Title: Trusting land to volunteers: How and why land trusts involve volunteers in ecological monitoring

Authors: Peters, C.B., Y. Zhan, M.W. Schwartz, L. Godoy, H.L. Ballard

Abstract

Land trusts play an increasingly important role in conservation both in terms of the magnitude of conservation activities in which they participate and the total proportion of all conservation that they represent. Making informed conservation management decisions and local community engagement are two critical problems facing operators of locally-owned protected areas including those managed by land trusts. Engaging volunteers for critical management needs, such as collecting ecological data, is one way to overcome the challenge of managing and monitoring resources as a small organization. Partnering with volunteers can also help achieve other conservation goals including educational outreach and increasing public support. Land trusts that engage in volunteer-based monitoring (VBM) provide an opportunity to study how citizen science activities can contribute to conservation in practice. We surveyed land trust organizations across the United States to learn about their VBM programs. We received survey responses 332 organization, 133 of which maintain VBM programs. We found that the majority of land trusts with VBM programs are small organizations with less than ten employees (79.1%), few volunteers (50.4% with <10 volunteers, 87.2% with <50 volunteers), and little funding dedicated to the volunteer management (70.9% with <\$1000 annually). Volunteers collect data on a wide variety of monitoring targets including vertebrate, invertebrate, and plant species, as well as water, soil and air quality measurements. Volunteers also engage in many different stages of the monitoring process including data collection, entry and analysis, and even dissemination of results. While increasing civic engagement and educational outreach were reported as the most important motivations for land trusts to engage in VBM, organizations reported that increasing civic engagement is the most difficult benefit to achieve. These results have implications for how land trusts can use citizen science and other participatory approaches to engage volunteers for conservation actions and increase public engagement. This study also shows that scientists interested in citizen science may engage with land trusts to learn about the potential for citizen science to improve conservation management.

Keywords: Land Trust, Volunteer-Based Monitoring, Citizen Science, Volunteer Management, Community Engagement, Conservation Management

1.0 Introduction

The number and scope of citizen science programs, and the peer-reviewed journal publications that result from them, have exploded in recent years (Bonney et al., 2009). Resource agencies and local land managers increasingly use and solicit volunteer or “citizen scientist” collected data for natural resource management (Conrad and Daoust, 2008; Schmeller et al., 2009). For local organizations and agencies, citizen science for conservation can help to achieve multiple goals, including providing new scientific insights and data needed to inform management while also engaging people with nature (Shirk et al., 2011). Potential benefits of citizen science programs for conservation organizations include providing a low-cost option for data collection (Gollan et al., 2012), encouraging collaboration to build social capital within local communities (Jordan et al., 2012), and leveraging scientific and natural history expertise of volunteers (Conrad and Daoust, 2008). However, potential barriers include difficulty in maintaining volunteer interest, lack of capacity for volunteer training and supervision, and data fragmentation (Conrad and Daoust, 2008; Cooper et al., 2012). The question of when, why and how to engage volunteers to help inventory and monitor natural resources for conservation is a common one for land managers turning to citizen science.

Land trusts, which are non-governmental organizations that conserve land by negotiating conservation easements and/or purchasing land, represent an important subset of conservation-focused land management organizations (Brewer, 2003). The number of land trusts in the United States has drastically increased since the 1980s (Chang, 2011). By 2011, there were over 1700 land trusts operating in the United States (Chang, 2011). While the primary activity of land trusts was negotiating conservation easements (Rissman et al., 2007),

63 many are now holding land in fee-title. State and local land trusts in the United States have
64 increased their fee-title land holdings from 455 thousand hectares in 2001 to 868 thousand
65 hectares in 2010, at an annual growth rate of 7.4% (Chang, 2011). This value strictly refers to
66 land owned by land trusts, and not land that land trust help place under easement or purchase
67 and then reconvey to other owners. Owning reserves requires that these land trusts manage
68 their natural resources and monitor progress toward stated objectives of that management.
69 This combination of numerous small organizations, with common needs in terms of monitoring,
70 creates an opportunity for intentional design of citizen science that fills both data and
71 engagement needs (Shirk et al., 2011).

