a practical necessity."

— K. D. Moore and M. P. Nelson (2010).

Groundswell of Art and Science Collaborations at Long-term Ecological Research Sites, Field Stations and Marine Laboratories

In recent decades, a great variety of efforts to reintegrate AHS have emerged– artists-in-the-laboratory programs, dance-your-Ph.D. competitions, installations and participatory art exhibits in major museums, and field-based artist–in-residencies, such as the National Park Service programs and the Antarctic artist-residency program. In ecology, a relatively rich history of AHS activities exists at individual LTER sites and FSMLs. *These programs are just beginning to converge and gain recognition* (Swanson 2015; Figure 1). LTERs and FSMLs are particularly conducive to this type of collaboration because they are place based, long term, and are already increasingly focused on social-ecological interactions (Box 2). The place-based science that occurs at these facilities focuses on collecting and investigating data from a specific site in order to create information and knowledge about that location, knowledge that in turn has relevance to other locations. The place-based art created at this same location allows for a deeper understanding of that site and produces emotional responses to it, responses that can apply to other sites and communities, inspiring empathy and action on local, regional and even global issues. Notable successes include engaging artists and scientists in common dialogues to address tough environmental issues in future scenario projects and formulation of conservation strategies, such as environmental change in interior Alaska and the upper Midwest (reviewed in Swanson 2015).

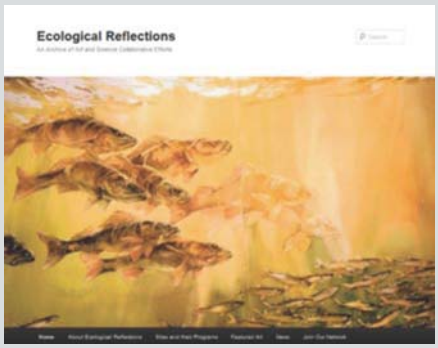

Figure 1. Ecological Reflections website offers an incipient archive of Arts and Science collaborative efforts at long term field sites (www.ecologicalreflections.com). This painting, "Vanishing Act" by Melinda Schnell, from North Temperate Lakes LTER depicts displacement of walleyes by invasive rainbow smelt (with the passage of time left to right).

Strong interest currently exists at LTER sites and FSMLs to increase Arts and Humanities (AH) activities and better integrate these activities with ongoing science. For example, in a recent survey, Principal Investigators (PIs) at 19 of 24 LTER sites agreed that AH inquiry is important and relevant for the sites because 1) the work is good in and of itself, 2) it successfully fosters public outreach and engagement in science, and 3) it can stimulate overall creativity (Goralnik 2015). Respondents also recognized the power of integrating AH with environmental ethics to better foster empathy in ways that can be valuable for addressing social-ecological challenges related to Earth stewardship. Similarly, the need to increase AH activities and integration with ongoing science at FSMLs is consistent with the recent National Academy of Sciences report on "Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century" (Schubel 2014). The report states that a critical need exists for the data and knowledge generated at field-based research stations to be better connected through to social policy and action in order to address critical environmental issues, and remain relevant to society. Follow-up publications (Schubel 2015) outlined the path from data —> knowledge —> wisdom/empathy —> policy —> action and specifically identified art as a powerful potential partner in this trajectory: noting that science cannot do this alone.

Building on this interest, a growing number of LTER sites, FSMLs, and other field stations are increasingly engaging with artists-in-residence and/or other AH-related projects (Figure 3). For example, a 2014 survey showed that 41 of 399 (~10%) of Organization of Biological Field Station (OBFS) and National Association of Marine Laboratories (NAML) members reported having current AH programs. Highlights of these efforts

are discussed in Swanson (2015) and can be found at the Ecological Reflections website (Figure 1). Examples of the diversity of these programs include the writers in residence program at HJ Andrews Experimental Forest and LTER; the visualization and sonification of real time water cycle data in the Waterviz program at Hubbard Brook Experimental Forest and LTER; integrated theater, dance, writing, and visual art programs at the Bonanza Creek Experimental Forest and LTER (including "In a Time of Change: the Art of Fire" and "In a Time of Change: Envisioning the Future"); integrated visual and performing arts in the LTEArts program at the North Temperate Lakes LTER (including the "Paradise Lost" and "Drawing Water" exhibits); and integrated environmental literacy, photography and arts in the LTEaRts program at the Harvard Forest LTER. Multi-site art exhibits have been displayed at National Science Foundation Headquarters (2012), LTER All Scientists Meetings (2012, 2015), Ecological Society of America meetings (2013), and the Soil Science Society of America meetings (2014). New partnerships have also emerged between field-station research and land management organizations to advance outreach efforts – such as Bonanza Creek LTER with Denali National Park and Preserve, Hubbard Brook with the White Mountain National Forest, and Sagehen Creek Field Station and the Tahoe National Forest. A few sites have forged ties with established art museums to help recruit important artist collaborators and facilitate, archive and disseminate significant artworks from these sites. Examples include the partnership between the UC Berkeley Sagehen Creek Field Station and the Nevada Museum of Art - Center for Art + Environment (CA+E), and collaborations between the Carnegie Museums and the Carnegie's Powdermill Nature Reserve (Figure 2).

Guidelines for action have been built during prior NSF-funded efforts to identify goals and challenges for AHS collaboration, and to propose potentially fertile areas for development. Our leadership team recently hosted an NSF-funded workshop, "Perspectives: Examining Complex Ecological Dynamics through Arts, Humanities and Science Integration" in Reno, NV; June 19-21, 2015 (DEB-1543827). The workshop provided a springboard to coalesce ideas fermenting within the emerging community of artists and scientists associated with field stations. This workshop solidified an effective leadership structure, collaborative team, and extended network that has laid the foundation for this proposed RCN project.

The need to understand the natural world.

