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To cite this article: Marco A. Janssen, Skaidra Smith-Heisters, Rimjhim Aggarwal & Michael L. Schoon (2019) 'Tragedy of the commons' as conventional wisdom in sustainability education, Environmental Education Research, 25:11, 1587-1604, DOI: [10.1080/13504622.2019.1632266](https://doi.org/10.1080/13504622.2019.1632266)

To link to this article: <https://doi.org/10.1080/13504622.2019.1632266>



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'Tragedy of the commons' as conventional wisdom in sustainability education

Marco A. Janssen^{a,b}, Skaidra Smith-Heisters^{a,b}, Rimjhim Aggarwal^{a,b} and Michael L. Schoon^{a,b}

^aSchool of Sustainability, Arizona State University, Tempe, AZ, USA; ^bSchool of Human Evolution and Social Change, Arizona State University, Tempe, AZ, USA

ABSTRACT

More than 50 years ago biologist Garrett Hardin published his influential essay 'The Tragedy of the Commons'. In his essay, Hardin argued that in situations where people share resources, external intervention via governmental regulations or privatization of the resource is needed to avoid resource overexploitation. While the article is considered by many resource governance scholars as misleading and incomplete, it is one of the most assigned articles in environmental studies courses. Here, we present findings from a survey of instructors who teach undergraduate courses on sustainability within the USA on how Hardin's essay is used and what the understanding is of the instructors about the essay. The results from the survey demonstrate that there is a mixed understanding of the current state of knowledge about commons governance. In particular, instructors trained in the natural sciences have more misconceptions about commons governance than instructors trained in other disciplines.

ARTICLE HISTORY

Received 22 December 2018
Accepted 10 June 2019

KEYWORDS

Tragedy of the commons; commons governance; misconception; sustainability; environmental science; environmental studies; undergraduate education; USA

Introduction

The essay 'The Tragedy of the Commons' published by the biologist, Garrett Hardin (1968) half a century ago, has been hugely influential in the way environmental governance is approached. Hardin famously evoked a pasture 'open to all', in which herdsmen received direct returns from their own animals while suffering delayed costs from the deterioration of the shared pasture when they overgraze. A rational herdsman is motivated to add more and more animals, and Hardin concludes 'herein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons' (Hardin 1968, 1244). In Hardin's conceptualization, the 'tragedy' refers to the inability of groups to manage common resources and the need for external intervention to avoid overharvesting. It provided a rationale for state regulation (specifically nationalization) or privatization as the only viable options to manage shared resources.

Hardin's essay had a major impact on environmental education and policy, as can be witnessed from the following list. Hardin's (1968) article:

- is one of the most-assigned texts in U.S. universities in the past decade (Open Syllabus Project 2018);

- has been described by biologists as the most influential journal article in their careers (Barrett and Mabry 2002);
- is one of *Science* magazine's most requested articles (AAAS 2003);
- has been described as a 'philosophical root' of essential readings in wildlife management and conservation (Krausman and Leopold 2013) and included in anthologies edited by science popularizers like Richard Dawkins (2008) and Bill McKibben (2008) – appearing in more than 100 anthologies in total, as estimated by his colleagues (Wenner and Schuyler 2003);
- has been one of the top-most cited articles in ecological economics (Costanza et al. 2004; Ma and Stern 2006; Costanza et al. 2016);
- is the 31st-most-cited article in climate change literature (Marx et al. 2017).

Despite the popularity of the essay, Hardin's argument was misleading and incomplete (Boyd et al. 2018). Self-governance of shared resources by resources users without external intervention often leads to the sustainable use of common resources. As many scholars of commons governance have pointed out (Cox 1985; Bromley and Cernea 1989; Berkes et al. 1989; Feeny et al. 1990; Burger and Gochfeld 1998; Ostrom et al. 1999; Ostrom et al. 2002), Hardin's article misses its mark because he fails to acknowledge that every enduring commons has rules to govern resource use. More pointedly, the type of commons at the center of the metaphor in 'The Tragedy of the Commons', communal pasture, has long been studied as an exemplar of sustainable institutions of commons governance. A commons is defined by its rules, not the absence of rules. An unmanaged resource without rules is best referred to as 'open access'.

Given the implicit political context of Hardin's essay, we developed a survey to investigate whether instructors using Hardin's essay in a sustainability-oriented course are familiar with the broader context of commons research, most pertinently, that successful self-governance of shared resources by local resource users is possible. We also want to identify which disciplinary backgrounds correspond with particular knowledge about the context of Hardin's argument.

It might be helpful for the reader to know that the authors of this article study the governance of the commons. We are members of the International Association for the Study of the Commons (IASC), which represents the transdisciplinary scholarship of ways people are managing shared resources. The first author is currently President of the IASC. We are past colleagues and students of the late Elinor Ostrom and study diverse elements of (self-) governance of shared resources, from within communities to international treaties. We use Hardin's article in our teaching as a historical starting point but then focus on the empirical understanding we have now about the successes and failures of resource users to govern their shared resources. In the next section, we provide some essential background and context behind Hardin's and Ostrom's research on the commons, which can help instructors understand how and why their approaches differ, and how to present this topic to the students with a critical approach.

Understanding the context of Hardin's essay

Hardin authored several articles following the controversial success of 'The Tragedy of the Commons', some of which interpret the metaphor of pastoral commons and extend his moral argument for 'lifeboat ethics' more clearly than his original article (e.g. Hardin 1974). These subsequent articles deal more directly with his objective of zero population growth through ending international aid in food, agriculture, and medicine; net-zero immigration; initiating compulsory sterilization of women (e.g. Hardin 1970); and segregating nations by ethnicity and religion (Hardin 1990). None of these subsequent efforts has enjoyed the same popularity. Indeed, the article has remained popular even while Hardin's ideas about population growth and commons governance have been refuted, and his opinions about race and public policy rejected by the mainstream public (see, e.g. Gardiner 2001; Oakes 2016; Patt 2017). Hardin was a signatory to

the 1994 *Wall Street Journal* editorial which argued that IQ tests provided unbiased ‘scientific evidence’ that the median intelligence of black Americans is 15 points lower than the median intelligence of white Americans, attributing this deficit largely to non-convergent genetic factors (Gottfredson 1997). Hardin’s low estimation of other people’s reason, conscience, and ability to cooperate corresponded with his fear that ‘in a universe programmed by natural selection (which is the only universe we can imagine)’, his own group would suffer ‘passive genocide’ through displacement by groups with higher fertility rates (Hardin 1998, 96).

