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Mobilization momentum: A network approach to the temporality and effectiveness of environmental movements

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ABSTRACT

Past environmental scholars have sought to explain why environmental mobilization succeeds or fails in reducing environmental hazards, but less scholarship has assessed why environmental mobilization occurs. To examine this question, we employ a month-level temporal model to predict the likelihood of a mobilization event taking place, and a network-analysis model that predicts the involvement of Social Movement Organizations (SMO's). Our results indicate that, with the exception of anti-nuclear mobilization, the environmental movement saw demobilization effects from past events, most strongly for institutional events such as lawsuits. However, past SMO participation significantly increased the likelihood of a non-nuclear environmental protest occurring in the subsequent period. We also find that SMO's prefer to participate in events which match their past experiences, have greater public participation, and target the government. These findings support resource mobilization theory by highlighting the positive influence that SMO's have on mobilization formation and momentum as well as demonstrating how SMO participation shapes and is shaped by event characteristics. We conclude with a discussion of the implications of our results for the future of the environmental movement.

1. Introduction

Recent years in the United States have seen a growing consciousness among the public about the causes and consequences of environmental inequities. Sparked by high-salience events like the Flint Water Crisis and the Keystone XL Pipeline, the U.S. public is increasingly concerned about the effects of environmental degradation. From 2016 to 2020, the number of Americans that say protecting the environment should be a top priority has risen by nearly 20 % points, and now rivals concerns about the strength of the economy [1]. Organizations like Sunrise Movement and Greenpeace have both capitalized on, and been instrumental in, the growth of these concerns. These and similar organizations use their resources to mobilize the public to engage in resistance against environmental hazards, including both global climate change and the siting of local noxious facilities.

High profile energy activism has become a touchpoint political issue, with several states enacting legislation on behalf of the energy industry to criminalize protest activities near energy infrastructure. This legislation, which has thus far been approved by more than a dozen state legislatures, deems oil, gas, coal and plastics facilities as "critical infrastructure" and imposes harsh penalties for protest activities that it deems as trespassing, subject to felony charges [2]. These conflicts are likely to continue to heighten as organizations and individuals persist in mobilizing around issues of climate and energy production and may shape movement tactics and strategies.

Most of the extant literature on energy mobilization has focused on what makes energy mobilization successful. For example, Piazza et al. [3] find that the nuclear protests from 1960 to 1995 succeeded when they made specialized claims and used a diverse range of tactics, Rootes [4] finds that local environmental movements succeed when they frame their demands in the context of national and transnational issues, and both Magnani and Osti [5] and Westerhoff et al. [6] find that identifying tangible benefits for funders and participants leads to success among climate activists. This scholarship often relies on a single case study of a movement that is chosen based on its success, such as Klein [7] on the impact of environmental organizations on the cruise industry, Bell [8] on mobilization against coal production in Appalachia, and Carruthers [9] on resistance to liquified natural gas terminal siting at the US-Mexico border. While these studies are valuable in understanding the characteristics of social movements, McAdam and Boudet [10] note that mobilization events are relatively rare occurrences, and thus selecting successful struggles as case studies limits our understanding of *why*

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mobilization events occur relative to non-action.

In this article, we provide an analysis of the organizational features that predict social movement formation and momentum over time. Our research design provides unique analytical leverage that allows us to identify the factors that make mobilization more likely to occur. Our primary finding is that SMO participation makes mobilization more likely to occur and be sustained over time. We also find that momentum effects differ between the anti-nuclear movement and the wider environmental movement, and that environmental SMO's exert strong preferences in the protests they choose to participate in.

Our study makes several important contributions. First, we use a resource mobilization theory framework to analyze the impact that environmental movement organizations have on institutional and extra-institutional mobilization events. Second, we incorporate temporal lags to assess the proximate impact of prior events and organization involvement over the course of one year. Finally, we employ a network modeling approach to explain how organizations are connected both to one another and to the movements in which they are involved.

This paper proceeds as follows. First, we examine the literature on social movement theory and the role of social movement organizations. Drawing on the literature, we construct a model to measure the impacts of organizational participation and past mobilization events on future mobilization over several lagged time periods. We conclude by discussing the implications of our results and a call for future research to expand on our findings.