BOX 2. "Amid rapid environmental change, a strong understanding of the natural world is more important than ever. Field stations and marine laboratories place scientists on the front lines of the changing Earth so they can better understand shifting climate and ecosystems and make robust projections of future conditions. Field stations are a critical part of the scientific infrastructure that bring the basic tools of science into the field and connect scientists, educators, and communities to their environments."

– Schubel, 2014.

Figure 2. Organization of Biological Field Station sites. ~10% (white markers) report AHS programs. Additional non-OBFS sites also host vibrant AHS programs, including Bonanza Creek LTER (star) in Alaska, lead institution for this RCN.

Recommendations from this and other research efforts include a call for engaging the public in science as a cultural tool that can address the compelling questions of our time, using AHS activities as the catalyst; greater documentation of learning and meaning-making in interdisciplinary contexts; policies that foster more interdisciplinary collaborations and syntheses of knowledge, including the creation of networks that

link educators, artists, scientists, and others committed to furthering the role of art as inquiry in interdisciplinary learning environments; conferences and workshops on important emerging topics; safe, productive environments for hybrid individuals and practices; "Alt spaces", like maker's labs, accelerators, etc.; capturing, publishing, curating, archiving; collaborations between individuals and disciplines; partnering across organizational boundaries; foregrounding and making overt issues of ethics and values and not deferring them to others (McDougall 2011; Malina 2013; Goralnik 2015). Given that field stations have always been interdisciplinary, collaborative, and non-traditional learning environments, they are ideally poised to address these recommendations.

All of these activities and programs underscore the growing and common interest in integrating and converging AHS programs at long-term ecological field sites. This ArtSciConverge RCN aims to solidify several important aspects: 1) a conceptual framework for fully integrating artists and scientists into the full intellectual merit of addressing socio-environmental problems at ecological field stations, 2) a means to share successes (and failures) at achieving this integration in specific projects and programs, 3) a virtual and in-person forum for members of this emerging network to come together as a cohesive community, 4) opportunities to increase inclusivity of underrepresented groups, and 5) mechanisms to archive and disseminate the growing body of work associated with this community.

Continued needs in order to advance these efforts include (but are not limited to): 1) innovative and effective models for integration among AHS research; 2) a sense of ownership of field research facilities by members of the AH communities and their academic departments or institutions; and 3) mechanisms for the organized distribution and archiving of AHS products emerging from these sites in order to make them more available to inform future AHS works (Goralnik 2015; Malina 2013). Issues of funding, time, and available labor (ubiquitous issues at field sites) often limit the advancement of these collaborations. Nonetheless, these sites with their communities of scientists, educators and artists committed to sustained inquiry and education offer exceptional venues where trust among members of different disciplines can be fostered, and connections made to larger societal contexts.

The Role of Neuroscience in AHS Integration

The Arts and Sciences all rely heavily on acute perception, cognition, and creativity, all of which are fields receiving growing attention from neuroscientists. The field of neuroscience is expanding rapidly, and is giving rise to sub disciplines of cognition (Gazzaniga 2002), neuroaesthetics (Skov 2009), neuroethics (Roskies 2002) and social neuroscience (Franks 2010). These sub disciplines, though broad in scope, are highly relevant to the discussion of the integration of AHS, as they probe the very biological basis of perception, memory, creativity, and action at individual and societal levels. Incipient discussions at LTER sites and FSMLs and other venues (including at our recent workshop "Perspectives", discussed previously) suggest that artists and ecologists seek to embrace these new concepts while avoiding the reductionism of regarding all action as simply a function of the neural circuitry of the brain. Precepts from neuroscience may help to elucidate the compatibility of AHS in new ways. For example, cognitive science suggests that perception is a pliable process that constructs itself, not just from the raw material of whatever reality lies beyond the senses, but from the experience and expectations of the perceiver. Artists and scientists working side by side at field research sites actually *see* differently (Neisser 1967; Gombrich 1960). These differences can enrich and complement each other to make deeper fundamental discoveries. In fact, Root-Berstein and Root-Bernstein (1985) provide compelling evidence that the most transformative science is conducted by scientists that are also involved in artistic practices. Understanding the neurobiological basis for the interplay between artistic and scientific modes of thought may help validate and advance art science convergence efforts and ultimately improve the productivity of scientific investments.

The Grand Challenge

The social-ecological challenges society faces are expanding, and the field of ecological science is poised to play a key role in overcoming them. The paradigm of scientific inquiry is undoubtedly highly powerful, yet

is not optimized to address all dimensions of ecological dynamics in the modern era, in which human social systems are major drivers of ecological change. The Arts, Humanities, and the developing field of neuroscience, offer productive sources of ideas and approaches to the grand challenges of this era. This ArtSciConverge RCN is a call to action to move the broad base of current AHS activities at long term ecological research sites beyond broader impacts such as outreach and illustration, and forward to tackle fundamental, complex problems of ecosystems in the context of dynamic social systems.

III. Goals

The objective of the ArtSciConverge RCN is to promote meaningful integration between AHS to advance ecological science and the ability of society to successfully address social-ecological challenges. Our primary focus is on creating synergy between the AHS toward the goal of transformational primary inquiry (Intellectual Merit). Secondarily, we will also capitalize upon the unique power of AHS collaboration to promote successful public engagement for the goals of outreach, education, and enhancing the role of science in society (Broader Impacts).

The specific aims of this ArtSciConverge RCN are to:

1. Create a conceptual model for more fully integrating AHS into collaborative, primary inquiry aimed at major socio-ecological problems.
2. Forge a strong network among existing and emerging place-based AHS integration programs and foster successful development of new AHS projects at long-term ecological research sites.
3. Create a social infrastructure in which AHS researchers can thrive and share their work on this integration across sites and bioregions.
4. Build diversity in AHS integration by actively engaging early-career participants from underrepresented groups and creating opportunities for educational and career advancement in the AHS.
5. Increase the visibility and ensure long-term accessibility of the growing body of AHS work through peer-reviewed publications, websites, online databases, and museum archiving - blending the archiving cultures and capacities of different AHS disciplines.
6. Assess and evaluate outcomes of the RCN, including impacts on participating students, scientists, artists, and communities.
7. Exchange strategies and methodologies for applying AHS integration to outreach and public education to better engage communities, policymakers, and under-represented members of the public with science.

