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Insight

Impacts of conservation activities on people who are incarcerated: a case study based on qualitative and quantitative analyses

Nalini M. Nadkarni[1], Jacqueline M. Chen[2,3], Jeremy S. Morris[4], Amanda E. Carriero[1], Thomas N. Kaye[5,6], Kelli Bush[7], Megan Young[1] and Laura George[1]

ABSTRACT. In the past two decades, conservationists and the corrections sector have implemented collaborative ecological restoration projects, creating more inclusive arenas for conservation. These venues provide people who are incarcerated with opportunities to have a positive impact on their environment, and for ecologists to communicate science and the importance of nature with people in nature-deprived environments. We provide examples of conservation programs and their associated media pieces nationwide, whose descriptions, to date, have been almost entirely anecdotal and without formal evaluation. In this study, a collaboration of ecologists and social scientists analyzed impacts on the "incarcerated citizen scientists" who participated in two conservation projects coordinated by these ecologists at the Salt Lake County Jail, Utah, using quantitative and qualitative approaches, including voluntary pre- and post-surveys. The quantitative results informed potential outcomes, but were inconclusive. However, the qualitative results revealed that a majority of the participants reported gaining knowledge about science and conservation, and that about a quarter of them reported psychological benefits from participating, such as feeling that they were able to give back to their community through the project. These results document the potential positive impacts that participation in ecological restoration projects can help promote well-being and community involvement, and to increase science knowledge from all participants. The results also reinforce the importance of collaborations between scientists who use quantitative and qualitative approaches and analytical tools, which, when combined, provide the capacity to measure, analyze, and interpret data from human participants. These considerations should be further explored with collaborations of natural scientists, social scientists, corrections staff, and people who are incarcerated as ecological restoration projects in correctional institutions become more prevalent.

Key Words: *citizen science; conservation; incarcerated; prisons; qualitative analyses; restoration ecology*

INTRODUCTION

Engagement between ecologists and groups outside of academia is increasingly common, to the benefit of both groups (Stoecker 2009, Nadkarni et al. 2019, MacArthur et al. 2020). Some of these undertakings have been through citizen science projects (Silvertown 2009, Raddick et al. 2013), in which non-scientists participate in collecting or analyzing data for projects established by scientists. Typically, these projects have engaged volunteers who are able to travel to field sites or who can gain access to internet-based data. Participation in citizen science projects therefore tends to be limited to people with financial and educational privilege, and involvement by those without such privileges and access has understandably been limited. However, individuals who lack access to field sites and the internet—many of whom have been underserved by science and deprived of the physical, psychological, and emotional benefits of nature—would also be likely to be interested in and benefit from participation in these scientific engagement activities.

In the past two decades, scientists and conservationists have innovated programs and projects that directly involve one such group—adults and youth who are incarcerated—with conservation and ecological restoration. The media described these early efforts in positive ways, reporting that people who are incarcerated demonstrated their value, care, and interest for nature and conservation. The positive reception of such programs encouraged incarcerated people and participating corrections institutions to participate in these programs (Horns et al. 2020, Nadkarni et al. 2022). Because the resources for implementing formal evaluative have been limited, the media have played an important role in giving people who are incarcerated and corrections staff a platform to describe anecdotal program impacts. In the last decade, scientists and conservationists have crossed sectoral and institutional borders to directly engage "incarcerated citizen scientists (ICS)" in rearing endangered and rare animal and plant species that have been released or out-planted for ongoing projects (Table 1). We use the term "citizen science" rather than the more recently coined "community scientist" because all of the participants are citizens of the United States and because it links them to established and well-respected "citizen science" efforts in which people who are not incarcerated participate.

Citizen science projects involving non-incarcerated citizens have provided benefits for conservation, which, among other projects, include greater numbers and high quality of organisms produced overall (Dickinson et al. 2010). These same benefits have also accrued from projects with individuals who are incarcerated that were carried out in state prisons and county jails, and juvenile detention centers. A summary of such projects (Kaye et al. 2015) highlighted multiple benefits of prison-based citizen science activities to date. First, participation in habitat conservation projects improves ecologists' capacity to restore landscapes, conduct research, and recover threatened and endangered species (Nadkarni 2006). Restoration ecologists partnering with Sustainability in Prisons Project (LeRoy et al. 2012), for example,

[1]School of Biological Sciences, University of Utah, [2]Department of Psychology, University of Utah, [3]Department of Psychological Sciences, University of Connecticut, [4]Department of Biology, Wofford College, [5]Institute for Applied Ecology, Corvallis, Oregon, [6]Department of Botany and Plant Pathology, Oregon State University, Corvallis, Oregon, [7]The Evergreen State College

Table 1. Projects, organisms, outcomes, and institutions of citizen science conservation projects that involve the incarcerated.