2. Theoretical background

2.1. Social movements and mobilization

Social movement theory has long been employed by scholars to examine how, why, and when social mobilization occurs as well as the efficacy of this mobilization in meeting desired goals. There is no consensus definition of a social movement (SM), but they are generally defined by a set of beliefs in a given population that represent a preference for changing social structures and distribution of rights and/or resources [11]. However, preferences being translated into mobilization events is a rare phenomenon [10]. Resource mobilization theory (RMT) has been advanced to explain why some movements are activated into mobilized action while others remain dormant [12]. RMT contends that the size, scope, and success of social movement are largely determined by the number of discretionary resources available to the movement, namely time and money [13]. Greater availability of resources generates growth in the social movement sector, shaping its orientation and organizational form [14], achieved through recruitment networks, creation of opportunities to participate, and perceived efficacy derived from participation at the individual and group level [15].

In addition to resource mobilization, scholarship has shown that both historic mobilization and the existence of pre-established social movement organizations (SMO's) are key to predicting future mobilization [16,17]. Koopmans [17] writes, "The most fundamental fact about collective action is its connectedness, both historically and spatially, and … with other instances of collective action of a similar kind" (pg. 19). This history can be long term, such as a multi-decade legacy of protest behavior in a community, or short term, such as mobilization yesterday predicting mobilization tomorrow. Chenoweth and Belgioioso [18] liken the momentum of social movements to a physics problem, where movement momentum is a production of participation (mass) and the number of protest events in a week (velocity). The authors find that these factors predicted movement momentum in their study of opposition to leadership in African countries between 1990 and 2014. A study of the Zapatista movement found that activists concentrated their protest activity in localities that had a history of protest behavior [19].

Scholars have found that SMO's are pivotal to building the institutional foundation for movement formation and activating latent dissatisfaction into organized mobilization. In a landmark article, Selznick [20] argues that organizations serve the role of economy, or coordinator of scarce resources, and adaptive social structure, which help define formal and informal forms of cooperation. Fisher et al. [21] note that organizations resolve collective action problems by connecting local activists and mobilizing them to participate in activism. Organizations not only provide key financial resources and expertise, but they also provide social movements with a mission and a sense of collective identity [22]. These organizations, seen in the context of social mobilization, often determine whether aggrieved individuals engage in public-facing activism, the form that activism takes, and who participates [23]. In their study of the wind energy industry, Pacheco et al. [24] find that the growth of social movements tends to lead to new, specialized SMO's with greater expertise, which diversify the movement and make it more likely to sustain and succeed.

3. Environmental movement organizations

Environmental SMO's (thus forth called EMO's) have several distinct features. Scholars have found that EMO's are likely to operate at a local level, as opposed to a national level, and that they often target corporations and private sector behavior [25]. The interests and mission of EMO's are heterogeneous; Brulle [26] identifies over 6500 national and 20,000 local EMO's with a diverse set of interests ranging from conservation of natural landscapes to opposing the siting of noxious facilities to ecofeminism. The growth of the EMO sector has largely mirrored the growth in public awareness and concern over environmental issues, with exceptionally rapid growth post-1960 [27]. This growth has created substantial competition among EMO's, with varying levels of resources, influence, and industry/government ties, over which types of mobilization should occur, who should be targeted, and which tactics should be employed [28]. For example, organizations like Friends of Earth most often advocate for professionalized political lobbying, attempting to enact changes to federal and state legislation, whereas organizations like Greenpeace advocate for disruptive direction action like mass public protest.

These differences in strategies and tactics have led to countervailing effects which have splintered the broader environmental movement. Purdy [29] traces the emergence of the environmental justice movement throughout the 1970's and 1980's, largely in response to the professionalized tactics (e.g., lawsuits and lobbying) and utilitarian approach of mainstream environmental organizations which they saw as too corporate-friendly and accommodating to financial interests. In the 1990's and early 2000's, the environmental justice movement formed and collaborated with SMO's that were oriented towards activist mobilization from the ground up [30], representing a substantial shift away from the preeminent tactics of the environmental movement for most of the 20th century [31]. During roughly this same period, however, there was a growing professionalization and partnership between environmental NGO's and both business and government [32,33], suggesting that the remaining EMO's who reject institutional engagement and continue to advocate for direction action may be becoming more ideological radical, and that the contemporary EMO sector is less cohesive in its approach [34,35].