As commons scholars ourselves, we (the authors) are not principally concerned with whether Hardin’s argument about overpopulation has merit, but rather how the context in which students read the article might affect their understanding of real commons dilemmas. In the rest of this section, we elaborate on this context of pedagogy. In particular, we discuss how this intrinsically interdisciplinary issue of governance of commons has been approached through varied disciplinary lenses, and how this is likely to influence how the material on the commons is presented to the students. In the next section, we discuss our empirical strategy to measure this.

To begin with, let us consider the disciplinary training and scholarship of the two leading scholars in this field: Garrett Hardin and Elinor Ostrom. Hardin was trained in zoology and microbiology, wrote his dissertation on unicellular organisms, and studied algae before turning to teach human ecology full-time at the University of California, Santa Barbara from 1946 to 1978 (Locher 2013; for a contextualization of Hardin’s arguments in the teaching of ecology see also Hagen 2008). Ostrom was trained in public administration and political science and published her dissertation on groundwater basin governance (an example of common-pool resources) in 1965. When Hardin’s essay was published, she found Hardin’s statements in contrast with her observations. Although the resource users of the groundwater basin had to overcome major challenges in order to have effective governance, they were not trapped. The contrast between her observations and Hardin’s metaphor led Ostrom to a long journey studying the collective action of shared resources (Ostrom 2010). Elinor Ostrom was awarded the Nobel Prize in Economic Sciences in 2009 because she ‘challenged the conventional wisdom by demonstrating how local property can be successfully managed communally without any regulation by central authorities or privatization’ (Nobelprize.org 2009).

As a parable or polemic about the human-nature interface, Hardin’s tragedy of the commons is a natural scientist’s view of society¹. Though contemporaries to a degree, Hardin’s contributions to environmental discourse primarily coincided with the first major wave of proliferation in environmental education programs in U.S. colleges and universities, beginning in 1965 and peaking in 1970, while Ostrom’s contributions coincided with the second major wave, beginning in the mid-1980s when Ostrom and a concerted group of scholars started to do comparative empirical research on resource governance (Romero and Silveri 2006). Commons research in general also rose with this second wave (van Laerhoven and Ostrom 2007).

In 2005, Romero and Silveri found that natural science curricula dominated environmental science, environmental studies, and the less-numerous environmental programs in engineering, biology/ecology/conservation and policy/analysis/planning – accounting for 35% of program curricula among the 1059 programs they surveyed. While many programs included different disciplinary approach, less than 4% of the environmental education programs were fully interdisciplinary, i.e. incorporating social science and humanities in addition to natural sciences. The inclusion of the humanities in undergraduate interdisciplinary training is relevant because it likely determines whether Hardin’s essay is understood in the context of ethical argumentation as opposed to a natural law or principle of social dynamics. Using a more exclusive definition, Vincent and Focht (2010) identified 840 ‘broadly interdisciplinary’ graduate and undergraduate environmental programs in the United States, the vast majority of these labeled either environmental science or environmental studies. Based on a representative survey of those programs, they claim there is a consensus that curricula for environmental education should be based on sustainability as a normative principle and a professional competency. On environmental

sustainability, however, Sherren (2007) suggests curricula designers may believe that natural sciences should take precedence at the core of the program while studies in human society are ideally optional electives that ‘can be easily picked up.’ Thus, in refuting the conventional wisdom of commons tragedies, Ostrom occupies what appears to be a less-valued interdisciplinary space, examining natural resource outcomes from a social science perspective. The notion that sustainability research in economics, humanities, and the social sciences is less-emphasized and less-valued in the academy than sustainability research originating in and referencing the natural sciences is also borne out by academic journal publication statistics (Schoolman et al. 2012). From publication statistics for the years 1996–2009, Schoolman et al. (2012) found that sustainability research was dominated by natural science journals citing work from other natural science journals, and not including much social, economic, and humanity scholarship.

Considering the likelihood that sustainability education in U.S. universities shares the bias toward natural science approaches evident in other nominally interdisciplinary academic enterprises, we think the particular popularity of Hardin’s ‘The Tragedy of the Commons’ should interest educators and sustainability advocates at large. Interdisciplinary environmental programs and sustainability curricula are still relatively nascent developments, with frameworks and assumptions drawn from training in earlier, adjacent fields. Given the current emphasis (for example, at our own university) on problem-based learning, we are especially concerned that a natural science biased perspective, ignoring the actual body of work by scholars in the field on managing common resources, could impact the way people look for governance solutions. In what follows, we investigate through survey research how instructors who teach ‘The Tragedy of the Commons’ understand Hardin’s essay in the context of current understanding of commons governance, and whether there are patterns in instructors’ perspectives based on their training or current field of practice.

Research methods

The aim of the survey was to derive information from instructors who use ‘The Tragedy of the Commons’ in their curricula or teach the ‘tragedy of the commons’ concept, on how and why they introduce the concept in their classes. We asked their opinion on ten statements related to motivations behind teaching the tragedy of the commons. The statements were constructed to address a range of perspectives significant in the governance of the commons, some of which we believe are misunderstandings of (or interpretations stemming from) Hardin’s essay. For example, we ask whether the tragedy of the commons demonstrates the need for external intervention in managing the commons and whether it represents the foremost thinking on the commons. Further, we asked how the concept of the tragedy of the commons was included in their course curriculum – for example, as a stand-alone concept, as historical context, or as a social science perspective on natural resource management. We also asked about the disciplinary context of the programs in which the material was taught and the graduate training of the instructor. For those who received the survey but were not currently teaching the concept, we provided a space for them to share their reasons for not teaching it. Several of the questions regarding the teaching of the tragedy of the commons were in the form of a 5-point Likert scale, for use by respondents to rate the degree in which they agree or disagree with a statement (with 1 representing strongly agree and 5 representing strongly disagree). The complete survey can be found in the [Appendix](#).