72 Many small conservation organizations, including land trusts, draw upon local volunteers to
73 conduct some or all of their monitoring activities (Conrad and Hilchey, 2011). The majority of
74 land trust in the Unites States are small organization, with a few exceptions. As of 2010, land
75 trusts in the United States had over 136 thousand active volunteers, representing a 70%
76 increase in volunteers from 2005 to 2010 (Chang, 2011). As a form of citizen science, volunteer-
77 based monitoring (VBM) programs involve non-professionally trained members of the public in
78 monitoring activities including data collection and analysis in collaboration with professionally-
79 trained scientists (Shirk et al., 2011). Within the larger context of citizen science programs
80 focused on conservation, we wondered how extensively VBM programs are employed by land
81 trusts, for what purposes, and what role this particular kind of citizen science plays in achieving
82 the goals for these conservation organizations. We do not consider monitoring for compliance
83 with conservation easement terms on lands not owned by land trusts because this monitoring

84 does not usually involve the collection of ecological data and therefore does not qualify as
85 citizen science.

86 Monitoring often represents a significant investment for a land trust. As of 2011, land trusts
87 collectively spent close to \$170 million per year in monitoring and stewardship activities,
88 representing a doubled annual investment since 2006 (Chang, 2011). Monitoring is a challenge
89 across a wide spectrum of non-governmental organizations (NGOs) engaged in land
90 management (Muir, 2010). We anticipate that monitoring is particularly difficult for land trusts
91 because they are typically organizations with limited resources and few staff.

92 Partnering with volunteers to conduct monitoring is a means for land trusts to meet some of
93 these resource needs and engage with the communities in which they operate. As land trusts
94 begin to own and manage more land, their public visibility as conservation actors increases.
95 Public outreach and engagement has become an important goal for many land trusts (Land
96 Trust Alliance, 2002). Land trusts often require public assistance to achieve critical management
97 actions in terms financial and political support (Brewer, 2003) as well as direct participation in
98 natural resource management through volunteer activities (Cooper et al., 2007). This need for
99 social capital and community engagement is a key challenge for many community-based
100 organizations focused on conservation (Press, 2002; Schwartz et al., 2002) and natural resource
101 management (Fernandez-Gimenez et al., 2008). Hence, engaging volunteers in citizen science
102 activities, such as ecological monitoring, provides an opportunity for land trusts to achieve
103 multiple organizational goals simultaneously.

We present results from a survey that queried land trusts across the United States regarding their VBM programs. We used the results from this survey to address five questions in this study. (1) What organizational characteristics of land trusts are associated with participation in VBM programs? (2) What are the barriers that prevent some land trusts from forming VBM programs? (3) What are the goals and motivations for VBM programs? (4) What specific practices characterize VBM programs in land trusts? (5) How successful do land trusts perceive their VBM programs to be?

2. Materials and Methods

2.1 Data Collection

We developed an online survey to query how and why land trust organizations involve volunteers in ecological monitoring. We piloted the survey and solicited feedback with six land trust staff to ensure the questions were appropriate and elicited useful information. With help from the Land Trust Alliance (LTA), a national non-profit organization, we sent surveys to contact persons at the 1,662 LTA member land trust organizations located in the United States. These accounted for more than 95% of all the land trust organizations in the United States according to the LTA. The survey was open from June 27 to August 27, 2012, with two reminder emails sent during that time.

All respondents were requested to answer basic information about their organizations including organization size, partnerships, and funding sources. We asked if they operate VBM programs, specifically defined as “activities in which volunteers are involved in the collection of ecologically-relevant data used to inform natural resource management.” For those with VBM programs, we asked the respondent to rate on a Likert-style 1-5 scale: (1) the importance of a

list of potential goals of their VBM programs, (2) the factors that contribute to VBM program success, and (3) their evaluation of their current VBM program success. Organizations with VBM programs also answered a wide variety of questions regarding their VBM practices including those related to volunteer recruitment, volunteer training, communication with volunteers, and development of monitoring protocols (see supplemental materials to view the full survey). The organizations without VBM programs rated (1) the potential benefits that VBM programs could contribute to their organization and (2) the barriers to VBM program implementation.