Project	Organism(s)	Outcomes	Roles of incarcerated participants	State(s)	Correctional institution(s)	Duration
Taylor's Checkerspot Butterfly Program	*Euphydryas editha taylori*, a federally-endangered species. Also grow Plantago to feed the leaves to the larvae upon release from cold diapause	24,500+ caterpillars and adult butterflies released in Salish lowland prairies in WA; 18+ certificates awarded;	Technicians receive education and training to rear, breed, and release butterflies and grow Plantago.	WA	Mission Creek Corrections Center for Women (MCCCW)	2011–present
Taylor's Checkerspot Butterfly Program	*Euphydryas editha taylori*, a federally endangered species.	caterpillars and adult butterflies released in prairies in OR	Technicians receive education and training to rear butterflies	OR	Coffee Creek Correctional Facility	2017–present
Western Pond Turtle Program	*Actinemys marmorata*	112 turtles re-released to wild; 17 certificates awarded	Technicians receive education and training to provide extended care to turtles with a "shell disease"	WA	Larch Corrections Center (LCC), Cedar Creek Corrections Center (CCCC)	2013–present
Prairie Conservation Nursery Programs	80+ species of plants for lowland prairie restoration	2.7 million+ plant-plugs delivered; 14 pounds of *Viola adunca* and *Viola howellii* seeds delivered	Technicians receive education and training to raise native plants and seeds for ecological restoration	WA	Stafford Creek Corrections Center (SCCC; now inactive), Washington Corrections Center for Women (WCCW), Washington Corrections Center (WCC)	2009–present
Woodpecker Nest Predation Study		1,000's of hours of video data reviewed; contributing to knowledge of threatened cavity-nesting woodpecker species; increases science ed and engagement for techs working with Western pond turtles	Technicians receive education and training on pacific northwest birds and mammals; learn to review and record observations from wildlife camera video data; earn certificate in association with turtle program	WA	Cedar Creek Corrections Center (CCCC)	2017–2020
Oregon Spotted Frog Program	*Rana pretiosa*, a federally endangered species	879 frogs raised	Technicians receive education and training to captive-rear and release state-endangered frogs	WA	Cedar Creek Corrections Center (CCCC)	2009–2017
Bighorn Sheep Conservation Program	*Ovis aries*	46 domestic sheep born	Technicians receive training and provide all aspects of care and breeding for domestic Suffolk sheep with aim to provide small herd managers stock free of a pathogen which presents major threats to wild bighorn sheep populations	WA	Washington State Penitentiary (WSP)	2018–present
Emergent Pre-Vegetated Mat (EVM) Program	Mats of various wetland plant species for habitat restoration	147+ mats and 10,000 plugs	Technicians receive education and training to produce emergent pre-vegetated mats and operate a complex aquaponics system	WA	Stafford Creek Corrections Center (SCCC)	2018–present
Sagebrush, Bitterbrush, and Sliver Sage in Prisons Project	*Artemisia tridentata, Purshia tridentata, Artemisia cana*	1.5 million+ sagebrush and other sage steppe plants grown	Technicians receive education and training to grow sage steppe plants	OR, ID, CA, NV, WY	Warner Creek Correctional Facility, Snake River Correctional Facility, South Boise Women's Correctional Center, Idaho State Correctional Center, Lovelock Correctional Center, Warm Springs Correctional Center, Northern Nevada Correctional Center, Wyoming Honor Farm, Federal Correctional Institution, Herlong, CA	2016–2020
Mojave Desert Seed Propagation Project	Desert needlegrass *(Achnatherum/ Stipa speciosum*), desert pepperweed (*Lepidium fremontii*), desert marigold (*Baileya multiradiata*), eastern Mojave buckwheat (*Eriogonum fasciculatum*), smooth desert dandelion (*Malacothrix glabrata*), desert Indianwheat (*Plantago ovata*), chia (*Salvia columbariae*)	Currently have germinated plants in 825+ pots and are planting annuals in a production field	Technicians receive education and training to grow plants	CA	CA City Correctional Facility, Federal	2019–2020
Oregon Silverspot Butterfly Program	*Viola adunca* plants are grown and leaves collected for the Oregon Silverspot butterflies (*Argynnis zerene hippolyta*)	Women adults in custody raise plants. The Oregon Zoo collects leaves to feed to the Oregon Silverspot butterflies at the zoo.	Technicians receive education and training related to ecology, butterflies, and growing *Viola adunca*	OR	Coffee Creek Correctional Facility	2013–present

have collaborated with correctional facilities to raise rare native plants for release into wild lands. Second, the act of caring for living organisms, including animals (Ormerod 2008) and plants (Relf and Dorn 1995, Clarke 2011, Lindemuth 2014), as well as exposure to nature imagery (Nadkarni et al. 2017a) provide significant therapeutic value to individuals who are incarcerated. These activities result in calmer, safer prison settings (Nadkarni et al. 2017b). Third, individuals who engage in actions that give back to their communities through conservation projects demonstrate greater accountability and pro-social behavior (e.g., sharing readings with cellmates, describing science lectures to visiting family members; Horns et al. 2020), as well as more positive attitudes about the environment (Gallagher 2013). The Great Plains Restoration Council's Restoration Not Incarceration program, for example, has positively engaged youth who are incarcerated to integrate with local communities in Gulf Coast habitats by "helping young adults reintegrate into society by achieving new insights, and which was associated with improved life outcomes" (Norton et al. 2013, Norton and Holguin 2011). Fourth, without access to libraries that provide science resources or the internet, many people in custody desire but are lacking in intellectual stimulation. Engaging in the scientific method and receiving training and presentations from scientists and other professionals provides opportunities for healthy pursuits of curiosity (Ulrich and Nadkarni 2009, Weber 2012, Horns et al. 2020). Lastly, vocational and general education have been demonstrated to reduce rates of recidivism (Bouffard et al. 2000, Wilson et al. 2000, Davis et al. 2013, Davis 2019), and improve post-release employment rates and earnings of individuals after they are released from incarceration (Tyler and Kling 2006, Cho and Tyler 2013).

In addition to these challenges, the field of restoration ecology, which has been practiced in the United States for the past century, has only existed as a recognized sub-discipline of ecology since the founding its research-based journal, *Restoration Ecology*, which was first published in 1993, and thus is a relatively young scientific discipline. Its youth has contributed to the only recent emergence of empirical evaluation of restoration programs. Combined with the other challenges outlined above, it is clear why there has been so little formal evaluation of ICS programs to date, which makes this study particularly timely.

Despite the growing interest in these activities, these publications on the impacts of science outreach to people who are incarcerated have not generally included quantitative or qualitative analyses of the impacts on the participants. Nearly all of the impacts of these projects have been documented anecdotally and disseminated through the media (Table 2). Formal qualitative and quantitative data on both the expectations of and the outcomes for the ICS who participate in such projects are lacking. Such evidence-based information would strengthen our understanding of the benefits of citizen science projects for people who are incarcerated and create best practices for scientists and conservationists who are or wish to implement projects for ICS and for other public groups that face some of the same barriers and challenges (e.g., lack of internet access, inability to gain physical access to plants and animals). These data would also yield evidence for policy makers to provide support for such projects in academia, conservation, and corrections arenas.

Why is it that, nearly two decades into the practice of involving ICS in ecological restoration work, we lack evidence-based information about the impacts on ICS? Although several states have well-established conservation programs in prisons (Table 1), they have had limited capacity to pursue program evaluation or implement research on these projects. This reduced capacity has significantly limited the scope of research and our understanding of the challenges and values of such work (Davis et al. 2013).