In addition to broader trends in the environmental movement, local factors are an important force in determining the likelihood and success of mobilization and EMO participation, presenting both obstacles and opportunities. Ternes et al. [36], in their study of opposition to the Keystone XL pipeline in rural Nebraska, find that coalitions built in the absence of state institutions often generate and sustain grassroots mobilization efforts against new energy project siting and environmental degradation. In a study of 772 EMO's founded between 1962 and 1998, Johnson and Frickel [37] found a correlation between local environmental impacts and the presence of organizations meant to address them. For example, the authors found that wildlife protection organizations were more likely to form in areas that had greater species decline (pg. 316). These findings show the importance and interconnectedness of EMO involvement and local environmental conditions in determining if environmental mobilization is likely to occur and persist over time.

This paper contributes to the literature on social movements by exploring the interaction of two outstanding research areas with respect to the environmental movement: the momentum of mobilizing efforts and the contribution of SMOs. We accomplish this task using a detailed, networked panel dataset of mobilization events covered in the New York Times, as well as their associated SMO's. We use Olzak and Soule's [38] study of environmental movement momentum on the same dataset as a comparison case.

4. Research design

We take two approaches to investigate the temporal variance of protest events. First, we predict the quantity of monthly protest events via a fixed effects negative binomial model which is similar to the approach of Olzak and Soule [38], but which iterates on this method by adopting a finer month time scale that also allows us to better control for omitted variables via fixed effects. Our fixed effects approach allows us to estimate event occurrence without relying on coarse and sparse environmental attitudes data, as well as account for year-level variation in the environmental movement. Additionally, this approach allows us to assess momentum at the more precise month-level time frame, giving greater insight into the impact of events on event occurrence rates soon after. Second, we predict the likelihood of a given SMO to be involved in a protest event using a dyadic network regression model. We draw particular inspiration from Balian & Bearman's [39] temporal model of conflict momentum in Northern Ireland, with our specification focusing on dyadic network relations rather than triadic ones.

4.1. Data

Our data comes from The Dynamics of Collective Action dataset, which chronicles collective action in the United States. Specifically, the dataset contains information on all protest events that occurred in the U. S. from 1960 to 1995, as reported by the New York Times[1] [38]. Protest events are classified by group participation (i.e., more than one participant), the specific claim being made by the movement, and the public nature of the event such that it could be adequately reported on. Despite its limitations, to the authors knowledge, the Dynamics of Collective Action dataset is the most comprehensive data on protest activity that is publicly available.

We focus on a large subset of environmental protest events, those which include events which make claims related to: the anti-nuclear movement, the environmental movement (specifically air pollution, water pollution, and solid waste disposal),[2] and anti-environmental racism. Protest events are those in which "individuals collectively make a claim or express a grievance on behalf of a social movement organization or social category," excluding those events initiated by the state or by elites. We differentiate from Olzak and Soule [38] in that we look at the effect of all events, not just those that are pro-environment, and include a longer longitudinal range. This decision is due to the coding for the event's valence ("pro" or "anti" towards the claim) having uncertain reliability, and the possibility that anti-environmental events have a similar effect on future events as pro-environmental events.

Following Olzak and Soule [38], we differentiate between *institutional* and *extra-institutional* events. *Institutional* events are conventional protests which occur within political institutions, including: information distribution (tabling, petition gathering, lobbying, letter-writing campaign, teach-ins), press conferences, organization formation announcements/meetings, and lawsuits/legal maneuvers. *Extra-institutional* events are unconventional protest which occur outside of political institutions, including: rallies/demonstrations, marches, vigils, pickets, civil disobedience, ceremonies, dramaturgical demonstrations, motorcades, symbolic displays, violent attacks, riots/melees/mob violence, employee work protests, and boycotts.

The dataset defines a social movement organization (SMO) as: "a complex, or formal, organization that identifies its goals consistent with a set of beliefs or opinions about changing some element of the social structure." SMO participation in an event is identified when the New York Times mentions the organization by name as having participated in the event. Additionally, protests are coded according to what entity they targeted, consisting of government, industry, other (containing: university/school, foreign government/state, medical facility/organization, ethnic/racial group, other), or no clear target. Finally, public participation is defined as the number of people participating in an event as reported by the New York Times, measured categorically due to a lack of consistently clear participant numbers across events. We show descriptive statistics for key event-level variables in Table 1.