2.2 Survey responses

We received 332 completed survey responses (20.0% response rate). An additional 144 organizations responded via email that they would not participate in the survey because they do not conduct ecological monitoring. While 155 organizations (46.7% of responses) reported having current VBM programs, 22 of these only do compliance monitoring which means volunteers only determined whether agreements set forth by conservation easements were honored and do not collect ecological data. These organizations were therefore treated as land trusts without VBM, resulting in a total of 133 active VBM programs in our study (40.1% of responses). In contrast, 164 (49.4% of responses) organizations reported that they have never had a VBM program. An additional 13 (3.9% of responses) organizations reported that they formerly had VBM programs. These responses were not included in this study.

2.3 Data Analysis

All results describing the characteristics of land trust organizations and their VBM programs were reported as the percentage of total responses for each question. Most questions were optional, and therefore the sample size varies by question. The sample size is reported for each

result. The comparison of average scores for questions that respondents ranked on Likert-scales were made using the Tukey-Kramer method for multiple comparisons and unbalanced sample sizes. Significant differences between average scores were determined for $\alpha=0.05$. To simplify the results on barriers to operating VBM programs experienced by land trusts without them, we combined positive responses (Agree and Strongly Agree) and negative responses (Disagree and Strongly Disagree). For other questions scored on a 1-5 Likert-scales we reported on the combined percentage of scores rated 4 and 5 to represent positive responses.

3. Results

We received survey responses from throughout the United States (Figure 1). We exerted equal sampling effort across all regions. The majority of land trusts respondents occur in the Northeast and the West (39.7% and 26.8% respectively). The South had the lowest proportion of VBM programs in relation to the total number of respondents from that region (43.9%), and land trusts in the Midwest had the highest proportion (64.0%).

Land trusts that do not have a VBM program reported that the greatest barrier to implementing VBM programs is that they are “too time consuming” (77.7% Agreed; 9.2% Disagreed). The second highest rated barrier to implementing VBM is that it is “too difficult to maintain volunteer interest” (60.8% Agreed and 14.7% Disagreed). The least important barriers reported are that the “data are not reliable enough” (33.0% Agreed, 34.0% Disagreed), and that VBM programs are “too expensive” (29.5% Agreed, 45.3% Disagreed) (Table 1).

The vast majority of land trusts that operate VBM programs are small organizations. Nearly 80% have fewer than 10 employees (Fig. 2A). The volunteer corps with whom these organizations

partner are also small. Most have few than ten volunteers (50.3%) and 87.2% have fewer than fifty volunteers (Fig. 2B). Many of the VBM programs are well established. Over half of the programs have existed for more than six years (Fig. 2C). Most VBM programs are operated for very little money; a majority of VBM programs operate on less than \$1000 annually (70.9%) and 32.5% operate for less than \$100 annually (Fig. 2D).

Despite the fact that most VBM programs are small in terms of the number of staff and volunteers involved, and the amount of funding dedicated to such programs, they tend to foster stable corps of volunteers. The majority of land trusts with VBM programs (64.7%) reported that they experience a volunteer turnover rate of less the 20% annually. This indicates that many volunteers participate in monitoring activities with a given land trust for multiple years. This continuity is likely important for monitoring program success.

We found that volunteers monitor a wide variety of different monitoring targets (Fig. 3A). Plants are the most common monitoring target. Volunteers monitor plants at 71.4% of land trusts with VBM programs, followed by vertebrates (59.4% of VBM programs). Water is the most common abiotic monitoring target (45.1% of VBM programs). Volunteers also participate in a variety of monitoring related activities beyond data collection (Fig. 3B). More than 90% of land trusts with VBM programs have volunteers that participate in data collection, but many also have volunteers that participate in data entry (52.6%), data analysis (32.3%), and the dissemination of results (24.1%). In fact, 65.4% of land trusts with VBM programs have volunteers that participate in two or more monitoring related activities.

We also found that land trusts use a variety of methods to communicate with and train volunteers. Just over 43% of land trusts have a single dedicated volunteer to communicate with other volunteers, while other organizations rely on a variety of staff and volunteers for communication (Fig. 3C). About half of land trusts have staff that train volunteers in the monitoring process. Other land trusts rely on partnering organizations or expertise within the volunteer corps to conduct training (Figure 3D).