We recognize four challenges facing those working in this arena, which involve a combination of logistics, pedagogy, and institutional values. First, the collection of formal quantitative and qualitative data is difficult because of the limited resources available to meet the need for strict human subject review, given that people who are incarcerated are justifiably designated a vulnerable population (Johnson et al. 2014). This designation means that researchers who work with ICS must be associated with an institution with an Institutional Review Board (IRB) that can review proposals involving vulnerable human subjects, and/or must use the specific IRB approved by their state corrections system. Extra care must be taken to implement study recruitment methods that respect the autonomy of people who are incarcerated, and ensure that informed consent is given voluntarily and without coercion. Research involving this population also requires significant, and often limited, resources from corrections staff for review of the methods' feasibility and subsequent implementation. Second, correctional populations tend to experience reduced access to education and have lower levels of literacy than the general population. Reading and writing responses to typical surveys can be more difficult for some, and may necessitate short consent forms and surveys with simplified language. Third, it can be difficult to elicit authentic responses to survey questions among populations who are incarcerated because of the power dynamics in a carceral setting. Some individuals are suspicious of authority, and may be less likely to provide authentic responses; others wish to please authorities (researchers or corrections staff) with the hope of gaining favor, and thus supply responses that they think are desired. Finally, the corrections environment is not geared toward education, conservation, or evaluation activities, so there are considerable logistical hurdles to work around, such as the use of pens in cellblocks, the rapid turnover of ICS, corrections staff collaboration to administer evaluation instruments, and unforeseen lockdowns that interfere with programming schedules.

Since 2014, a team of scientists and conservationists, based at the University of Utah, has operated a program that addresses these challenges. The Initiative to bring Science Programs to the Incarcerated (INSPIRE) has brought scientists (STEM graduate students and faculty) from the university to present monthly science lectures, discussions, and readings, inside the state prison, county jail, and juvenile detention centers. Their formal surveys documented that these lectures increased science knowledge content, shifted the self-identity of individuals who are incarcerated toward being science learners, and inspired actions to seek more information about science (Nadkarni and Morris 2018). These effects were manifested even with one or a few exposures, but impacts were amplified by increasing the number of lectures attended (Horns et al. 2020). Similar responses were documented in response to science lectures in other correctional institutions across the United States (Nadkarni et al. 2020).

Table 2. Examples of media reports of conservation projects at the local, regional, and national level.

Level	Organism	Correctional institution	News source (state)	Article title	Date
Local	Sagebrush (*Artemisia tridentata*)	Warner Creek CF	Lake County Examiner (OR)	Warner Creek AIC's reap what they 'sow'	May 2019
Local	Taylor's checkerspot butterfly (*Euphydryas editha taylori*)	Coffee Creek CF	Oregon Zoo News (OR)	With inmates' help, rare NW butterfly is homeward bound	Mar 2019
Local	Taylor's checkerspot butterfly	Mission Creek CC for Women	The Daily Chronicle (WA)	Endangered butterflies rebound in South Sound prairies	May 2019
Local	Coho Salmon (*Oncorhynchus kisutch*)	Olympic CC	Forks Forum (WA)	Inmates and others help create salmon habitat	Aug 2018
Local	Sagebrush	Salt Lake County Jail	Spectrum (UT)	BLM restoring land with aid from inmates	Nov 2016
Local	Taylor's checkerspot butterfly	Coffee Creek CF	Patch (OR)	Oregon corrections inmates to protect, raise endangered butterflies	Mar 2017
Regional	Sagebrush	Warm Springs Correctional Center	KTVN Ch. 2 Reno (NV)	Saving Nevada's sage-grouse, with inmate volunteers	Apr 2019
Regional	Taylor's checkerspot butterfly	Coffee Creek CF	KPTV Fox 12 (OR)	Coffee Creek inmates help raise hundreds of endangered butterflies	Mar 2019
Regional	Western pond turtle (*Actinemys marmorata*)	Cedar Creek CC	Medium; Gov. Inslee (WA)	Turning education into jobs	Jun 2019
Regional	Sagebrush	South Boise Women's CC	Idaho Press (ID)	Inmates help restore habitat through sagebrush planting program	Oct 2018
Regional	Least chub (*Iotichthys phlegethontis*)	Salt Lake County Jail	KSL (UT)	Science behind bars is improving lives, reducing crime	Nov 2015
Regional	Sagebrush	Northern Nevada CC, Warm Springs CC & Lovelock CC	Nevada News Group (NV)	Inmates help restore sage grouse habitat: sage grouse remains off endangered list due to prisoners' efforts	Aug 2016
Regional	Taylor's checkerspot butterfly	Coffee Creek CF	KATU 2 (OR)	Endangered butterfly lab at Coffee Creek Prison nurtures insects and inmates	Jul 2017
National	Western pond turtle	Cedar Creek CF	Seattle Times (WA)	Inmates feel better, too, after helping ill turtles	Apr 2014
	Oregon spotted frog (*Rana pretiosa*)	Cedar Creek CC	New York Times (WA)	Raising frogs for freedom, prison project opens doors	Sep 2012
National	Taylor's checkerspot butterfly	Mission Creek CC for Women	Discover Magazine	Prisoners do science, help to save endangered butterfly	Aug 2012
National	Taylor's checkerspot butterfly	Mission Creek CC for Women	PBS NewsHour	Do call it a comeback: how the checkerspot butterfly found salvation in a women's prison	May 2016
National	Oregon spotted frog	Cedar Creek CC	Associated Press	Prison inmates save endangered species at Cedar Creek Corrections Center	Sep 2012
National	Native plants & checkerspot butterfly	Stafford Creek CC & Mission Creek CC for Women	Yes! Magazine	How inmates, scientists, and government workers are teaming up to save this butterfly	Oct 2017
National	Oregon spotted frog	Cedar Creek CC	National Geographic	Biologist wants nature for everyone, including prisoners	Sep 2016
International	Western Pond Turtle	Cedar Creek CC	UK Ministry of Justice	Returning home	Jun 2019
International	WA Conservation Programs	WA State Prisons	Solutions Journal (Australia)	Slowing Australia's revolving prison door through biodiversity and conservation projects	May 2017
International	Taylor's checkerspot butterfly	Mission Creek CC for Women	UK Ministry of Justice	Restoring hope and habitat: prison-based collaborations for ecological conservation in the USA	Dec 2018
International	Sagebrush	Correctional Facilities in WA, UT, ID, NV, MT	Nos Actus (France)	Former les détenus à protéger la nature	Mar 2017

In addition to science lectures, INSPIRE has provided experiential informal science education through hands-on training and participation by people who are incarcerated in five ecological restoration projects (2015–2019) at the Salt Lake County Jail (SLCJ). These included adult ICS in the construction of nest boxes for the American Kestrel (*Falco sparverius*) and participation in an exploratory horticulture research project to re-establish native plants in wetlands habitat around the Great Salt Lake (Marty and Kettenring 2017, Crockett et al. 2018). A third conservation project involved ICS youth (14–18 years old), who grew native milkweed that were out-planted by community conservationists to provide habitat and food for migrating monarch butterflies (*Danaus plexippus*). Participation by ICS were formally assessed for two other projects: the Least Chub Refuge Pond Project and the Sagebrush Restoration Project, described below.