We sent the survey to two partially overlapping sample populations, namely a sample of instructors who currently teach introductory sustainability-related courses at universities in the U.S.A, and educators affiliated with the Association for Environmental Studies and Sciences (AESS).

In order to derive a sample of relevant instructors, we built a database of 549 instructors from universities affiliated within the Association for the Advancement of Sustainability in Higher Education (AASHE). The creation of the database was restricted by the availability of public information on instructors teaching an introductory course related to sustainability topics as part of the undergraduate curriculum in the academic year 2017/2018. Up to five instructors from a university were selected, and we selected universities by going through the list of about 700 universities and colleges in the U.S. alphabetically and selecting every third university. A reminder was sent after two weeks to those who had not responded. The second sample was derived by posting to the general discussion list of AESS.

The survey was sent out in March 2018. We received 177 responses (32% response rate) from the targeted survey of instructors within organizations affiliated with the AASHE, and 98 responses (5%) response rate from the distribution list of the AESS. In all, 235 of 250 respondents who use Hardin's essay gave answers to all statements provided. All data used for our analysis is available at <https://osf.io/hg43b/>.

Results

Twenty-five respondents indicated that they are not teaching the tragedy of the commons, and seven of them explained why they do not teach it: one found the article unpersuasive, one said it was outdated, one had not heard of the article, one said the concept did not fit in their current course, two indicated that the concept was taught in a companion course to the one they themselves were teaching, and one thought the concept of market failure sufficiently covered the topic.

Descriptive statistics

Two hundred fifty respondents indicated they taught courses in which the tragedy of the commons concept was featured. In the remaining presentation of the results, we focus on these, the vast majority of respondents. We also collapse both samples together – unless explicitly stated otherwise – since both samples have similar patterns. When we refer below to the share of the population which agree or disagree we aggregate, respectively, 'agree' and 'strongly agree', and 'disagree' and 'strongly disagree'. According to 56% of the respondents, 'The Tragedy of the Commons' is required in the course curriculum they are responsible for teaching. Forty-two percent of the respondents agree that 'The Tragedy of the Commons' demonstrates that external intervention is needed to avoid a tragedy of the commons, while a large majority (74%) agree that the 'The Tragedy of the Commons' illustrates the fundamental dilemma that occurs when people share resources. More than a third (35%) of the respondents agree that the tragedy of the commons represents the foremost thinking about commons governance and the concept that student should learn if they learn one thing about commons governance, while 10% agree that they are not aware of alternative theories. One-third (33%) of the respondents agree that the tragedy of the commons provides a useful counterpoint to empirical case studies, but more respondents (46%) agree that it establishes the utility of property rights².

Those results confirm that there is a wide spectrum of understanding of the concept and context of the tragedy of the commons, and the broader literature on commons governance. When we evaluate correlations between the responses to the statement, we find a high correlation (>0.2) between many of the statements (Table A12, Appendix C).

The main context in which the tragedy of the commons is taught is as a social science perspective on how to cope with shared resources (34%), while 25% use the tragedy of the commons as a background for the literature on the common pool resource governance. As discussed in the introduction, scholarship on the commons demonstrate that external interventions are not

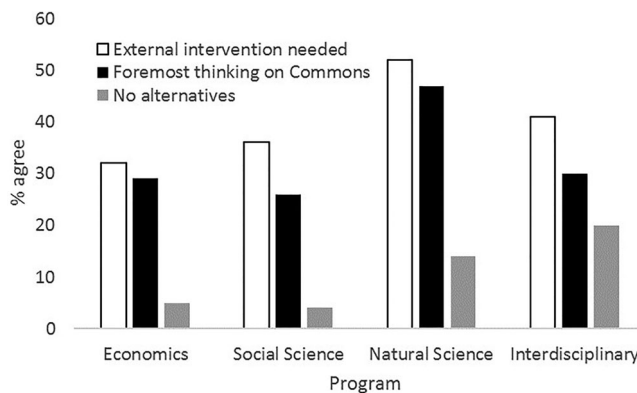


Figure 1. Percentage of participants who teach courses in a program identified as economics, social science, natural science or interdisciplinary, who agree and strongly agree with statements Q4, Q6, and Q7 (see Appendix).

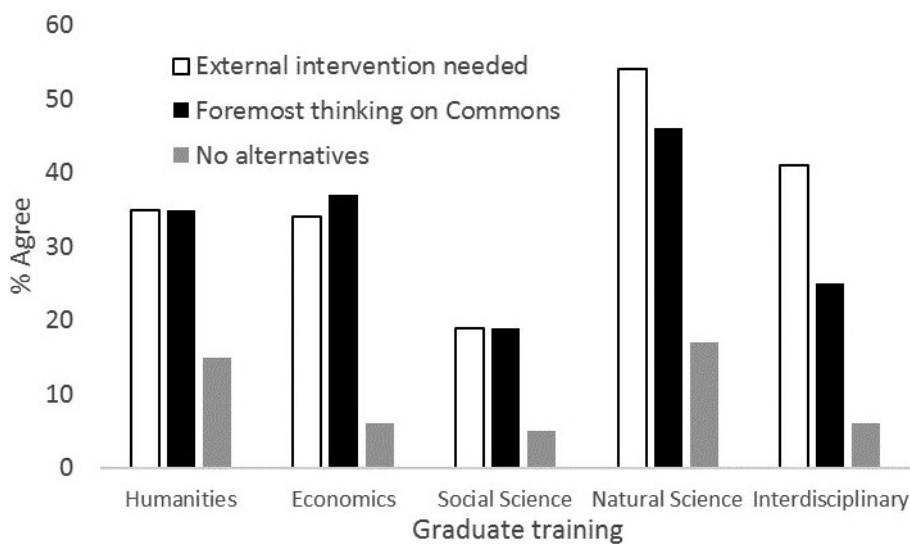


Figure 2. Percentage of participants classified according to the 5 main disciplinary area according to their graduate training, who agree and strongly agree with statements Q4, Q6, and Q7 (see Appendix).

always needed for successful governance of the commons and that Hardin’s argument is limited to open access situations. As such those who agree with statements Q4 (‘It demonstrates that external intervention is needed to avoid a “tragedy of the commons”’), and Q6 (‘It represents the foremost thinking on the commons if students learn one thing about commons governance it should be this concept’.) indicate a misunderstanding of the current state of knowledge in this field. When courses taught were in natural science programs we find instructors have a greater misunderstanding of empirical commons governance than in other programs (Figure 1). We selected Q4, Q6, and Q7 (‘I am not familiar with alternative theories on managing common resources’) since they have high correlations with various other statements (Table A12, Appendix C).