We expect that the network of artists, humanists, and scientists that emerges from the ArtSciConverge RCN will be uniquely and powerfully poised to co-produce problem-solving strategies (sensu Driscoll 2011), engage larger segments of society in tackling critical environmental issues, enhance public understanding and appreciation of the natural world and address important societal challenges.

Our vision is that, within five years, it will be the norm and not the exception to include artists, humanists and social neurobiologists with ecologists on teams that are exploring and seeking to solve the complex social and environmental problems we face in the coming decades.

IV. Networking Activities

The ArtSciConverge RCN will achieve its goals through a variety of networking activities from the local to national levels, including meetings (in-person and virtual), conference participation, early-career diversity fellowships, case studies, information exchange, website development and archiving, public/community outreach, as well as evaluation and assessments of impacts. Our networking activities will be designed to foster meaningful interaction, collaboration and synergy among diverse disciplines within the AHS. While

the scientific focus area of this RCN is ecosystem science and social-ecological issues, neuroscience will play a significant role in the methodology of bridging the fields by identifying aspects of perception, cognition and critical analysis that may be shared or enhanced to optimize the AHS integrative process.

Efforts to bridge disciplines have previously proven successful with respect to science-environmental policy coupling (Driscoll 2011). Although not explicitly aimed at social-ecological challenges, impressive advances in multidisciplinary networking were made by The Network for Sciences, Engineering, Arts, and Design (SEAD), who prepared a series of white papers designed to build community awareness of perceived challenges and opportunities for transdisciplinary collaboration across the breadth of science, engineering, art, design and the humanities (Malina 2013). These and other AHS integration projects provide a solid basis for the undertaking we propose.

Our ArtSciConverve RCN employs a multi-site AHS network model, illustrated in Figure 3. The network features five diverse sites, each of which has strong interconnections within AHS disciplines as well as outreach to the local communities in which they're based. Network ties connect the major sites and a growing network of new AHS sites, through which methodologies and outcomes are freely exchanged.

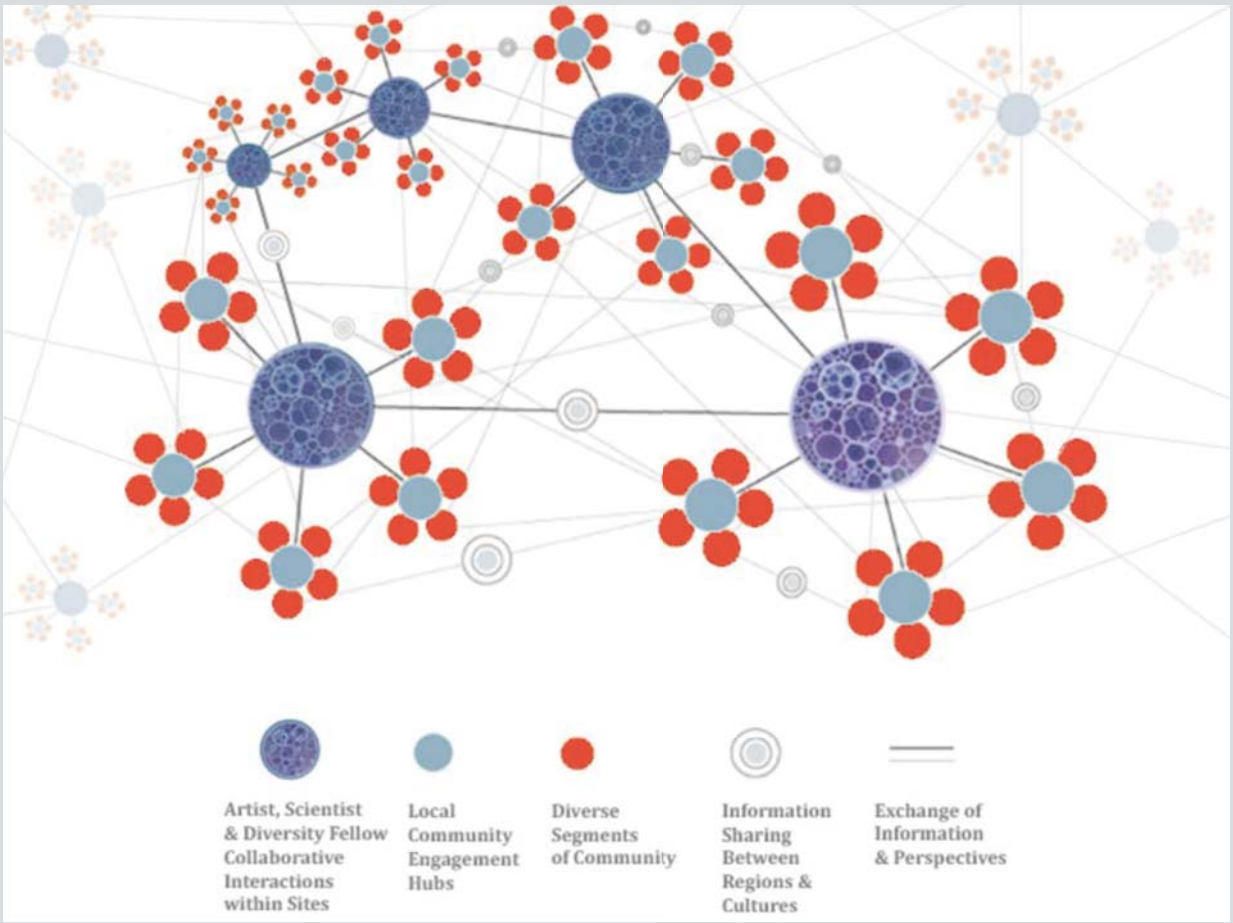

Figure 3. ArtSciConverge RCN network hub and spoke model. Interdisciplinary AHS and Diversity Fellow teams collaborate within each of the five main sites. Site activities create hubs for local community engagement, through outreach and collaborative opportunities that are designed to reach diverse segments of local communities. Information is shared among sites, creating a broad geographic network. Sharing of information and perspectives also occurs among segments of local communities and diverse cultures. The five primary RCN sites are linked to each other through information exchange to the growing network of other long-term research sites with AHS activities.