Assessment of the impacts of participation in conservation projects on individual ICS is a complex matter that involves different expertise from that of giving ecological science lectures or leading conservation activities. Specifically, the design and implementation of learning assessments requires expertise in psychological construct validity and measurement. These skills are not in the typical "toolbox" of ecological researchers involved and, therefore, properly assessing the impact of ICS on participants' outcomes requires close collaboration with social scientists.

First, measuring the impacts of lectures and activities on participants' science knowledge content requires expertise in designing and implementing learning assessments to be completed by attendees before and immediately after science presentations. We collaborated with experts in STEM education and evaluation who helped to design these learning self-assessments. Second, it was challenging to determine how to assess participants' expectations of ICS before engaging with an ongoing long-term conservation project, and understanding the psychosocial impacts of involvement in conservation activities, including interacting with scientists over weeks or months, given that this type of work with this type of audience has little precedent. These assessments required additional knowledge of the potential psychosocial consequences, positive and negative, that could emerge from the ICS experience and the best way to assess these impacts. Also, because the impacts of ICS can differ from scientists' expectations, we included open-ended survey questions or interviews in order to capture responses unforeseen by the researchers who design and select the pre- and post-ICS assessments.

In this paper, we provide a case study that reveals some of the challenges to understand the impacts of participation in conservation projects on ICS. We describe assessment outcomes of two conservation projects carried out in the Salt Lake County Jail in Utah. We report on and compare results using closed-ended and open-ended data from surveys. We discuss the importance of collaboration of ecologists and other scientists involved with citizen science projects with social scientists to more holistically assess impacts of these projects on participants. Finally, we provide recommendations on how to initiate, maintain, and assess citizen science projects with people who are incarcerated, which may be applied to other populations who lack access to nature and traditional citizen science projects.

MATERIALS AND METHODS

Study site

The conservation projects took place at the Salt Lake County Jail (SLCJ), which is operated by the Salt Lake County Sheriff's Office, and houses approximately 2300 inmates, from minimum to maximum security. Previous baseline surveys of people incarcerated at the SLCJ (Nadkarni and Morris 2018), document that 77% are men, with the majority of them White non-Hispanics (65%). Hispanics made up the largest proportion of minority groups (26%). For the highest level of education attained, the largest category was a high school diploma (26%), followed by "some college" (23%) and "some high school" (18%).

The ICS for this study were drawn from the general jail population and from SLCJ's Horticulture Program, established in 2009 under its Jails Program Division. It provides education and vocational training to qualified, non-violent inmates ("trustees"). Working cooperatively with community partners to facilitate reintegration and reduce recidivism, the program supports a 1.2 ha garden, two greenhouses, three hoop houses (plant-growing spaces with flexible structural members), and a chicken coop on the jail premises. The composition of the trustee pool varies because they rotate in and out of these programs, depending on their sentences and other responsibilities such as meetings with lawyers and families. In general, the number of trustees at any time ranges from 40 to 60 individuals, and so represents a small proportion of the general jail population. Because our study extended over a period of six years, the number of surveyed participants involved over 200 individuals.

We assessed impacts of participation in two conservation projects. The Least Chub Refuge Pond Project was initiated in May 2015, when the INSPIRE program partnered with the SLCJ and the Utah Division of Wildlife Services (DWS). The SLCJ created a 1.0 ha "refuge pond" on its property for the least chub (*Iotichthys phlegethontis*), a Utah state-sensitive fish. This native mosquito-eating species plays an important role in Utah's natural mosquito abatement efforts, and is threatened by more aggressive introduced species called the western mosquitofish (*Gambusia affinis*; Ayala et al. 2007). The program was funded by $150,000 from the prisoner-services (commissary profits) account, and was approved by the Salt Lake City Council. The DWS provided 5000 native fish for the refuge pond to help repopulate this species. Scientists from the DWS and INSPIRE provided ICS with lectures on concepts and skills in science and sustainability, including fish biology, aquatic macroinvertebrate ecology, water chemistry, and the rationale for and practices of conservation. Staff at the SLCJ provided security clearances for scientists, and officers provided oversight for safe behavior. The ICS carried out fish censuses, cleared the pond of algae, conducted and recorded water chemistry measurements, and attended lectures and workshops, with accompanying readings, presented by INSPIRE staff.

The second project, the Sagebrush Restoration Project, involved growing seedlings of sagebrush for ongoing work to restore burned habitat of the iconic sage grouse (*Centrocercus urophasianus*), whose numbers are decreasing across the intermountain west. In 2017, INSPIRE contracted with the Institute for Applied Ecology (IAE) to involve adults in correctional institutions. Funded by the U.S. Bureau of Land Management (BLM), this effort involved ICS (men and women) to grow ca. 24,000 seedlings as plugs of native sagebrush from local and regional provenance. The IAE provided seeds, soils, containers, and established protocols, and coordinated the out-planting of mature seedlings with BLM staff. INSPIRE staff provided accompanying science lectures and workshops about sage grouse biology, the rationale for the Endangered Species Act, and horticultural protocols.

Recruitment of participants

All participants in the least chub program were men recruited from the horticulture program. The inclusion of men only was because the large majority of people who are incarcerated are male (nearly 95% on average across the United States), and the capacity for gaining access to women exceeded the time and effort

that was available to the participants at that time. Recruitment for the Sagebrush project was from women and men's minimum-security cellblocks. In all cases, selection of participants was made by officers and staff of the SLCJ. Participants were required to have indicators of good behavior and no violent infractions. All participation was voluntary and those who participated received no extra incentive or rewards from INSPIRE. Letters of appreciation were offered to participants, and most accepted them. Participant demographics are provided in Table 3.

Design of surveys and evaluation protocols

Survey design and data management were carried out in collaboration with the Utah Education Policy Center (UEPC), an independent educational research organization at the University of Utah. This study was reviewed and approved by the Institutional Review Board (IRB) of the University of Utah (IRB_00061095) for all protocols, consent letter, survey documents, study logic model, and recruitment flyer texts.

Since 2004, our research team has been carrying out a range of activities that bring science and nature to people who are incarcerated (Ulrich and Nadkarni 2009). For the first eight years, science lectures were sporadically delivered to adults who are incarcerated in a variety of correctional institutions without formal and systematic evaluation instruments. These provided opportunities for informal feedback of participants who are incarcerated and corrections staff and allowed us to gauge the level of appropriate lecture terminology and concepts and to gain an understanding of the learning abilities of these audiences. This information led us to place necessary constraints on language, amount of text, and length of written surveys.