The most important reported VBM program goal (Table 2) was “increasing educational outreach,” followed by “increasing civic engagement” and “saving money.” The least important goal was “affecting policy change”. When asked to rate their own success at achieving several outcomes of VBM programs, respondents rated themselves lowest in “increas[ing] community engagement” (Table 3). “Quality of information generated” was rated highest in terms of self-evaluated success, followed closely by “achievement of land management goals.” When asked to rate the most important factors that contribute to their VBM program successes, land trusts rated “good communication with volunteers” as the most important factor, followed by having “appropriate monitoring targets” for the volunteers to monitor (Table 4). The “past monitoring experience of volunteers” was rated as the least important factor.

4. Discussion

This study revealed several important lessons of interest for citizen science and monitoring used to inform conservation decision making. Land trusts with VBM programs tend to be small organizations based on number of employees with small budgets available for running their VBM programs. In light of these constraints, we suggest that developing partnerships with other conservation organizations may facilitate volunteer engagement. Coordination with

211 larger volunteer monitoring programs (e.g. eBird (ebird.org); the National Phenology Project
212 (usanpn.org)), in particular could enable small organizations to take advantage of volunteer
213 coordination tools, gain assistance for the development of monitoring methodologies, and
214 benefit from data aggregation tools. This is also a great way for land trusts to share the
215 information they gather through their monitoring activities with the larger conservation
216 community by contributing to collective databases.

217 Although concerns about data quality are a commonly-cited obstacle to widespread use of
218 citizen science (Bonney et al., 2014), land trusts without VBM programs did not report that
219 concerns about data quality were a substantial barrier to VBM participation. Land trusts with
220 VBM programs rated themselves as relatively successful at achieving adequate data quality.
221 Instead, the time required for volunteer management and the difficulty in maintaining
222 interested volunteers were cited as the biggest barriers to implementing VBM programs. While
223 these barriers are real, we found that organizations with VBM programs tend to have small,
224 long-standing, committed volunteer corps as evidenced by low reported rates of annual
225 volunteer turnover. This suggests that good volunteer management keeps volunteers
226 interested and engaged in VBM programs. Indeed, “good communication with volunteers” was
227 rated as the most important factor contributing to VBM program success. Our results indicate
228 that land trusts achieve good volunteer management and communication with volunteers in a
229 variety of ways. Less than half of the VBM programs we surveyed had a single staff member
230 that is dedicated to communicating with volunteers. Nearly a quarter of land trusts reported
231 that motivated volunteers are the primary party responsible for communication with other

232 volunteers. This speaks to the importance of developing core volunteer members that are
233 invested in the mission of the organization and the success of the monitoring programs.

234 Land trust organizations rely heavily on the support of the local communities where they
235 operate, and land trusts reported increasing civic engagement and educational outreach as the
236 most important goals for their VBM programs. This is consistent with a major rationale for
237 engaging in citizen science which is to foster collaborative participation in order to promote
238 new forms of learning and engagement that can result in the development and spread of
239 conservation values (Wals and Rodela, 2014). Land trusts view partnering with volunteers to
240 accomplish monitoring as a good way to educate the public about the goals and progress of the
241 land trust, and share in conservation successes with citizens that support the land trusts’
242 mission. This relationship also provides an opportunity for the organization to become more
243 informed and more responsive to the concerns of the community it aims to serve. It is
244 therefore concerning that among all potential VBM program successes, land trusts rate
245 themselves lowest at achieving “increased in community engagement.” This leads us to
246 consider why this might be, and how organizations can improve in this area.

247 Alexander and Hess (2012) found that, in at least one region of the United States, most land
248 trusts they surveyed did not have clear conservation goals, nor could they successfully
249 determine whether they were meeting the goals that they did have. Clear conservation goals
250 are an essential ingredient for fostering successful conservation (CMP, 2013), but this is also
251 true for fostering civic engagement because sharing in the success of achieving conservation
252 goals is critical for public support of the land trust’s mission (Pilz et al., 2005). Land trusts

253 wishing to increase civic and community engagement should therefore make sure their
254 conservation goals are clear, both within the organization and to the public they wish to engage.

255 Conservation organizations hoping to use citizen science programs to achieve community
256 outreach and engagement goals can learn from the VBM programs of the land trusts that rate
257 themselves as successful in this area. Our finding that communication with volunteers and
258 successful volunteer retention were rated as the most important factors for successfully
259 engaging in VBM is consistent with research on community-based and collaborative monitoring.