Our RCN networking model is designed to provide mechanisms and incentives for artists and scientists, including early-career students and professionals, to work in formal and informal settings together at field research sites; these teams will create mechanisms for working productively and advancing discovery, as interdisciplinary scientific teams do within field research stations. Within the context of formal meetings and workshops, the teams will further analyze, reflect upon and assess their working models and exchange their systems with teams from other sites.

We are confident that this RCN effort will carry a high-probability of success because of the long-term stability and positive working environments provided by LTER and OBFS sites for interdisciplinary teams and their previous achievements of scientific education and outreach through AHS collaboration.

We will accomplish our networking goals by the following specific networking activities, and according to the Timeline shown in Figure 4:

1. Network Meetings:The network leadership, Steering Committee, Advisory Board and participants will meet by a combination of virtual and in-person meetings. Virtual meetings will include regular teleconference, Skype, and Adobe Connect conference and web calls. Specific major meetings are listed below:
   - ArtSciConverge RCN Launch Meeting – A network wide meeting (~consisting of ~35 fully funded participants and others at their own expense) will be held in Year 1 of the RCN. This meeting of initial ArtSciConverge network participants (Table 1) will be a focused 2.5-day event at the Nevada Museum for Art (NMA) and Center for Art + Environment (Reno, NV) where The Grand Challenge will be presented, a conceptual framework for integrating the Arts and ecological sciences with assistance from cognitive neurosciences at long term research sites will be developed, a roadmap of ArtSciConverge RCN work will be discussed, specific tasks will be concretely established and assigned, and opportunities for seeking additional funding for ArtSciConverge RCN initiatives explored. Specific products will be a peer-reviewed paper, building on Swanson (2015) but presenting a new conceptual model for future activities and engagement between the AH and ecological sciences. Results will also be communicated as regular updates on the ArtSciConverge RCN website and social media, and as outreach to local, regional, and national press. (Led by PI Leigh, UAF and Bill Fox, NMA).
   - Mid-Project RoundTable Meeting – A Roundtable Meeting will be convened in Year 3 at one of the participating field stations (tentatively Hubbard Brook LTER) with ~20 participants (invitee expenses fully budgeted), including Diversity Fellows and representatives from all five regional sites, to develop a peer-reviewed journal synthesis paper, revisiting and revising the conceptual framework published in Year 1/2, identifying obstacles to progress, and examining examples of successful ArtSciConverge programs. Results will be communicated on the ArtSciConverge RCN website and through social media. Outreach to local, regional, and national press will help disseminate the message further. (Led by PI Leigh, UAF and Lindsey Rustad, US Forest Service).
   - Final Meeting: The ArtSciConverge RCN will culminate with a final workshop (35 invitees fully budgeted, additional attendees at own expense) with retrospective sessions presenting ArtSciConverge RCN findings, highlighting the work of Diversity Fellows, and with forward-looking working group sessions targeting how best to build on the synergy and momentum developed over the course of the ArtSciConverge RCN. The conference will be held at the Nevada Museum of Art and Center for Art + Environment, and will coincide with an exhibit showcasing successful ArtSciConverge projects, and finalizing of the academic catalogue and educational pieces associated with the exhibit. (Led by PI Leigh, UAF; Jeff Brown, CAL Berkeley, Bill Fox, NMA, and CoI Duffy, UAF).
   - Participation in Major Arts, Humanities and Science Conferences, Symposia and Meetings: Part of our foundation of relationships stems from histories of informal AHS working group gatherings at meetings of FSML (annual) and LTER (All-Scientists Meetings every three years). We will continue these with an effort to engage more artists and humanists at these meetings. Support will

also be provided for PI and Co-I (one conference each in years 2 and 4) and several other senior personnel and Diversity Fellows (6 trips total, shared among 2 senior personnel and/or fellows per year in years 3, 4 and 5), to propose ArtSciConverge symposia, present papers, and attend both art and science conferences to further the reach and broaden the impact of the network. A portion of the support will be designated for artist members to attend science conferences and for science members to attend art conferences and/or events. Members will present ArtSciConverge activities at these conferences as well as gather input from others outside of the network to ensure that additional perspectives are represented. (Coordinated by the Steering Committee and the Advisory Board).

- Regional Site Networking Activities: The ArtSciConverge RCN will support five sites (Figure 3) to enhance within-site AHS activities. The goal is for each site to use the conceptual framework developed in the initial RCN launch meeting to bring together an interdisciplinary team of artists, humanitarians, ecologists and neuroscientists to identify and tackle a specific social-ecological issue from different disciplinary perspectives. A total of $15,000 will be provided to each of the five sites for participant support to bring interdisciplinary teams together in meaningful ways. It is expected that these teams will organize in Year 1 of the RCN, meet and accomplish their objectives in Years 2 and 3, contribute a paper on their efforts to a special issue of a peer reviewed journal in Year 4, and contribute their work to an exhibit at the final RCN meeting at the NMA Center for Art + Environment, Reno, NV in Year 5. The sites will be recruited from participating networks of field stations, with final selections made by a combined review of the PIs, the Steering Committee and the Advisory Board. The five sites will be selected from LTER and OBSF sites by the Steering Committee with input from the Advisory Board. We intend to include sites with established and/or emerging AHS integration activities, leadership committed to innovation, and a strong potential to engage diverse, under-represented groups and the local community. We will also strive to include a broad geographic range of sites, with at least one urban site. (Led by Jeff Brown, CAL Berkeley, and by Leigh, UAF).