Using this knowledge, the questions and categories for our surveys were created by a professional educational evaluator at the Utah Education Policy Center (UEPC). Survey questions were based around the topics of science, math, nature, and conservation. Evaluation instruments were based in part on the theory of planned behavior and the theory of reasoned action (Ajzen and Fishbein 1980, De Leeuw et al. 2015). However, the novel nature of this audience and lack of preceding formal studies did not allow direct use of that literature. Where possible, we selected items from validated surveys, modified items as necessary, and developed our own questions when preexisting surveys did not apply. The question topics for our surveys (listed below) were derived from validated scales: attitudes toward science, who can do science, and enjoyment of studying science and math (Scientific Attitude Inventory; Moore and Foy 1997); perception of the utility of science in daily life (Motivated Strategies for Learning Questionnaire; Pintrich and De Groot 1990); value of knowing math to help earn a living (Fennema-Sherman Mathematics Attitudes Scale; Fennema and Sherman 1976); and value of environmental protection for benefits to self and others (New Environmental/ Ecological Paradigm scale; Dunlap and Van Liere 1978, Dunlap et al. 2000). All other survey questions were original and not derived from validated scales.

INSPIRE staff and select SLCJ staff gave individual ICS a pre-participation survey and consent forms for assessment when they started their work on the project, and a post-participation survey when they left the project because of release or transfer to a different cell block. In many cases, neither the INSPIRE staff nor the ICS received notice of release or transfer, which resulted in a large number of unmatched surveys. For quantitative analysis, only matched pre- and post-participation surveys were used in the analyses (n = 225). For qualitative analyses, all non-duplicate completed entrance and exit surveys were used in the analysis.

Methods for quantitative analyses

The quantitative portion of the survey included Likert scale questions with responses ranging from "strongly disagree to strongly agree"; for behavioral intent questions, responses ranged from "very unlikely" to "very likely". Questions on the surveys were randomly ordered but are reordered here to facilitate interpretation. Reliability scores of greater than 0.70 indicate acceptable agreement (Fleiss 1981); most constructs in our survey, other than Logistics and Incarceration questions, were near or acceptably reliable. We categorized 35 survey questions into ten categories (with Cronbach's alpha reliability scores for matched entrance and exit surveys, respectively): Identity with science and scientists (ISS; α = 0.68, 0.82); Science and math connection to life (SML; α = 0.77, 0.81); Math education (ME; one question); General education (GE; one question); Relationship with the environment (RE; α = 0.80, 0.77); Employment related to the environment (EE; α = 0.91, 0.80); Incarceration (IN; α = 0.44, 0.52); Logistics (LOG; α = 0.60, 0.41); Behaviors related to science (SB; α = 0.80, 0.89); and Personal relationships with others (PR; α = 0.86, 0.89). All questions and question categories are provided in Table 4.

Entrance and exit surveys were matched using identification numbers issued by the correctional institution and provided by participants on the surveys. We matched 44 entrance and exit surveys from the Least Chub Project. For the Sagebrush Project, we only obtained five matched entrance and exit surveys; these were not included in the quantitative analysis. Although we collected demographic information on the survey (Table 3), the sample size of matched surveys was too small to differentiate responses with respect to ethnicity or educational background. To determine if survey responses changed as a result of participation in the conservation project, we compared entrance and exit survey results for both individual questions and for question categories using nonparametric Wilcoxon signed rank tests. Significance levels were adjusted using the false discovery rate procedure (Benjamini and Hochberg 1995). Quantitative analyses were carried out in the R statistical programming environment (R Core Team 2021).

Methods of qualitative analyses

Across the two projects, there were 202 responses to the entrance survey open-ended question and 60 responses to the exit survey open-ended questions. Of the 202 participants who responded to the entrance survey, 33 responded to the exit survey. An additional 27 participants, who had not responded to the entrance survey, responded to the exit survey.

In the entrance surveys, participants were asked one question about what they hoped to gain from the project. There were 202 unique (non-duplicate) responses to code. In the exit surveys, participants were asked two questions, one about what benefits they gained from the project and the other about what benefits the project provides to the community outside of the jail. Across the two questions, there were 93 unique (non-duplicate) responses

Table 3. Demographics and education levels of participating incarcerated citizen scientists.

	Least Chub Project				Sagebrush Project[‡]	
	Total participants (n = 255)		Matched entrance and exit surveys (n = 44)		Total participants (n = 39)	
	Count	%	Count	%	Count	%
Ethnic background[†]						
White (non-Hispanic)	176	70	32	73	26	67
Hispanic or Latino	26	10	2	5	4	10
Native American or Alaska Native	3	1	0	0	1	3
Black or African American	17	7	2	5	1	3
Native Hawaiian or Pacific Islander	5	2	1	2	0	0
Asian	4	2	1	2	2	5
Two or more ethnicities	11	4	6	14	5	13
Highest level of education attained						
Junior high or less	7	3	1	3	2	6
Some high school	40	18	8	21	3	8
HS diploma	65	29	12	32	11	31
GED	41	18	5	13	2	6
Some college	39	18	6	16	6	17
Associate's degree	18	8	4	11	7	19
Bachelor's degree	8	4	2	5	4	11
Graduate or professional school	4	2	0	0	1	3

[†]Ethnic background categories sum to more than 100% because respondents could select more than one category.
[‡]Matched entrance and exit surveys for the Sagebrush Project were insufficient for analysis (n = 5).
Note: Percentages may not sum to 100% due to some respondents choosing not to complete all portions of demographic section of the survey. All participants in the Least Chub Project were men. Participants in the Sagebrush Project were mixed gender.

to code. The responses to open-ended questions ranged from no response (blank) to a few sentences. The blank answers were not coded or included in the counts.

After initial read-through of the responses, we generated a coding scheme that included each of the themes mentioned by the participants. For each participant response, themes were coded as present or absent by two trained coders. Agreement between the two coders was extremely high (90%), and disagreements were resolved through discussion.

RESULTS

Quantitative results

Quantitative analysis of responses grouped by question category indicated a significant change ($P < 0.05$, Wilcoxon signed rank test) from entrance to exit survey for only two categories (Fig. 1): Math education (ME; entrance survey = 4.66 ± 0.57, exit survey = 4.38 ± 0.17; data are means ± standard deviation), and Relationship with the environment (RE; entrance survey = 4.50 ± 0.55, exit survey = 4.30 ± 0.52). However, these results were not significant after correction for multiple comparisons using the false discovery rate procedure. The Math education category consisted of a single question: "I am sure that I can learn math."