260 Researchers in these fields find that communication with, and particularly feedback to,
261 participants about how their data contributes to science and management is crucial to
262 successful ongoing monitoring programs (Pilz et al., 2005). The importance of paying attention
263 to the needs and interests of volunteers is also aligned with research in collaborative
264 monitoring on the concept of social learning, which is the “intentional process of collective self-
265 reflection through interaction and dialogue among diverse participants (stakeholders)”
266 (Fernandez-Gimenez et al., 2008). Social learning emphasizes learning through social
267 interactions embedded in a particular biophysical and socio-cultural context. Considering the
268 way that volunteer monitoring and other types of citizen science can contribute to social
269 learning for participants can make volunteering with land trusts and other conservation
270 organizations more meaningful. With frequent and two-way communication with volunteers,
271 VBM programs can also be a vehicle for sharing local ecological knowledge that contributes to
272 the conservation goals of the land trusts (Ballard et al., 2008). Hence, land trusts could
273 potentially improve their achievement of civic engagement goals by not only clearly
274 communicating with volunteers, but also by engaging volunteers in multiple stages of the

275 management process including data collection, data interpretation, and management decisions
276 based on the monitoring results (Fernandez-Gimenez et al., 2008; Shirk et al., 2011). Engaging
277 in social learning can not only improve civic engagement, but can also result in more robust
278 decision making and better conservation outcomes especially when it involves a diversity of
279 stakeholders (Lauber et.al, 2011)

280 VBM programs in land trusts provide an excellent context in which to further explore more
281 participatory ways to encourage social learning, improve civic engagement, volunteer retention,
282 and ultimately, the impact of conservation outcomes associated with these citizen science
283 programs. We consider here a few ways in which our research can be extended in the future to
284 gain more insight into the value of citizen science in land trusts. We provided limited space for
285 open ended comments associated with each question in our survey, but these comments did
286 not inform our primary findings. We recommended a more open ended inquiry into reasons
287 that land trusts organizations feel it is difficult to achieve the goal of increasing civic
288 engagement. We also recommend looking more carefully at the links between specific
289 organization characteristics, VBM program practices, and VBM program outcomes.

290 Several of other papers published in this special issue address critical issues in citizen science
291 that can be further investigated in the context of land trusts in order to provide important
292 insight to both improve the ability of land trusts to meet their VBM program goals, and help
293 conservation scientist better understand the relationship between citizen science practices and
294 outcomes. Among these issues are understanding how different citizen science programs
295 influenced the participants' environmental science literacy (see Ballard et al., 2016),
296 understanding the motivations of for volunteers to participate in citizen science programs (see

297 Domroese and Johnson, 2016; Grodzińska-Jurczak and Kobierska, 2016), and understanding
298 how programs can use the concept of place to improve local conservation decision making and
299 community engagement (see Newman et al., 2016).

300 **5. Conclusion**

301 We found that a large and growing number of land trusts in the United States conduct
302 volunteer-based monitoring programs, and that increasing civic engagement is a key goal of
303 these programs. Further, while concerns about data quality, lack of time and money are often
304 cited as obstacles to wider adoption of citizen science and other non-professionally collected
305 data, these were not major concerns of most land trusts who responded to our survey.
306 Respondents that rated their programs as successful cited volunteer communication and
307 retention as key to their success. Our findings suggest that conservation organizations wishing
308 to engage the public can begin by thoughtfully designing a volunteer-based monitoring program
309 and communicating regularly with volunteers, but research is needed to identify practices for
310 volunteer management that contribute to success of VBM programs in particular. We
311 additionally stress the importance of formulating clear conservation and community
312 engagement objectives (see Alexander and Hess, 2012). Clear objectives will make it easier for
313 small-scale, private conservation organizations to evaluate the efficacy of their VBM programs,
314 and make communication of program successes with volunteers more meaningful. One
315 limitation of this study was that we did not ask respondents to define what educational
316 outreach or civic engagement mean to them or precisely why they value those potential
317 benefits so highly. An important area of future research will be determining the specific goals
318 organizations have within the categories of educational outreach and civic engagement, and

319 working to understand how the achievement of those goals serve the missions of land trusts. As
320 guidance for designing citizen science programs continues to grow (Shirk et al., 2011), further
321 research is needed regarding the particular needs and goals of private, small-scale conservation
322 organizations, and why, when and where citizen science can help increase the conservation
323 efforts of these organizations.