2. ArtSciConverge Diversity Fellowship Program: The ArtSciConverge RCN incorporates mechanisms for increasing diversity at all levels of participation from core leadership to community engagement (see *Increasing Diversity* section below). Towards this goal, we will support the professional development of early-career participants from underrepresented groups to work on AHS integration through ArtSciConverge Diversity Fellowships. Fellowships of $2,000 each will be awarded to fellowship applicants from each of five sites during Years 2-3 (1 fellow per site per year), plus two additional fellowships per year in Years 4 and 5 will open to applicants from non-core sites to help expand the network. Fellowships will be available to graduate students and early career professional in all fields of AHS relevant to the RCN theme who are from underrepresented groups. The funds are intended to defray living expenses and create incentives for fellows to engage actively in regional site AHS integrative and outreach activities. Fellows will be invited and offered additional funding to travel to regional and network-wide RCN meetings. Altogether, this will create 14 diversity fellowships over the five years. The fellowships will provide education and exposure in both the arts and sciences among our emerging scholars who may have increasing impacts on these fields for many years to come. It is our expectation that this group of aesthestic and scientific investigators will return to their own communities and networks to share what they have learned, publish, exhibit and ideally build upon the experience — ultimately creating a large footprint that will continue to impact fields of AHS in ways that at this point cannot be foretold.

   As part of the fellowship selection process, candidates from diverse or non-traditional backgrounds will be recruited and encouraged to apply. We will leverage relationships with established outreach efforts at urban and rural LTERs, FSMLs, EFRs, and at academic institutions that partner with these sites. For example, we will reach out to students in the Alaska Native Science and Engineering Program and Native Art Center at UAF, and programs targeting diverse participants in AHS at academic institutions associated with participating ecological sites (e.g UAF, UC Berkeley, Oregon

State University, Harvard University, University of Puerto Rico). Ultimately we hope to incorporate many different voices from traditional and non-traditional backgrounds in the activities of this new ArtSciConverge RCN.

3. Website, Listserve and Social Media: A core focus of communications within and beyond the RCN will be the ArtSciConverge RCN website, listserve and social media. A subgroup of the PIs, Steering Committee, Advisory Board and participants will form a website committee, which will envision and launch a network website. The website will be home to network content, updates on projects, calendars of network-related events, links to related activities and network news. Content will be actively managed and coordinated with a social media program featuring Twitter, Instagram and Facebook accounts. The hashtag "#ArtSciConverge" has already been claimed by and launched for our nascent network at our *Perspectives* workshop in June 2015. We have also established a listserve for participants that we expect to grow as our network expands. Additional outreach will be made throughout the ArtSciConverge RCN program to more traditional local, regional and national press outlets. (Led by CoI Duffy, UAF).
4. Publications on Modeling, Case Studies, and Synthesis: As described in section II Background, a growing number of field stations are embarking on place-based projects engaging the Arts and/or Humanities with ecosystem science. These programs are highly diverse in their aims and approaches. Careful studies of these may reveal keys to success and warning of possible shortcomings for future projects. Over the course of five years, during meetings and by outreach to participants, the ArtSciConverge RCN will identify and highlight case studies of successful programs. These will be spotlighted on the website, and will the topic of peer-reviewed journal articles to be prepared over the course of the RCN. Some articles will focus on collaborative network modeling and specific case studies, while others will be written as synthesis articles highlighting and integrating a number of different projects. A key opportunity is our collaboration with appropriate communications systems/networks, such as the Orion Socity and the on-line journal terrain.org: A Journal of the Built + Natural Environments, which has a readership of approximately 100,000. We will also actively seek funding from other sources (beyond this RCN grant) to create a synthesis book in large, color, hard-cover format, to be published at the end of our five year RCN, potentially through the University of Alaska Press, which has expressed interest in the project.
5. Data Management and Archiving: While the RCN does not support generation of new primary data, we will perform such tasks as compiling and synthesizing information regarding AHS integration throughout our network and archiving RCN activities. This will require a unique effort to manage, archive and make available these uncommon, multidisciplinary products. We will capitalize on several different disciplinary cultures for these data management tasks: (A) the scientific culture of archiving data (and in some cases physical samples/records) in well documented, publically accessible digital datasets – exemplified by the distributed archiving and sharing systems within LTER for data with unified protocols allowing multi-site data harvesting, and publishing results in peer-reviewed journals; (B) the museum culture of large institutions with a long record of curating large, high-value, primary art works; and (C) web-based formats for making information freely available to the public, students, and researchers through portals and links on our website. Data management and archiving tasks are further detailed in our Data Management Plan.
6. Assessment: Because of the non-traditional collaborations in the ArtSciConverge RCN, we will use professional social science evaluation techniques to assess the level of engagement and involvement between artists and scientists at a suite of field stations and outcomes of the activities. We will subcontract the Hubbard Brook Research Foundation (HBRF) for assessment and evaluation tasks. HBRF will use a mixed-method approach that will include designing and conducting focus groups, interviews, and surveys at the beginning and end of the RCN period. These methods and instruments will be designed to gather data on the quality of the engagement, collaboration, and relationship-building at the beginning of the project, and will capture information on the successes and challenges of the

collaborative process, especially any new scientific ideas, insights, or discoveries that arise through the process of integrating across these different disciplines. We will also partner with HBRF to develop guidance documents for current and future network sites on assessment of impacts and outcomes of their outreach activities as well as AHS inquiry projects.

7. Outreach Methods Exchange: While RCN funds do not support new outreach projects per se, we will facilitate outreach activities at primary, regional, and expanded network sites through an open exchange of methodologies, outcomes and assessment tools for site-based AHS public outreach and education. This will be accomplished through inclusion on the website, as well as highlighted in specific RCN case studies and in conference presentations, workshops, and special sessions of RCN meetings. We will work to exchange and further develop methods and roadmaps for outreach and educational activities at sites that are innovative in combining AHS to excite, engage and educate diverse groups within regional networks, including women, ethnic/racial minorities, native/indigenous communities, diverse K12 and first-generation college students. Our regional networks will also be engaged in developing and assessing methods for creating successful educational materials to be presented to the public in conjunction with AHS outreach events such as performances and exhibits.