Instructors with graduate training in natural sciences exhibit a greater misunderstanding of the commons concepts (in terms of their responses to all the three questions), while those with social science training exhibit lower misunderstanding compared to the other disciplines (Figure 2). With respect to the period of training of the instructor (Figure 3), the results are less straight forward. For the statement that the tragedy of the commons is the foremost thinking about

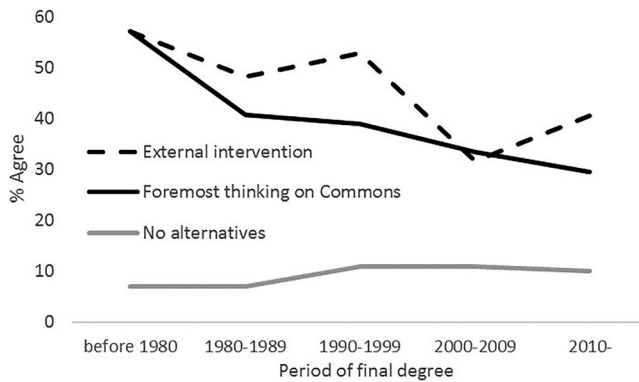


Figure 3. Percentage of participants classified according to time of finishing highest degree, who agree and strongly agree with statements Q4, Q6, and Q7 (see Appendix).

Table 1. Results of ordered logistic model: responses by disciplinary training of instructor (Five point Likert scale: 1 – Strongly agree; 5 – Strongly disagree).

	Q4	Q6	Q7
	Need for external intervention	Represents foremost thinking	Not familiar with alternative theories
Economics, Pol. Science	–0.5029	–1.2341	0.09580
Humanities	–0.5151	–0.8740	–0.8748
Interdisc. studies	–0.8795*	–0.5326	–0.3437
Natural Science	–1.2225***	–1.5001***	–1.4010**
Year of degree	0.0158	0.0139	0.0096
Likelihood ratio chisquare	–323.0792**	–304.6966***	–219.459***
# of observations	184	183	184

Notes: Left out dummy is social sciences (including anthropology).

*Sig at 10% level; **Sig at 5% level; ***Sig at 1% level.

commons governance and the need for external intervention to avoid the tragedy of the commons, the overall trend is towards less agreement for instructors with more recent training (Figure 3). However, for the statement about no other alternatives, the percentage who agree is higher for instructors with more recent training. The statistical analysis in the next section provides a more rigorous methodology for teasing out these varied effects, and draw inferences.

Statistical analysis

As mentioned before, several of the questions regarding the teaching of the tragedy of the commons in our survey were in the form of five-point Likert scale type questions. The differences between ‘strongly agree’, ‘agree’, and ‘neutral’ on a Likert scale are not necessarily equal. Such ordinal scale responses can be ranked, but the distance between responses is not measurable. Given categorical responses, the assumptions of Ordinary Least Squares (OLS) regression do not hold. A logistic regression is thus the preferred choice, and since the response categories are ordered, ordered logistic has potentially greater power than baseline-category logistic models (Agresti 2007; Sullivan and Artino 2013).

We tried two different specifications of the ordered logistic regression: one based on the disciplinary training of the instructor (Table 1) and the other based on the disciplinary program within which they teach (Table 2). Interestingly, the correlation between these two variables is significant but the magnitude is not very high (Pearson correlation coefficient = 0.44). This suggests that putting both variables in the same regression may cause multicollinearity problems but it is worth exploring if the story changes depending on which one we choose to use in the

Table 2. Results of ordered logistic model: Responses by discipline of program (Five point Likert scale: 1- Strongly agree; 5- Strongly disagree).

	Q4	Q6	Q7
	Need for external intervention	Represents foremost thinking	Not familiar with alternative theories
Economics, Pol. Science	0.0085	−0.4056	0.2841
Humanities	−0.4812	−0.8537	−1.0741*
Interdisc. studies	−0.0108	−0.3114	−0.1713
Natural Science	−0.6273*	−1.2215***	−1.5256***
Year of degree	0.0211**	0.0198**	0.0084
Likelihood ratio chisquare	−323.0792**	−304.6966***	−219.459***
# of observations	206	205	206

Notes: Left out dummy is social sciences (including anthropology).

*Sig at 10% level; **Sig at 5% level; ***Sig at 1% level.

regression. Thus we have reported on both specifications in [Tables 1](#) and [2](#), respectively. Results for responses to the following three major questions are reported: Q4 ('It demonstrates that external intervention is needed to avoid a "tragedy of the commons"'), and Q6 ('It represents the foremost thinking on the commons if students learn one thing about commons governance it should be this concept') and Q7 ('I am not familiar with alternative theories on managing common resources').

In [Table 1](#), the year of instructor's degree and dummy variables for the instructor's disciplinary training are listed as explanatory variables. The left out (i.e. reference) dummy here is social science and so all coefficients need to be interpreted with reference to it. Thus, for example, the table shows that among the different disciplines, only natural sciences have a significantly different effect (relative to social sciences) on responses to **all** the three major questions. The negative sign on the coefficient for natural sciences implies that if the instructor's disciplinary background is natural science he/she is more likely to agree with the statements in Q4, Q6, and Q7; implying greater misconception of commons. Interestingly, the coefficient for interdisciplinary studies is also statistically different for Q7, implying that if the instructors's disciplinary background is interdisciplinary studies, then they are significantly more likely to agree with the need for external intervention.