When individual questions were tested separately, four showed a significant decrease from entrance survey to exit survey (i.e., a change indicating that the experience was negative); these were: "I am interested in learning science" (Identity with science and scientists [ISS] category), "I can contribute to science" (ISS category), "I am sure that I can learn math" (ME category; see above), and "If I can, I want to start a garden after I leave here" (RE category; Table 4). In one case ("Even though I am in jail,

Fig. 1. Summary of quantitative survey data from entrance surveys (first bar for each category) and exit surveys (second bar for each category). Bars represent mean score for each survey question category ± standard deviation. Scores for Math education (ME) and Relationship with the environment (RE) signficantly decreased from entrance to exit survey ($P < 0.05$, Wilcoxon signed rank test); however, this difference was not significant after correction for multiple comparisons.

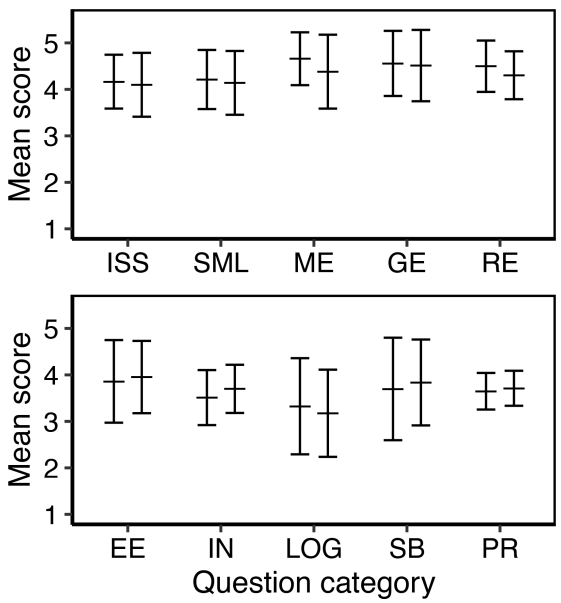

Table 4. Entrance and exit survey questions and responses of incarcerated citizen scientists for this study.

Survey categories and questions	Mean ± s.d.						Wilcoxon signed rank test		
	Entrance survey			Exit survey			V	P	
Identity with science and scientists (ISS)									
1. Only highly trained scientists can understand science.†	1.81	±	1.22	1.64	±	1.04	94	0.449	
2. Scientists are not so different from me.	3.86	±	0.99	3.95	±	1.21	117	0.323	
3. Scientific work is useful only to scientists.†	2.07	±	1.24	2.29	±	1.31	133	0.545	
4. Scientific work would be too hard for me.†	2.07	±	1.30	2.10	±	1.34	118.5	0.929	
5. Working in science or learning about science would be fun.	4.35	±	0.72	4.36	±	0.76	85.5	0.686	
6. I am interested in learning science.	4.45	±	0.71	4.10	±	0.81	100.5	0.016	*
7. I am interested in doing science.	4.38	±	0.78	4.15	±	0.84	85.5	0.141	
8. I can contribute to science.	4.50	±	0.75	4.03	±	0.95	151.5	0.018	*
Mean of question category	4.17	±	0.58	4.10	±	0.69	422.5	0.454	
Science and math connection to life (SML)									
9. Science helps me in my daily life.	4.07	±	1.00	4.16	±	0.75	72.5	0.571	
10. Math helps me in my daily life.	4.41	±	0.79	4.16	±	1.13	138.5	0.074	
11. Knowing science will help me earn a living.	3.98	±	0.83	4.00	±	0.76	69	0.729	
12. Knowing math will help me earn a living.	4.39	±	0.69	4.23	±	0.81	102.5	0.202	
Mean of question category	4.21	±	0.64	4.14	±	0.69	394	0.523	
Math education (ME)									
13. I am sure that I can learn math.	4.66	±	0.57	4.38	±	0.79	100	0.017	*
General education (GE)									
14. I would like to continue my education.	4.56	±	0.70	4.51	±	0.77	55.5	0.871	
Relationship with the environment (RE)									
15. Engaging in actions that help the earth, such as recycling and reducing waste, is important to me.	4.55	±	0.63	4.21	±	0.91	166	0.071	
16. I really enjoy being outdoors.	4.86	±	0.42	4.67	±	0.61	58.5	0.122	
17. If I can, I want to start a garden after I leave here.	4.44	±	0.77	4.14	±	0.83	221.5	0.032	*
18. I feel a personal bond with things in my natural surroundings, like trees, a stream, wildlife, or the view on the horizon.	4.36	±	0.87	4.19	±	0.70	126.5	0.172	
19. In order to conserve resources, I would be willing to take personal action such as using less water and turning off lights.	4.33	±	0.94	4.24	±	0.69	124	0.466	
20. Environmental protection benefits everyone.	4.51	±	0.80	4.40	±	0.79	124.5	0.455	
Mean of question category	4.50	±	0.55	4.30	±	0.52	470	0.011	*
Employment related to the environment (EE)									
21. When I leave jail, I would prefer a job where I work with plants or animals.	3.84	±	0.90	4.10	±	0.79	78.5	0.18	
22. When I leave jail, I would prefer a job that helps to protect the natural environment.	3.88	±	0.96	3.84	±	0.90	108	0.6	
Mean of question category	3.86	±	0.89	3.95	±	0.78	174	0.722	
Incarceration (IN)									
23. My family or friends outside jail know what sort of work or programs I am involved in here.	3.95	±	1.29	4.28	±	0.98	64.5	0.218	
24. I don't feel like I am a part of a community inside this jail.	2.50	±	1.25	2.54	±	1.27	176.5	0.99	
25. Even though I am in jail, I still feel connected to the outside community.	3.15	±	1.28	3.67	±	1.21	100.5	0.016	*
26. Even though I am in jail, it is important to me to contribute to the outside community if I can.	4.37	±	0.79	4.21	±	0.80	143	0.321	
Mean of question category	3.51	±	0.59	3.70	±	0.52	293	0.531	
Logistics (LOG)									
27. I do not like filling out surveys.†	2.91	±	1.19	3.07	±	1.18	103	0.448	
28. I would be willing to complete a longer survey than this one.	3.56	±	1.26	3.38	±	1.19	146.5	0.276	
Mean of question category	3.33	±	1.03	3.17	±	0.94	205	0.452	
Behaviors related to science (SB)									
29. How likely are you to look for information about science (for example, on television or in newspapers)?‡	3.93	±	1.10	3.88	±	0.99	96.5	0.623	
30. How likely are you to talk to someone in the jail about issues related to science?‡	3.51	±	1.23	3.77	±	0.95	49	0.057	
Mean of question category	3.7	±	1.10	3.84	±	0.92	139.5	0.357	