Figure 4. ArtSciConverge RCN Timeline

Activities	Years 1	2	3	4	5
Launch meeting (Reno, NV)					
Graduate Diversity Fellowships (#)		5	5	2	2
Website and social media outreach					
Data archiving					
Conference presentations and symposia (#)		2	2	4	2
Regional site meetings (#)		5	5		
Round-table meeting (Hubbard Brook)					
Outreach methods workshop sessions					
Assessment and evaluation					
Publications (model, case studies, assessment, synthesis)		2	2	2	3
Final meeting (Reno, NV)					

Figure 4. ArtSciConverge RCN Timeline, listing RCN activities planned to occur and the years in which they will happen.

V. Network Management Plan

Our network management plan will include a Lead Principal Investigator, (Leigh), a Co-Principal Investigator, (Duffy), a Steering Committee (seven members), and an Advisory Board (five members). The Lead PI will provide overall leadership for the RCN; the Co-I will support the PI and help with leadership, fiscal and administrative duties; the Steering Committee will represent different network interests, provide leadership for specific network activities, and share fiscal decisions and equitable allocation of the budget with the PI and Co-I. Steering Committee member Michael Nelson will take a leadership role in representing Humanities perspectives and William Fox (NMA) will take a comparable role in representing the Arts. The Advisory Board will represent the broader interests of the network, and will advise the Steering Committee and PIs. We will seek a balanced Steering and Advisory Board membership, equally representing AHS, accordingly. The PIs and Steering Committee will meet virtually on a regular basis for the duration of the RCN, and regularly evaluate progress. A mid-RCN assessment will be made in Year 3 following the Round Table to allow for mid-RCN corrections. Funds for a pre-RCN and post-RCN professional survey are included in the budget to gage the overall effectiveness of the RCN.

For initial participants, we will build on relationships from Ecological Reflections, LTERs, FSMLs, and the "Perspectives" Workshop held at the Nevada Museum of Art in June 2015, to create a network of highly diverse participants that span several spectrums of art and scientific institutions, each with substantive histories and groundwork on these issues. In addition, individual artists, scientists, and philosophers well established for working in these arenas, along with representatives from major funding agencies in AHS will be part of this long-term network.

With an eye for continued future development, we will seek out international participants; involve current undergraduate and graduate students, and postdocs and early career scientists; and encourage participation of underrepresented groups. The PIs and Steering Committee will evaluate the effectiveness of our recruiting on an annual basis, and adjust participation accordingly.

Principle Investigators:

- PI: Mary Beth Leigh, Associate Professor of Microbiology, Institute of Arctic Biology, Department of Biology and Wildlife, University of Alaska Fairbanks (UAF); Director of *In a Time of Change* Arts and Humanities program at Bonanza Creek LTER.
- Co-I: Annie Duffy, Artist, Department of Art, UAF; Curator/Coordinator of *In a Time of Change* Arts and Humanities program at Bonanza Creek LTER.

Steering Committee:

- Arts Lead: William Fox, Director, Center of Art + Environment, Nevada Museum of Art
- Humanities Lead: Michael Paul Nelson, Ruth H. Spaniol Chair of Renewable Resources and Professor of Environmental Ethics, Oregon State University
- Lindsey Rustad, Team Leader / Research Ecologist, Center for Research on Ecosystem Change, USDA Forest Service
- Frederick J. Swanson, USDA Forest Service, Pacific Northwest Research Station
- Jeff Brown, Director - Central Sierra Field Research Stations, University of California – Berkeley
- Michael A. Casey, James Wright Professor, Neuroscientist, Departments of Music and Computer Science, Dartmouth College, Hanover, NH, USA; University of London, UK
- Faerthen Felix, Asst. Manager, UC Berkeley – Sagehen Creek Field Station

Advisory Board:

- Randall Koch, Alliance of Artists Residencies
- Stephen Tonsor, Director for Science and Research, Carnegie Museums, Pittsburgh, PA
- Kesler Woodward, Art Professor Emeritus, University of Alaska Fairbanks
- Sarah Garlick, Policy Analyst and Evaluator, Hubbard Brook Research Foundation
- Arthur Shimimura: Neuroscientist, U.C. Berkeley Department of Psychology

Potential Initial ArtSciConverge RCN Participants:

The following list includes individuals carefully identified for their roles in leading current LTER-based *Ecological Reflections* projects and others active in the field of AHS integration. The list is intended as a starting point for potential participants and is not intended to be exhaustive or exclusive. Membership will expand also based on the five participating sites to include members of the site programs. Diversity Fellows (14 planned) will also be considered as full participants.