The results shown in [Table 2](#), with dummies for the disciplinary program shows broadly similar results, with the coefficient of natural sciences being significant for all the three questions. One important exception in this specification is the statistically significant coefficient for humanities for Q7, implying that if the instructors teach a humanities course they are less likely to be familiar with alternative theories on common resources. The effect of the year that the instructor got his/her degree is positive everywhere, implying that the later that the degree was obtained, the misconception is lessened. However, this effect is significant only in [Table 2](#) for Q4 and Q6. This suggests that the extent of misconception is significantly lower for newer instructors for these two questions.

Comments from participants

In addition to the respondents who explained why they were not teaching the tragedy of the commons, many respondents who were currently teaching the concept wrote extended, useful feedback to us, either in the survey space provided or in individual emails. Twelve respondents took issue with our scaled survey items (Q1–10, in the [Appendix](#)) because two of the questions were double-barreled, because the questions did not allow respondents to provide nuanced information on the context of their teaching, because the term neoliberalism 'could mean very different things to different respondents', or because it seemed 'like the questions were written by someone unfamiliar with scholarship on sustaining CPRs [common pool resources].' We were

sensitive to these issues, but also mindful of designing the survey to be efficient. It was not within the scope of this survey to reduce longstanding ambiguities of meaning about terms like ‘neoliberalism’ – which, indeed, means different things even to the several authors of the survey. We have attempted to balance results from the quantitative survey instrument with qualitative analysis of the nuanced feedback we received from survey respondents (principally in Q0, Q11, Q17, and by email) in order to address the limitations of either approach alone.

One of our concerns about the frequency with which ‘The Tragedy of the Commons’ evidently appears on syllabi was understanding whether it is taught in a critical context. Seven respondents explained that is exactly how they teach it, or how it should be taught if it is taught at all. For example, one respondent called it ‘analytically incorrect, historically fully falsified, and with very good alternatives available’ and said the teaching of the concept should be abandoned because the policy consequences are destructive. Another said the article is ‘utterly wrong ... yet is repeatedly used by policy-makers and other scholars to perpetuate myths.’ One said the teaching of the article should be ‘accompanied by [a] critique of its racism and sexism’, while another respondent said, ‘Hardin has for too long been taught without critique and the full context of Hardin’s larger intellectual project, which was eugenical and racist, is rarely mentioned.’ Another of these respondents mentioned that they teach the full article, rather than an excerpt, so that the more radical of Hardin’s observations and recommendations can be critiqued. Two others said they deconstruct the article in class or use it as a ‘strawman’ argument.

Though we did not reach out directly to Hardin’s students or colleagues at the University of California, Santa Barbara, two respondents to our survey recounted having been students of Hardin’s in the 1970s. Both felt fortunate to have been in a class he taught and had used the article in their subsequent professional careers, with one saying it offered a ‘brilliant and easy to understand analogy’ that teaches respect and responsibility for individual actions which otherwise ‘appear to have no effect on other people’.

Seven respondents wrote to explain why they think teaching ‘The Tragedy of the Commons’ is important, citing how ‘Hardin provides a concrete and vivid example ... helps make the concept sticky’, that the article is ‘vastly important’, and ‘still highly influential in ecological circles’, despite or because of the fact that in the article Hardin makes ‘important errors’ and that ‘reflections of the time, and how governance research has disproven many of its conclusions is important’. Many of these respondents explained how they try to position the article in the context of other research on commons governance. One wrote that, since the article is a clear argument on the role of technology in addressing the policy issue of population growth, it should be taught in the historical policy context of technology and population growth. Four of these seven people mentioned Ostrom explicitly as the intellectual counterpoint for contextualizing Hardin’s article. (It should be noted that our survey explicitly mentioned Ostrom in Q11.) In all, twelve respondents wrote to us to explain that they teach Ostrom alongside Hardin. Political science topics like capitalism, socialism, and colonialism were additional issues that individual respondents mentioned teaching in relation to commons governance. Other recommendations respondents made about the context in which ‘The Tragedy of the Commons’ should be understood are provided below in our discussion of teaching recommendations.

Discussion

Hardin’s argument for external intervention to govern the commons was not novel (Feeny et al. 1990). Gordon (1954) and Scott (1955), for example, introduced mathematical models of resource management inspired by fisheries, that defined the conventional theory of the commons. Perhaps the succinct metaphor and catchy title boosted the appeal of Hardin’s article (Burger and Gochfeld 1998; Banner 2018; Boyd et al. 2018). One reason its appeal endures is that though Hardin was dramatic about the need for action, he was vague about how action should be

taken, leaving ample space for interpretation. ‘Mutual coercion, mutually agreed upon by the majority of the people affected’, was an afterthought in his 1968 article (Hardin 1998) that he did not go on to elaborate in most of his arguments except to say, ‘only under a strong and far-sighted sovereign – which could be the people themselves, democratically organized – can a population equilibrate’ but ‘a restriction of the usual democratic franchise would be appropriate and just in this case’ (Hardin 1974). People have taken inspiration from Hardin to justify their own ends. Readers can assume what Hardin assumed, which was that common property needed to be eliminated through privatization or nationalization (Feeny et al. 1990) – but, since Hardin’s constitution of global human carrying capacity as a commons was problematic, so, too, are these prescriptions. Feeny et al. (1990) even point out that ‘mutual coercion, mutually agreed upon is consistent with communal-property arrangements, although he [Hardin] appears to have meant state institutions’ (p. 13). The potential interpretation of Hardin’s polemic argument as an argument for community-based resource use and management is supported by comments from at least one of our survey respondents, who wrote, ‘I was taught to scorn this paper and the supposed argument in graduate school, until I finally read it, and thought it was pretty good’. A lesson to be learned, perhaps as authors more so than instructors, is that openly-interpretable motivational texts have a place in the imaginations of students that endure into their professional careers.