324 **Acknowledgments**

325 The authors would like to thank the Land Trust Alliance for their input and their help
326 distributing the survey. We also thank Mark Lubell, staff at the Solano Land Trust, and several
327 UC Davis Ecology graduate students for their review and input which greatly improved the
328 survey content and design. Special thanks to the survey participants. This paper is dedicated in
329 the loving memory of Dr. Loreto Godoy. This project was supported by Conservation
330 Management Fellowship at UC Davis, funded by the Packard Foundation.

331 C. Peters was supported by the National Science Foundation GK-12 Teaching Fellowship
332 Program under DGE grant #0841297 to S.L. Williams and B. Ludaescher.

333 The survey was approved by the UC Davis Institutional Review Board – Study Number: 351545.

334 **References**

- 335 Alexander, L., Hess, G.R., 2012. Land Trust Evaluation of Progress toward Conservation Goals.
336 *Conserv. Biol.* 26, 7–12.
- 337 Ballard, H.L., Fernandez-Gimenez, M.E., Sturtevant, V.E., 2008. Integration of local ecological
338 knowledge and conventional science: A study of seven community-based forestry organizations
339 in the USA. *Ecol. Soc.* 13.
- 340 Ballard, H.L., C.G. Dixon and E.M. Harris. 2016. Youth-focused Citizen Science: Examining the
341 Role of Environmental Science Learning and Agency for Conservation. *Biological Conservation*.
- 342 Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., Wilderman, C.C., 2009.
343 Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for
344 Informal Science Education. A CAISE Inquiry Group Report.
- 345 Bonney, R., Shirk, J.L., Phillips, T.B., Wiggins, A., Ballard, H.L., Miller-Rushing, A.J., Parrish, J.K.,
346 2014. Citizen science. Next steps for citizen science. *Science* 343, 1436–7.
- 347 Brewer, R. 2003. Conservancy. The Land Trust Movement in America. University Press of New
348 England. Hanover, NH. Chang, K. 2011. The 2010 National Land Trust Census Report. Land Trust

349 Alliance. Available at <http://www.landtrustalliance.org/land-trusts/land-trust-census>. (accessed
350 November 25, 2013).

351 CMP. 2007. Open standards for the practice of conservation, version 2.0. Conservation
352 Measures Partnership Washington, DC.

353 Conrad, C.C., Hilchey, K.G., 2011. A review of citizen science and community-based
354 environmental monitoring: Issues and opportunities. *Environ. Monit. Assess.* 176, 273–291.

355 Conrad, C.T., Daoust, T., 2008. Community-based monitoring frameworks: Increasing the
356 effectiveness of environmental stewardship. *Environ. Manage.* 41, 358–366.

357 Cooper, C.B., Dickinson, J., Phillips, T., Bonney, R., 2007. Citizen science as a tool for
358 conservation in residential ecosystems. *Ecol. Soc.* 12.

359 Cooper, C.B., Loyd, K.A.T., Murante, T., Savoca, M., Dickinson, J., 2012. Natural history traits
360 associated with detecting mortality within residential bird communities: Can citizen science
361 provide insights? *Environ. Manage.* 50, 11–20.

362 Domroes, M. and E.A. Johnson. 2016. Why Watch Bees? Motivations of citizen science
363 volunteers in the Great Pollinator Project. *Biological Conservation*.

364 Fernandez-Gimenez, M.E., Ballard, H.L., Sturtevant, V.E., 2008. Adaptive management and
365 social learning in collaborative and community based monitoring: a study of five community-
366 based forestry organizations in the western USA. *Ecol. Soc.* 13.

367 Gollan, J., De Bruyn, L.L., Reid, N., Wilkie, L., 2012. Can volunteers collect data that are
368 comparable to professional scientists? a study of variables used in monitoring the outcomes of
369 ecosystem rehabilitation. *Environ. Manage.* 50, 969–978.

370 Grodzińska-Jurczak, M. and H. Kobierska. 2016. Biodiversity conservation and monitoring –
371 engagement, values and motivations of citizen scientists. *Biological Conservation*.

372 Jordan, R.C., Brooks, W.R., Howe, D. V., Ehrenfeld, J.G., 2012. Evaluating the performance of
373 volunteers in mapping invasive plants in public conservation lands. *Environ. Manage.* 49, 425–
374 434.