Table 1. Potential Initial Participants in ArtSciConverge RCN		
Name:	**Title:**	**Affiliation:**
Janet Brown	Executive Director	Grantmakers in the Arts
Jerry Schubel	Director	Aquarium of the Pacific
Brandon Balengée	Artist, Biologist	McGill University
Xavier Cortada	Artist	Florida International University
Marty Quinn	Musician, Ph.D. student	University of New Hampshire, Durham, NH
Leslie Ryan	Ph.D. Candidate	HJ Andrews LTER
Art Shimamura	Professor	UC Berkeley, Psychology
Brian Smith	Professor	Drexel
Amy Ione	Managing Editor	SEAD
Ariane Koek	Director	Collide@CERN
Helen Harrison	Artist, Professor	UC Santa Cruz
Newton Harrison	Artist, Professor	UC Santa Cruz
Kelly Skye	MFA, biologist	Harrison Studio
Sara Frantz	Archivist	Nevada Museum of Art - Center for Art + Environment
Colin Robertson	Curator of Education	Nevada Museum of Art - Center for Art + Environment
Wendy Quinn	Dancer, psychologist	
Roger Malina	Scientist and Editor	University of Texas; Leonardo Magazine
Carlos Rodriguez-Franco	Assoc. Deputy Chief, R&D	US Forest Service, Washington Office
Lauren Bon	Artist	Metabolic Studio
Shannon Jackson	Assoc. VC for Arts and Design; Director	UC Berkeley; Arts Research Center
Holly Sidford	President	Helicon Consulting
Carol Strohecker	Vice Provost	RISD; SEAD network
Carol Lafayette	Professor; PI	Texas A&M; SEAD network
Nalini M. Nadkarni	Ecologist	University of Utah
Hao Tran	Assistant Director	US Forest Service Northern Research Station
Alexis Frasz	Arts consultant	Helicon Consulting
Curt Meine	Writer	Aldo Leopold Legacy Center
Mark Dion	Artist	
Matt Coolidge	Director	Center for Land Use Interpretation (CLUI)
Eric Magrane	Poet, Ph.D. candidate	University of Arizona
Emily Dolson	Ph.D Candidate Computer Science	Michigan State University
Erica Osborne	Artist, Assoc. Professor	Colorado State University
Zion Klos	Ph.D. Candidate, hydrology	University of Idaho
Beth Stephens	Artist, Professor	UC Santa Cruz
Russell Dudley	Artist, Professor	Sierra Nevada College
Edward Morris	Artist	Canary Project
Susannah Sayler	Artist	Canary Project

VI. Coordination Plan

The only organized network that shares a similar mission to this proposed ArtSciConverge RCN, to our knowledge, is the existing *Ecological Reflections* network of AHS activities based within LTER sites, co-lead by PI (Leigh) and Steering Committee Member, Fred Swanson. This proposed project does not compete with *Ecological Reflections*, but rather dramatically expands upon it to include other non-LTER sites of long-term, place-based AHS inquiry, to the mutual benefit of Ecological Reflections and the ArtSciConverge RCN.

VII. Increasing Diversity

Diversity is fundamental to the success of our mission to find innovative methods, through highly diverse disciplinary, cultural and sub-cultural perspectives, to develop mechanisms for more effectively tackling social-ecological problems. As professional scientists, artists and field station managers, our RCN PIs, Steering Committee and Advisory Board members are acutely aware of the need to increase diversity and the active participation of underrepresented groups in place-based research. We will actively cultivate diversity within our programs and incorporate specific guidance for increasing cultural, gender, ethnic and age diversity into our conceptual models for AHS integrative work. This ArtSciConverge RCN, which by its nature integrates a rich mosaic of disciplines and approaches, may be particularly effective at attracting underrepresented groups to AHS fields. Our RCN is lead by a female PI/Co-I team (Leigh and Duffy), and our potential participant list includes members of racial groups and ethnicities that are underrepresented in AHS and particularly in science. Of the 37 total potential participants on our list (Table 1), there are 19 women, 6 non-white (African American, Latino, East Indian, etc.), and 7 early career academics/Ph.D. candidates. Our ArtSciConverge Diversity Fellowship program is designed to increase diversity within the sciences and AHS integrative research, and will engage 14 early-career fellows from across the U.S., as detailed in the Network Activities section of this proposal.

The success of community engagement and outreach activities also depends upon the ability to connect in meaningful ways to individuals from an array of cultural, racial, ethnic and socioeconomic backgrounds, gender identifications, disabilities, and ages. Our RCN will help promote the expansion of outreach activities that connect with underrepresented groups in local communities to science. Examples of past successes that will be built upon are AHS education and outreach activities for minority K12 schoolchildren and members of the public such as African Americans through urban sites and rural Alaska Natives through Bonanza Creek LTER.

VIII. Broader Impacts

The primary mission of this ArtSciConverge RCN is to identify novel means for advancing ecological science and addressing major social-ecological issues through multi-disciplinary mechanisms of AHS integration. Our work aims to impact many spheres of Science, the Arts, Humanities, and society.

Fostering diversity of personnel, ideas and perspectives is essential to achieving our mission of advancing AHS integration toward better addressing social-ecological issues. In addition to engaging leadership diverse in terms of gender, race, discipline and background, our RCN proposes to advance the education and training of diverse, early-career AHS students. Our 14 ArtSciConverge Diversity Fellowships are designed specifically to engage, inspire and encourage early-career students in AHS integrative fields to establish a career track that can lead to increased diversity and innovation in this field in the future. In partnership with academic institutions, we will reach out to underrepresented groups with these fellowships, including racial/ethnic minorities (Alaska Natives, African Americans, Latinos, etc.), urban and first-generation college students, students with limited socio-economic backgrounds, women, students with disabilities, and other underrepresented groups. As these students proceed in their academic and outreach work, and network within their communities, the impacts of our program will continue to expand.

Integrative AHS work will be documented in the peer-reviewed literature, archived in museums, and broadly disseminated through websites, online portals to digital databases, and reaching out to the community through email listservs and multiple lines of social media (e.g. Facebook, Twitter, Instagram) to bring attention to the existence of the data and to highlight major activities and findings to the public, students, and other AHS researchers.

The growing network of sites engaged in AHS activities most frequently employ them toward the purpose of education and outreach, in order to increase public awareness and understanding of science. Our

ArtSciConverge RCN will encourage continued growth and development of these efforts by identifying successful methods for AHS outreach activities, including those that reach diverse segments of the public and K12 students. Our documentation and exchange of methodologies, outcomes and assessment tools for site-based AHS public outreach and education will be available online and we will offer information exchange opportunities at workshops and symposia to help sites establish, enhance, or expand their outreach activities. Our site networks will also engage in developing and assessing methods for creating successful educational materials to be presented to the public and schoolchildren in conjunction with AHS outreach events such as performances and exhibits.