Our survey results show clearly that there is a disciplinary bias in the understandings of instructors on commons governance. Instructors trained in natural science (Hardin’s own field) are less informed than those from other disciplines about the empirical understanding of the management of shared resources and may use Hardin’s essay as the state-of-the-art argument. Interestingly, instructors whose disciplinary background is economics or political science (broadly representing disciplines based more on rational choice theory) did not respond significantly different from those with other social science backgrounds.

There are several questions we did not ask instructors in our survey because we either did not believe these could be effectively answered in a survey of this format or because we prioritized other questions in the effort to make the survey quick for participants to complete. We did not ask what knowledge of commons governance theory instructors have. We did not ask whether instructors had read ‘The Tragedy of the Commons’ when they themselves were students. We did not ask whether, when assigning the article, instructors used an abridged or anthologized version instead of the original (five-and-a-half page) article as it appeared in *Science*. We did not ask about whether instructors teach ‘The Tragedy of the Commons’ in Hardin’s originally intended context, i.e. human overpopulation (or in its mythical context, the enclosure movement in England).

We might concede that there is a place for teaching the concept of the tragedy of the commons as a model, like the Prisoner’s Dilemma, – a null hypothesis about the outcomes of rational action that is frequently disproven by reality. However, in this context, we would also urge students to complement the thought experiment with empirical research, as Ostrom did and other commons scholars continue to do. Economics has a history of argument from first principles and this could be complemented by insights from interdisciplinary anthropological research³. Berkes et al. (1989) cautiously framed Hardin’s contribution in this way: ‘Hardin’s model provides insight into the divergence between individual and collective rationality. But it fails to take into account the self-regulating capabilities of [common resource] users ... [showing] the dangers of trying to explain resource use in complex socio-ecological systems with simple deterministic models’ (pp. 92, 93).

When asked about teaching recommendations a common response of the respondents was the use of games, whether they are board games or computerized versions, to experience the tragedy of the commons and explore solutions. Another recommendation is to use case study material of successful cooperative governance of the commons. Finally, many respondents

recommended using the work of Ostrom to contrast Hardin's analytical argument with an empirical, well tested conceptual framework.

Our findings are compatible with studies of interdisciplinarity in sustainability education cited earlier which suggest that interdisciplinary environmental science and environmental studies programs (i.e. sustainability programs) tend to be dominated by natural science curricula and that publishing in sustainability science is more interdisciplinary at the fringes than in respective efforts grounded in social sciences and natural sciences, which have accounted for the bulk of articles in sustainability. We share an interest in increasing the effective interdisciplinarity of sustainability education, and submit that the 'conventional wisdom' on commons governance may be symptomatic of the challenges the academy faces in meaningfully integrating disciplinary approaches.

Conclusions

In this article, we presented results of a survey of instructors of introductory courses in sustainability that teach Hardin's concept of the tragedy of the commons in their course. However, there is a wide variation among the instructors on how they interpret the material itself and whether they provide alternative viewpoints. Among scholars of resource governance, it is commonly accepted that Hardin's essay is incomplete and dangerous as argued by some. Still, the concept is widely taught in introductory courses in sustainability and, based on this survey, sometimes by instructors who have limited familiarity with the study of resource governance. We found that especially in sustainability-related courses in natural science programs – in contrast to social science and economics programs – there was a significantly greater misunderstanding of the current knowledge of commons governance.

Misunderstanding of the ways shared resources can be governed has important implications for solutions to conflicts in the real world. These implications stretch far beyond the small-scale common pastures studied by Hardin to larger and inter-connected networks such as river basins, and on to newer commons such as the information commons. Several cases of resource mismanagement can be traced to misdiagnosis of the underlying problem (often characterized rather simplistically as 'tragedy of the commons') and the drive for panaceas, such as privatization or government regulation. In order for students to derive a proper understanding of governance concepts about shared resources, there is an urgent need to improve teaching material, specifically in the direction of exposing students to a critical review of the diversity across empirical cases of the commons, some that result in a tragedy and several others that do not. Free educational materials on the governance of the commons for the undergraduate level are available as a textbook (Anderies and Janssen 2016) and a MOOC (Merino Pérez 2018). However, given the persistence of misconceptions on the subject, special effort is needed to better inform instructors on the current state of knowledge, especially among environmental science scholars. Hardin's essay might be used in teaching, as an eye-opener to the social dilemmas in resource governance, but it would be recommended to be complemented by other essays, such as Dietz, Ostrom, and Stern (2003) and Bollier (2014). 'Not doing so would be a tragedy'.

Notes

1. Hardin (1998) later described it as "an ecologist's view of the human overpopulation problem."
2. The question asked did not specify a type of property rights – e.g. common or private – so respondents may have made assumptions based on their own insights.
3. To borrow another example from Coase, generations of economists used the metaphor of the lighthouse as an essential public good, tragically prone to under-provisioning, without bothering with the historical realities of lighthouse construction and upkeep (Coase 1974).

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Marco A. Janssen is a professor in the School of Sustainability, Arizona State University. His research interests are the governance of shared resources, especially related to water, using lab and field experiments, case study analysis and agent-based modeling.

Skaidra Smith-Heisters is a PhD candidate in Environmental Social Science in the School of Human Evolution and Social Change, Arizona State University. Her research interests include self-governance and polycentric decision making in large-scale infrastructure systems, particularly irrigation.

Rimjhim Aggarwal is an associate professor in the School of Sustainability, Arizona State University. Her research interests are the governance of shared resources, specifically related to water in rural and urban areas, in the context of economic development and climate change.

Michael L. Schoon is an associate professor in the School of Sustainability, Arizona State University. His research interests are about collaborative governance in the resolution of environmental dilemmas. He focuses on case studies in the US Southwest and on transboundary conservation initiatives in southern Africa.

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Appendix A. Recruitment email to instructors

Dear Professor \${m://LastName},

2018 marks the 50 year anniversary of the Science article “The Tragedy of the Commons” of Garrett Hardin. We contact you as an instructor of an undergraduate course within sustainability or environmental science related programs. I am recruiting instructors to investigate how Hardin’s essay is used in higher education. We will describe the results in a scholarly paper.