(con'd)

Personal relationships with others (PR)								
31. How well would you say you get along with prisoners?	3.68	±	0.47	3.71	±	0.46	12	0.777
32. How well would you say you get along with officers?	3.58	±	0.50	3.6	±	0.50	32.5	0.594
33. How well would you say you get along with teachers working at the jail?	3.65	±	0.48	3.68	±	0.47	30	0.802
34. How well would you say you get along with civilians working at the jail?	3.65	±	0.48	3.73	±	0.45	22	0.565
35. How well would you say you get along with your family?	3.83	±	0.38	3.79	±	0.42	33	0.565
Mean of question category	3.65	±	0.39	3.71	±	0.38	138.5	0.526

[†]Question with reversed polarity; responses were reversed for calculation of mean of question category.
[‡]Behavioral question; Likert scale responses were 1 (very unlikely) to 5 (very likely).
*$P < 0.05$; no results were significant after correction for multiple comparisons using the false discovery rate method.

I still feel connected to the outside community"; Incarceration [IN] category), responses were significant in the direction that indicated a positive response to the experience. None of the differences for individual questions was statistically significant after correction for multiple comparisons.

Qualitative Results

Among the responses to the entrance survey question, the modal response was one goal mentioned and ranged from zero to five. The mean number of goals was 1.42 ($SD = 0.09$); the median was one goal provided. Of the participants who supplied responses to this question, participants varied in the types of outcomes that they hoped would result from their experiences in their project entrance surveys (Table 5). The majority of respondents (68.8% of those who responded to the question) reported that they wanted to learn and gain knowledge. For example, participants said they wanted to "learn more about natural resource and life science" and gain "a better understanding of different environments & wildlife preservation." Another commonly reported motivation was to gain skills (27.2% of those who responded to the question).

Most of these responses described wanting to gain concrete knowledge and/or skills that participants could use after being released, such as "How to go about growing and processing my own food for me and my family." Some also mentioned wanting to gain skills for future employment: "I was told I would take a class and if I pass a test, I will receive a certificate helping me with my landscaping/arborist job/career."

Some respondents (22.8% of those who responded to the question) also reported that they hoped the experience would help them become a better person or give back to the community. For example, participants hoped "to be more connected to nature and work better with others" and "to give back to the community, and help the environment." They also hoped to gain "the feeling that I am contributing somehow" and wanting to "[give] back to the community doing something positive with my time." In addition, some respondents (17.3% of those who responded to the question) reported that they hoped to gain a positive experience from participating in the program. Many of these participants said they wanted to get "fresh air" or time outdoors. For example, "fresh air and knowledge about sagebrush" and "good time, sunshine, and learning how to husband fish on a large scale."

In response to the open-ended question about benefits gained personally, the modal number of benefits mentioned was one and ranged from zero to four. The average number of personal benefits was 1.51 ($SD = 0.84$). Most responses described scientific knowledge (68.8% of responses), with many explicitly mentioning learning about conservation (44.1% of responses). For example, participants said they gained "knowledge of endangered fish and pesticides" and "greater knowledge of fish & wildlife care & conservation." Several participants also reported gaining hard skills (18.6% of responses), such as "learning how to tend to fish and pond upkeep" in the Least Chub Project.

Some respondents (22.1% of responses to the question) mentioned gaining psychological benefits from the experience. Participating in the program provided some participants with a personal sense of accomplishment, especially from being able to make a positive contribution to the world. For example, "Knowing that I contributed to the better health of the chub and also the betterment of the condition of the pond and the natural habitat of its surroundings" and "I enjoyed being a part of a project to better our habitat." Similarly, respondents mentioned that the experience was a positive or even healing one: "I was able to get a sense of accomplishment as well as educate myself. I feel like it was very therapeutic as well." Furthermore, the experience clearly shaped some participants' feelings of connection with the environment, "We are all a part of nature!!" "It's an opportunity to provide a service to the community and give back to the environment." A minority of responses (3.4%) stated that they did not think there were any personal benefits of their participation to themselves nor to society.

In terms of post-project benefits to the broader community, the modal number of benefits mentioned in responses was one and ranged from zero to three. The average number of benefits mentioned was 1.10 ($SD = 0.68$). Of those who responded to the question, the majority (78.3%) mentioned conservation. Participants mentioned that the broader community would gain from conservation, "by helping save an endangered species" and "everyone can benefit from the least chub by eliminating mosquitos." Also, "How to maintain and care for a plant so that it grows to be a strong and healthy plant."

Some respondents (25% of those who responded) mentioned that the program provided inmates the opportunity to give back to society, such as "That we help out in a major project to jelp [sic] our planet" and "It is providing a service to the community by providing an ecosystem for an endangered species to survive." A few respondents also mentioned that the program gives them the opportunity to change people's views about prisoners (6.7% of those who responded). For example, "We helped in working to restore the sagebrush habitat to protect the sage grouse and several other species. I think it helps the community know we are doing productive things." A very small proportion of responses (1.7%) indicated that they did not think there were any community benefits to the program.

Table 5. Themes, percent of total responses, and examples of entries in written responses of incarcerated citizen scientists on entrance and exit surveys.