375 Land Trust Alliance. 2002. Land Trust Standards and Practices. Available at
376 <https://www.landtrustalliance.org/training/sp/lt-standards-practices07.pdf> (Accessed on
377 September 29, 2014).

378 Lauber, T.B., R.C. Stedman, D.J. Decker, and B.A. Knuth. 2011. Linking Knowledge to Action in
379 Collaborative Conservation. *Conserv. Biolo.* 25, 1186–94.

380 Muir, M. 2010. Performance measurement in the conservation community. Measuring
381 conservation effectiveness summit. Organized by the Conservation Measures Partnership. Palo
382 Alto. May 5th–6th, 2010.

383 Newman, G., M. Clyde, B. McGreavy, M. Chandler, M. Haklay, H.B. Ballard, S. Gray, D. Mellor,
 384 and J. Gallo. 2016. Leveraging the power of place in citizen science for effective conservation
 385 decision making. *Biological Conservation*.26(6)

386 Pilz, D., Ballard, H.L., Jones, E.T., 2005. Broadening Participation in Biological Monitoring :
 387 Guidelines for Scientists and Managers. *Ecology* 1–153.

388 Press, D. M. 2002. Saving open space: the politics of local preservation in California. University
 389 of California Press.

390 Rissman, A.R., Lozier, L., Comendant, T., Kareiva, P., Kiesecker, J.M., Shaw, M.R., Merenlender,
 391 A.M., 2007. Conservation easements: Biodiversity protection and private use. *Conserv. Biol.* 21,
 392 709–718.

393 Schmeller, D.S., Henry, P.-Y., Julliard, R., Gruber, B., Clobert, J., Dziock, F., Lengyel, S., Nowicki,
 394 P., Déri, E., Budrys, E., Kull, T., Tali, K., Bauch, B., Settele, J., Van Swaay, C., Kobler, A., Babij, V.,
 395 Papastergiadou, E., Henle, K., 2009. Advantages of volunteer-based biodiversity monitoring in
 396 Europe. *Conserv. Biol.* 23, 307–16.

397 Schwartz, M.W., Jurjavic, N.L., Brien, J.M.O., Poor, U., 2002. Conservation’s Disenfranchised
 398 Urban Poor, 601–606.

399 Shirk, J., Ballard, H., Wiggins, A., Phillips, T., Jordan, R.C., Wilderman, C.C., McCallie, E., Bonney,
 400 R., 2011. Public Participation in Scientific Research: A Framework for Intentional Design. *Ecol.*
 401 *Soc. Am.* 17.

402 Wals, A.E.J., Rodela, R., 2014. Social learning towards sustainability: Problematic, perspectives
 403 and promise. *NJAS - Wageningen J. Life Sci.* 69, 1–3.

404

Figure 1. Regional distribution of 325 land trusts that participated in a 2012 survey regarding the use of volunteers for resource monitoring activities. An additional 7 land trusts participated in the survey but could not be assigned to a particular region. We report the proportion of survey respondents located in each region, and the proportion of land trusts that do or do not have VBM programs within each region.

Figure 2. The characteristics of VBM programs and the land trusts that operate them. Survey participants from land trusts without VBM programs were asked to characterize their organization and VBM programs. Here we present the results for a) the number of employees b) the number of volunteers that participate in a given monitoring season c) the age of VBM programs and d) the amount of annual funding devoted to VBM programs. All survey questions were optional.

Figure 3. Additional characteristics of VBM programs and the land trusts that operate them. Survey participants from land trusts without VBM programs were asked to characterize their organization and VBM programs. Here we present the results for a) the types of targets monitored by volunteers b) the steps of the monitoring process in which volunteers participate c) the party responsible for communicating with volunteers and d) the party responsible for training volunteers. All survey questions were optional.

Table 1. Data reporting survey results rating the barriers to participating in VBM. Survey participants from land trusts without VBM programs were asked to rate whether various factors represent barriers to participation in VBM programs on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Superscripts indicate significant differences ($\alpha < 0.05$) in average Likert-scale rating. Barriers that share the same superscript letter were not scored significantly different from one another.

Table 2. Rating the importance of VBM program goals. Survey participants from land trusts with VBM programs were asked to rate the importance of various potential goals of their VBM programs on a scale of 1 to 5, where 5 is the most important. Superscripts indicate significant differences ($\alpha < 0.05$) in average Likert-scale rating. Goals that share the same superscript letter were not scored significantly different from one another.