IX. Results from Prior NSF Support (PI Mary Beth Leigh)

DEB-1543827. "Workshop; Perspectives: Examining Complex Ecological Dynamics through Arts, Humanities and Science Integration; Reno, Nevada; June 19-21, 2015". 2015-16. $49,567. PI Leigh.

The goal of the workshop was to advance the integration of the arts and humanities with science in the interest of addressing complex ecological and social-ecological challenges. This workshop solidified an effective leadership structure, collaborative team, and extended network, and directly laid the conceptual foundation for this proposed ArtSciConverge RCN project.

DEB-1257424. "Control of Boreal Forest Soil Decomposition Processes by Plant Secondary Compounds". 2014-16. $692,977. PI Leigh. This research project investigates chemical-ecological interactions between plant and microorganisms in boreal forests of Alaska and Europe. An important component of the project is community education and outreach through integration of the arts, humanities and science. *In a Time of Change (ITOC)* is the program directed by PI Leigh, in which visual and performing artists, writers and scientists work to integrate scientific and artistic perspectives on interior Alaskan ecosystems and engage the public through exhibits and performances. This project will generate new production by ITOC, entitled *Microbial Worlds*, which will culminate in exhibits and events focused on the invisible, yet essential, role of microbes in mediating ecological function and resilience to human disturbance. Artists have competitively applied and selection is now in progress in anticipation of 2.5 years of artist, humanitarian and scientific collaboration leading up to a 2017 exhibit.

REU Supplement to DEB-1257424. 2015. $15,004. Two UAF undergraduate students, one of whom is Alaska Native, and another is both an artist and scientist, are actively involved in research and AHS integration activities associated with the project above.

DEB-0626544 (NSF Postdoctoral Fellow New Faculty Startup Grant). "Microbial Degradation of Lignin, Plant Aromatics and Polychlorinated Biphenyls (PCBs) in Boreal Forest Soil". 2006-09, $50,000. PI Leigh. The project contributed to the training of 4 MS students (3 female), 1 PhD student (female), 6 undergraduates (3 female), and 5 high school students (3 Alaska Native females), and the development of a new integrative arts-sciences program, *In a Time of Change*, which reached >1500 members of the public. To date, the project has contributed to 10 peer-reviewed publications, 4 book chapters (including one on AHS integration), 5 M.S. theses, a portion of 1 Ph.D. thesis, and 4 manuscripts in preparation.

References Cited

Driscoll C.T., Lambert K.F., & Weathers K.C. 2011. Integrating Science and Policy: A Case Study of the Hubbard Brook Research Foundation Science LinksProgram. *Bioscience* 61(10):791-801.

Franks, D. 2010. *Neurosociology: The Nexus Between Neuroscience and Social Psychology*. Springer Science & Business Media, Dordrecht, Netherlands , 216pp.

Gazzaniga, M., R.B. Ivry, and G.R. Manhun. 2002. *Cognitive Neuroscience - The Biology of the Mind (2nd, Second Edition)*. W. W. Norton & Company, New York, NY USA.

Gombrich, E. H. 1960. *Art and Illusion*. Princeton, NJ: Princeton University Press.

Goralnik, L., M.P. Nelson, L. Ryan and H. Gosnell. 2015. Arts and humanities efforts in the US Long Term Ecological Research (LTER) network: Understanding perceived values and challenges. *Earth Stewardship,* Ecology and Ethics 2, R. Rozzi et al. (eds.). Springer International Publishing, Switzerland.

Malina, R.F., C. Strohecker, C. Lafayette, and A. Ione, on behalf of the SEAD Network White Papers Group and 200 White Papers Contributors. 2013. Steps to an ecology of networked knowledge and information: Enabling new forms of collaboration among sciences, engineering, arts, and design. Volume 1: Synthesis Report. (NSF Award #1142510)
https://seadnetwork.files.wordpress.com/2014/01/volume_i_print_final.pdf

McDougall, M., B. Bevan and R. Semper. 2011. Art As A Way Of Knowing - Workshop Report. Exploratorium Museum, San Francisco, CA March 3-4, 2011 (NSF Award #DRL-0905069)
http://sagehen.ucnrs.org/blogs/Art+Reserves/2015/SFExplor_art%20as%20way%20of%20knowing%20-%20report.pdf

Moore, K.D., M.P. Nelson (eds). 2010. Moral ground: ethical action for a planet in peril. Trinity University Press.

National Research Council. 2014. Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century. Washington, DC: The National Academies Press. http://www.nap.edu/catalog/18806/enhancing-the-value-and-sustainability-of-field-stations-and-marine-laboratories-in-the-21st-century

National Research Council. Report in Brief: Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century.
http://dels.nas.edu/Materials/Report-In-Brief/4252-Field-Stations?bname=osb

Neisser, U. (1967). *Cognitive Psychology*. New York: Prentice Hall.

Root-Bernstein, R., M. Root-Bernstein, 2013. The Art and Craft of Science. *Educational Leadership*, Feb 2013: 16-21

Root-Bernstein, R., and M. Root-Bernstein. Artistic Scientists and Scientific Artists: The Link Between Polymathy and Creativity. *In* Sternberg, R.J. (Ed); Grigorenko, E.L. (Ed); Singer, J.L. (Ed), (2004). *Creativity: From potential to realization*. (pp. 127-151). Washington, DC, US: American Psychological Association, 226 pp. http://dx.doi.org/10.1037/10692-008

Roskies, A. 2002. Neuroethics for the new millennium. *Neuron*, Volume 35: 21 - 23 .

Schubel, J.R. Some Thoughts on Keeping Field Stations and Marine Labs Afloat in Turbulent Times. *BioScience* 65.5 (2015): 458-459.

Skov, M. and O. Vartanian. 2009. *Neuroaesthetics: Foundations and Frontiers in Aesthetics*. Baywood Publishing Company, Inc., Amityville, NY, USA. 302 pp.

Swanson, F.J. 2015 (in press). Confluence of arts, humanities, and science at sites of long-term ecological inquiry. *Ecosphere*.