The survey will take approximate 5 minutes to complete.

Follow this link to the Survey:

[\\${l://SurveyLink?d=Take the Survey}](#)

Or copy and paste the URL below into your internet browser:

[\\${l://SurveyURL}](#)

If you know other instructors who may want to participate in this study you can forward this email.

Your participation is voluntary and all individual responses will be confidential. If you have any questions concerning the research study, you can contact me at XXXXXXX about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the Office of Research Integrity and Assurance at XXXXXXX.

Thank you for your precious time.

XXX

Follow the link to opt out of future emails:

[\\${l://OptOutLink?d=Click here to unsubscribe}](#)

Recruitment email send to listserv of the Association for Environmental Studies and Sciences

Dear colleagues

2018 marks the 50 year anniversary of the Science article “The Tragedy of the Commons” of Garrett Hardin. I am recruiting instructors in environmental studies and sciences to investigate how Hardin’s essay is used in higher education. We will describe the results in a scholarly paper.

The survey will take approximate 5 minutes to complete.

You can access the survey in the following link: https://asu.co1.qualtrics.com/jfe/form/SV_9HrWw5k4NE1OmiN

Your participation is voluntary and all individual responses will be confidential. If you have any questions concerning the research study, you can contact me at XXXX. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the Office of Research Integrity and Assurance at XXX.

Thank you for your precious time.

XXXX

Appendix B. Survey on Commons in Higher Education

50 years ago, biologist Garrett Hardin's essay "The Tragedy of the Commons" was published in Science, and this essay has since become one of the most-assigned readings in American colleges. We are doing a survey among instructors in colleges and universities in the U.S.A. about how they use the concepts popularized by this essay in their courses. You are invited to participate in this survey if you have recently taught an undergraduate course related to environmental and/or sustainability topics.

There are two pages to this short survey. The first asks about learning objectives associated with teaching this concept. The second page invites you to share background and feedback about your teaching of this concept in undergraduate courses

Q0. Do you teach the concept of the "tragedy of the commons"?

<Choose: Yes, I currently teach this concept; Not currently, but I have in the past; No>

If "No" was selected:>

This survey is primarily concerned with understanding how the concept is being taught. If you'd like to share your reasons for not teaching "the tragedy of the commons," please use the space below to give us feedback.

<Free form text entry>

You are welcome to view or complete the remainder of this short survey, or simply skip to the end to submit your reply.

<Otherwise>

Please indicate how much you agree or disagree with the following reasons for teaching the concept "the tragedy of the commons."

Q1. It is required in a course curriculum I am responsible for teaching.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q2. Teaching alternative theories on the governance of commons confuses students.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q3. It is convenient to teach because it is in existing course materials^{3/4} I would teach something else if the materials were easily available.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q4. It demonstrates that external intervention is needed to avoid a "tragedy of the commons."

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q5. It illustrates the fundamental dilemma that occurs when people share resources.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q6. It represents the foremost thinking on the commons if students learn one thing about commons governance it should be this concept.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q7. I am not familiar with alternative theories on managing common resources.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q8. It provides a neoliberal perspective on managing common resources.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q9. It serves as a useful counterpoint to empirical research on governance of commons.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q10. It establishes the utility of a system of property rights.

<Rank 1–5: Strongly agree, Somewhat agree, Neither agree or disagree, Somewhat disagree, Strongly disagree>

Q11. In what context do you teach the concept of "the tragedy of the commons"?

Choose the answer that best fits:

- a. As part of a program in action research
- b. As a standalone concept or unit on governance in a course
- c. In a survey of contrasting philosophies of governance (e.g. political economy or political ecology)
- d. As a social science perspective on coping with shared natural resources
- e. As background for common pool resource governance scholarship (e.g. Ostrom)
- f. In a historical context (e.g. social and political movements)
- g. Other (please specify):

Q12. How much time in the course is devoted to teaching about commons governance overall (including both "the tragedy of the commons" and other theoretical or empirical approaches)?

- a. Part of a class
- b. A whole class
- c. A week
- d. More than a week

Q13. What is the type of program in which this course is taught? (e.g. Social Science; Natural Science; Humanities; Engineering; Business/Economics)

Q14. What is the typical class size of this course?

Q15. In what field(s) or discipline(s) did you receive your graduate degree(s)?

Q16. In what year(s) did you receive your graduate degree(s)?

Q17. Do you have suggestions for improving teaching material, or other ideas to contribute to this survey?

Q18. Do you want to receive notification of the outcomes of this research?

<Choose: Yes; No>

Appendix C. Descriptive statistics

Table A1. Do you teach the concept of the tragedy of the commons?

	Total
Yes	220 (80%)
No, but did in the past	30 (11%)
No	25 (9%)
Total	275

Only people who have used TotC in past.

Table A2. Distribution of responses to questions 1–10 of the survey.

	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	N
Q1	85 (37%)	43 (19%)	39 (17%)	22 (9%)	43 (19%)	234
Q2	5 (2%)	12 (5%)	38 (16%)	62 (27%)	115 (50%)	232
Q3	5 (2%)	16 (7%)	51 (22%)	64 (28%)	95 (41%)	231
Q4	38 (16%)	60 (26%)	40 (17%)	45 (19%)	49 (21%)	232
Q5	80 (34%)	93 (40%)	14 (6%)	18 (8%)	27 (12%)	232
Q6	20 (9%)	60 (26%)	37 (16%)	43 (19%)	71 (31%)	231
Q7	6 (3%)	16 (7%)	18 (8%)	51 (22%)	141 (61%)	232
Q8	22 (10%)	71 (31%)	83 (36%)	26 (11%)	28 (12%)	230
Q9	21 (9%)	56 (24%)	99 (43%)	32 (14%)	24 (10%)	232
Q10	15 (6%)	92 (40%)	55 (24%)	42 (18%)	27 (12%)	231

Table A3. In what context do you teach the concept of “the tragedy of the commons”?