Table 3. Rating the success at achieving VBM program outcomes. Land trusts were asked to rate their success at achieving various VBM program outcomes on a scale from 1 to 5, where 5 is most successful. Superscripts indicate significant differences ($\alpha < 0.05$) in average Likert-scale rating. Outcomes that share the same superscript letter were not scored significantly different from one another.

Table 4. Rating the factors contributing to VBM program success. Land trusts were asked to rate the extent to which various factors contribute to VBM program success for 1 to 5, where 5 is most important. Superscripts indicate significant differences ($\alpha < 0.05$) in average Likert-scale rating. Factors that share the same superscript letter were not scored significantly different from one another.

Figure

Figure

Figure

Table

	Lowest Rated Barrier to VBM Participation		
Barrier to VBM Participation	Cost of Maintaining Program ^a	Concern Regarding Data Quality ^a	Monitoring Targets Not Appropriate for Volunteers ^b
Percentage Rated Agree or Strongly Agree	29.47%	32.98%	51.89%
Average Rating Out of 5, s.d., sample size	$\mu = 2.78,$ $\sigma = 1.13, n = 95$	$\mu = 2.93,$ $\sigma = 1.09, n = 94$	$\mu = 3.45,$ $\sigma = 1.16, n = 106$

Table

	Lowest Rated Barrier to VBM Participation					Highest Rated Barrier to VBM Participation
Barrier to VBM Participation	Cost of Maintaining Program ^a	Concern Regarding Data Quality ^a	Monitoring Targets Not Appropriate for Volunteers ^b	Lack of Volunteer Interest ^b	Lack of Volunteer Expertise ^b	Managing Program is Too Time Consuming ^b
Percentage Rated Agree or Strongly Agree	29.47%	32.98%	51.89%	60.78%	61.06%	77.78%
Average Rating Out of 5, s.d., sample size	$\mu = 2.78,$ $\sigma = 1.13, n = 95$	$\mu = 2.93,$ $\sigma = 1.09, n = 94$	$\mu = 3.45,$ $\sigma = 1.16, n = 106$	$\mu = 3.58,$ $\sigma = 1.01, n = 103$	$\mu = 3.53,$ $\sigma = 1.18, n = 113$	$\mu = 3.83,$ $\sigma = 0.92, n = 108$

Table

	Lowest Rated Program Goal				Highest Rated Program Goal
Program Goal	Affecting policy change ^a	Promoting basic science ^b	Saving money ^b	Increasing civic engagement ^{bc}	Increasing educational outreach ^c
Percentage Rated 4 or 5	22.90%	45.50%	50.00%	50.80%	59.70%
Average Rating Out of 5, s.d., sample size	$\mu = 2.3,$ $\sigma = 1.41, n = 109$	$\mu = 3.28,$ $\sigma = 1.34, n = 123$	$\mu = 3.24,$ $\sigma = 1.53, n = 106$	$\mu = 3.47,$ $\sigma = 1.28, n = 122$	$\mu = 3.77,$ $\sigma = 1.28, n = 124$

Table

	Lowest Rated Factor Contributing to VBM Program Success						Highest Rated Factor Contributing to VBM Program Success
Program Factor	Past Monitoring Experience of Volunteers ^a	Size of Volunteer Base ^{ab}	Adequate Funding ^b	Support of Partnering Orgs. ^b	Successful Data Management ^c	Appropriate Monitoring Targets ^{cd}	Good Communication with Volunteers ^d
Percentage Rated 4 or 5	37.70%	42.50%	45.60%	50.00%	65.04%	77.05%	82.40%
Average Rating Out of 5, s.d., sample size	$\mu = 3.13$ $\sigma = 1.14, n = 139$	$\mu = 3.28,$ $\sigma = 1.10, n = 120$	$\mu = 3.39,$ $\sigma = 1.24, n = 125$	$\mu = 3.40,$ $\sigma = 1.24, n = 133$	$\mu = 3.94,$ $\sigma = 1.05, n = 123$	$\mu = 4.14,$ $\sigma = 0.83, n = 122$	$\mu = 4.25,$ $\sigma = 0.87, n = 125$