Entrance question themes	Percent of total responses	Examples
Increase knowledge	68.8	"learn more about natural resources and life science" "a better understanding of different environments & wildlife preservation."
Gain skills	27.2	"How to go about growing and processing my own food for me and my family." "I was told I would take a class and if I pass a test, I will receive a certificate helping me with my landscaping/arborist job/career."
Gain social or personal benefits	22.8	"to be more connected to nature and work better with others" "to give back to the community, and help the environment." "the feeling that I am contributing somehow"
Have positive experience	17.3	"fresh air" "Good time, sunshine, and learning how to husband fish on a large scale"
Exit survey about personal benefits themes		
Learned knowledge	68.8	"knowledge of endangered fish & pesticides"
Learned about conservation	44.1	"greater knowledge of fish & wildlife care & conservation"
Psychological benefits	22.1	"Knowing that I contributed to the better health of the chub and also the betterment of the condition of the pond and the natural habitat of its surroundings" "I enjoyed being a part of a project to better our habitat." "I was able to get a sense of accomplishment as well as educate myself. I feel like it was very therapeutic as well." "We are all a part of nature!!"
Gained skills	18.6	"learning how to tend to fish and pond upkeep"
Had a positive experience	10.2	"I was able to get a sense of accomplishment as well as educate myself. I feel like it was very therapeutic as well."
Don't think there were any	3.4	
Exit survey about societal benefits themes		
Conservation	78.3	"by helping save an endangered species" and "everyone can benefit from the least chub by eliminating mosquitos" "How to maintain and care for a plant so that it grows to be a strong and healthy plant."
Giving back to others	25	"That we help out in a major project to jelp [sic] our planet"
Don't think there are any	1.7	

DISCUSSION

Incorporating concepts and actions for natural resource conservation into correctional facilities is part of a wider movement to broaden participation in environmental work (Taylor 2014). The activities we describe here contribute to understanding and documenting the influence and impacts of the young but growing field of citizen science programs on people who are incarcerated. This might lead to increasing access of science sustainability, and conservation actions—with its accompanying psychological, physical, and emotional benefits—for populations who live or work in areas without access to wild nature, and/or in built environments that lack connection to or views of nature, such as seniors in assisted living centers, military personnel who live in barracks, and those in rehabilitation centers, in addition to ICS (Nadkarni et al. 2017a).

In this study, the quantitative survey data by itself suggested that there was little apparent response to participation in conservation projects. Our quantitative results, when taken on their own, suggest caution in how citizen science programs are implemented, as there was some indication that these programs have the potential to degrade the confidence of people who are incarcerated. However, the questions indicating that participation in a conservation project had a negative effect (four out of 35 questions) were not statistically significant when multiple comparisons were controlled for. We speculate that the manner in which some scientific topics were discussed by academic lecturers may have been off-putting or intimidating, because of vocabulary or presentation style, and that the questions did not directly measure the impacts that were documented in the qualitative responses.

In contrast, the qualitative analyses of participants' open-ended responses clearly document positive impacts from participation. These included ICS reports that they had learned about science, and conservation specifically. Their responses went far beyond learning facts about science, and included their reporting that they felt a sense of contribution, an emotion that is often lacking in the sphere of people who are incarcerated. These findings also provide additional context for the interpretation of the quantitative results. A close inspection of the numbers in Table 4 reveals a relatively high level of agreement (averages typically above four on a five-point scale) with items reflecting the importance of conservation, personal enjoyment of the outdoors, and desire to contribute to society at large. Thus, the open-ended responses provided insights into the most rewarding aspects of ICS for participants.

Ecologists have a tendency to focus on quantitative data to provide evidence for patterns, and typically (with exceptions), do not have training in psychological theories or research design and methodology for studying psychological processes. For this reason, we strongly encourage ecologists to partner with social scientists who are (generally) trained in psychological constructs underlying human behavior and the methodologies needed to rigorously assess ICS impacts.

Our results indicate that relying on quantitative data alone does not reveal the entire story, particularly when the questions asked only address a portion of the potential impacts of the experience of the citizen scientists. Our outcomes encourage researchers to use mixed methods, i.e., both qualitative and quantitative, approaches to understand impacts of such projects, as survey measures using Likert-type responses are likely to miss impacts that are unforeseen or do not seem central to the purpose of the scientific activity. These findings are not without limitations. The open-ended survey questions were asked at the end of the larger closed-ended survey, and consequently participants' responses could have been influenced by the measures that preceded them. It is possible that some participants used the open-ended responses to emphasize certain aspects of their responses to the closed-ended surveys or to highlight aspects of the experience that they did not feel were adequately captured by the survey items before. Nonetheless, the results of the qualitative analysis clearly showed that some participants gained significant psychosocial benefits from participating. These limitations highlight the need for deeper, more extensive qualitative research, such as a series of interviews and focus groups, to more fully investigate the impacts of ICS on participants.

It is important to note that qualitative research is a broad category that is defined by collecting non-numerical data (Jansen 2010). Although open-ended survey questions are one method of collecting qualitative responses, there are other tools such as interviews and focus groups that render much richer data. Social scientists often encourage researchers to first conduct qualitative research (e.g., interviews, focus groups) to more deeply understand a context and then design quantitative surveys to show the results more definitively in a larger sample (Creswell and Creswell 2017). One barrier to this two-step approach in correctional institutions is that you might only get "one shot" to collect data. Although one-shot data collection is not the "ideal" way to conduct mixed methods research, which specifies that the qualitative and quantitative methods should mutually inform one another (Creswell and Tashakkori 2007), we contend that collecting both at the same time is better than the alternative of relying on only one form of information in the single-shot data collection scenario. Furthermore, when social scientists can be engaged in ICS from the beginning, they may be able to conduct truly qualitative research that informs improvements to the ICS programs, and partner with ecologists to assess the impacts of the ICS programs as well. As a result, the interdisciplinary partnership between ecologists and social scientists in ICS programs, from development to evaluation, will provide the most rewarding outcomes across the board.

In our study, the quantitative questions did not cover the range of goals and benefits reported in participants' qualitative responses to the open-ended questions. If we had collected and reported only the traditional Likert scale data, then we would have missed some of the motivations behind ICS participation and the subjective impacts of these activities reported by the ICS. In most academic settings such as R1 universities, natural scientists and social scientists tend to occupy different arenas, with different theories, journals, approaches, and tools. Few ecologists have access to social science tools, and, because of this limitation, many of the impacts of conservation and ecological restoration activities on public groups might be misinterpreted or lost. Even fewer have the time and capacity to write and maintain IRB permissions for Human Subjects Review, and many may work at institutions where no IRB exists (e.g., small liberal arts colleges or community colleges).

Further questions that arise from this study include the following: (1) How generalizable is this approach across types of correctional institutions, security levels, age, gender, ethnic groups, and education levels of ICS? (2) What are the impacts, benefits, and challenges for the scientists who become engaged with people who are incarcerated? (3) How might corrections institutions' needs and capacity constraints be addressed and shifted to improve the ability to research program impacts? If ecologists can develop and sustain collaborations with social scientists, ecologists will be better poised to answer these questions.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.php/13423

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Data Availability:

The data/code that support the findings of this study are available on request from the corresponding author (NMN). None of the data/code are publicly available because they contain information that could compromise the privacy of research participants. Ethical approval for this research study was granted by University of Utah Institutional Review Board # IRB_00061095.

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