	Response
Part of program in action science	1 (0%)
Stand alone concept on governance	25 (11%)
Part of a survey on governance	26 (12%)
Social science perspective on coping with shared natural resources	76 (34%)
Background on common pool resource scholarship	55 (25%)
Historical context	10 (4%)
Other	31 (14%)
<i>N</i>	224

Table A4. How much time in the course is devoted to teaching about commons governance overall (including both “the tragedy of the commons” and other theoretical and empirical approaches)?

	Response
Part of a class	94 (42%)
A whole class	59 (26%)
A week	52 (23%)
More than a week	19 (8%)
<i>N</i>	224

Table A5. What is the type of program in which this course is taught?

	Response
Economics and Political Science (rational choice)	22 (9%)
Engineering	4 (2%)
Humanities (incl. Env Ethics)	13 (5%)
Interdisciplinary (incl. Env. Studies)	68 (29%)
Natural resources management	5 (2%)
Natural science (incl. Env. Science)	59 (25%)
Public administration and planning	6 (3%)
Social science (Anthro and sociology)	13 (19%)
Other –general –unknown	15 (6%)
<i>N</i>	237

Based on Romero and Silveri (2006) and Vincent and Focht (2010) we defined 8 types of disciplines and a rest category. We classified each program based on the information provided.

Table A6. What is the typical class size of this course?

	Total
(0,10]	10 (4%)
(10,30]	100 (44%)
(30,100]	90 (40%)
(100,500]	26 (12%)
<i>N</i>	226

Table A7. In what field(s) or discipline(s) did you receive your graduate degree(s)?

	Responses
Economics and Political Science (rational choice)	35 (14%)
Engineering	4 (2%)
Humanities (incl. Env Ethics)	20 (8%)
Interdisciplinary (incl. Env. Studies)	49 (20%)
Natural resources management	13 (5%)
Natural science (incl. Env. Science)	59 (24%)
Other –general –unk.	38 (15%)
Public administration and planning	11 (4%)
Social science (Anthro and sociology)	21 (8%)
<i>N</i>	250

Based on Romero and Silveri (2006) and Vincent and Focht (2010) we defined 8 types of disciplines and a rest category. We classified each final degree based on the information provided.

Table A8. What year did you got your latest graduate degree?

	Responses
<1980	14 (6%)
1980–1989	27 (12%)
1990–1999	36 (16%)
2000–2009	57 (26%)
2010–2019	89 (40%)
<i>N</i>	223

Table A9. It demonstrates that external intervention is needed to avoid a 'tragedy of the commons' (kind of course).

	Economics	Social Science	Natural Science	Interdisciplinary	Total
Strongly agree	1 (5%)	7 (16%)	12 (20%)	11 (16%)	38 (16%)
Agree	6 (27%)	9 (20%)	19 (32%)	17 (25%)	60 (26%)
Neutral	5 (23%)	9 (20%)	10 (17%)	7 (10%)	40 (17%)
Disagree	6 (27%)	7 (16%)	11 (19%)	12 (18%)	45 (19%)
Strongly disagree	4 (18%)	13 (29%)	7 (12%)	21 (31%)	49 (21%)
<i>N</i>	22	45	59	68	232

Table A10. It represents the foremost thinking on the commons. If students learn one thing about commons governance it should be this concept (kind of course).

	Economics	Social Science	Natural Science	Interdisciplinary	Total
Strongly agree	0 (0%)	2 (4%)	6 (10%)	8 (12%)	20 (9%)
Agree	6 (29%)	10 (22%)	22 (37%)	12 (18%)	60 (26%)
Neutral	4 (19%)	6 (13%)	13 (22%)	8 (12%)	37 (16%)
Disagree	5 (24%)	6 (13%)	11 (19%)	13 (19%)	43 (19%)
Strongly Disagree	6 (29%)	21 (47%)	7 (12%)	27 (40%)	71 (31%)
<i>N</i>	21	45	59	68	231

Table A11. I am not familiar with alternative theories on managing common resources (kind of course).

	Economics	Social Science	Natural Science	Interdisciplinary	Total
Strongly agree	0 (0%)	0 (0%)	3 (5%)	1 (1%)	6 (3%)
Agree	1 (5%)	2 (4%)	9 (15%)	2 (3%)	16 (7%)
Neutral	0 (0%)	4 (9%)	7 (12%)	5 (7%)	18 (8%)
Disagree	4 (18%)	6 (13%)	18 (31%)	13 (19%)	51 (22%)
Strongly Disagree	17 (77%)	33 (73%)	22 (37%)	47 (69%)	141 (61%)
<i>N</i>	22	45	59	68	232

Table A12. Restricting it to those who have taught the TotC, *N* = 228.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Q2	0.092								
Q3	0.077	0.147							
Q4	0.067	0.329	0.079						
Q5	0.181	0.293	0.022	0.543					
Q6	0.139	0.394	0.129	0.611	0.557				
Q7	0.008	0.374	0.271	0.420	0.312	0.459			
Q8	0.050	−0.093	0.182	−0.193	−0.271	−0.248	−0.077		
Q9	0.114	0.071	0.213	0.218	0.118	0.066	0.148	0.129	
Q10	0.195	0.077	0.058	0.156	0.208	0.246	0.099	−0.132	0.176

Q1 = It is required in a course curriculum I am responsible for teaching.

Q2 = Teaching alternative theories on the governance of commons confuses students.

Q3 = It is convenient to teach because it is in existing course materials^{3/4} I would teach something else if the materials were easily available.

Q4 = It demonstrates that external intervention is needed to avoid a "tragedy of the commons."

Q5 = It illustrates the fundamental dilemma that occurs when people share resources.

Q6 = It represents the foremost thinking on the commons^{3/4} if students learn one thing about commons governance it should be this concept.

Q7 = I am not familiar with alternative theories on managing common resources.

Q8 = It provides a neoliberal perspective on managing common resources.

Q9 = It serves as a useful counterpoint to empirical research on governance of commons.

Q10 = It establishes the utility of a system of property rights.