We impose two additional cleaning procedures on the dataset. We recode SMO names to remove minor spelling and formatting differences that lead to organizations being erroneously coded as unique from other organizations in the dataset. In total, this reduced the number of supposedly unique organizations from 545 to 484. Additionally, we recoded the protest target category for 18 events based on the accompanying descriptive data for each event.

4.2. Event prediction regression, non-network

We run a fixed effect negative binomial regression of the number of protest events on lagged predictors. We consider a set of *t* months since

Table 1
Descriptive statistics for event-level variables.

Variable	Variable type	Levels	Mean	SD
Nuclear Event	Binary	1: Yes, 0: No	0.318	0.466
Non-Nuclear Event	Binary	1: Yes, 0: No	0.682	0.466
# of SMO's Participating	Continuous	0–10	0.839	1.250
Extra-Institutional	Binary	1: Yes, 0: No	0.479	0.500
Institutional	Binary	1: Yes, 0: No	0.486	0.500
Target: Government	Binary	1: Yes, 0: No	0.586	0.493
Target: Industry	Binary	1: Yes, 0: No	0.362	0.481
Target: Other	Binary	1: Yes, 0: No	0.069	0.254
Target: None or Not Clear	Binary	1: Yes, 0: No	0.066	0.249
Participation × Extra-Institutional	Categorical	1: Small, few handful (1–9 people) 2: Group, committee (10–49 people) 3: Large, gathering (50–99 people) 4: Hundreds, mass, mob (100–999 people) 5: Thousands (1000–9999 people) 6: Tens of thousands (10,000 or more people)	1.610	1.910

[1] Accessed on 5/1/2022 at http://web.stanford.edu/group/collectiveaction/cgi-bin/drupal/node/21.

[2] In order to increase the validity of lagged effects, we focus specifically on a subset of environmental protest claims that are most similar: "air quality protection," "anti-current method of solid waste disposal," and "water quality protection." We did not select on the following environmental claims: "soil protection," "landscape protection (plants, trees)," "reducing noise pollution," "limiting waste/recycling," "restriction of pharmaceutical/chemicals," "rainforest preservation," "ozone protection to prevent global warming, etc." and "zero population growth, as environmental issue." However, these claims are included in the sample set when they are co-claims to events that feature our target claims. This sample construction differs from Olzak and Soule (2009).

01/1990, where $t = 1\ldots431$. Each t contains a month of the year m and year r, such that $m = 1\ldots12$ and $r = 1960\ldots1995$.

$$Pr(y_t|\lambda_t) = \frac{exp(-\lambda_t)\lambda_t^{y_t}}{y_t!}$$

$$\lambda_t = \mu_t v_t$$

$$\mu_t = exp(\beta X_t)$$

$$\beta X_t = \beta_1 x_{(t-1)} + \beta_2 \sum_{\tau=t-2}^{t-6} x_t(\tau = t) + \beta_3 \sum_{\tau=t-7}^{t-12} x_t(\tau = t) + \alpha_m + b_r + \varepsilon_t$$

where y_t is a count of protest events in month t, x_t is a vector of explanatory covariates which are then lagged in the function, a_m is a month of the year fixed effect, b_r is a year fixed effect, and ε_t is the error term. Month of the year fixed effects function as controls for seasonality in event occurrence.

In this model, the total impact of combined lags is equivalent to the impact of a one-year lag on the covariates on y_t, represented by:

$$\beta_1 x_{(t-1)} + \beta_2 \sum_{\tau=t-2}^{t-6} x_t(\tau = t) + \beta_3 \sum_{\tau=t-7}^{t-12} x_t(\tau = t)$$

We apply this regression to four total models. Models 1 and 2 compare protest events that included a nuclear issue in their claims to protest events which did not, looking specifically at the date range which includes the vast majority of nuclear protests: 08/1971–05/1992. This time range makes for a fairer comparison, assuming the anti-nuclear movement had a more distinct period of relevance [40]. Model 1 uses nuclear protests as the dependent variable, while Model 2 uses non-nuclear protests as the dependent variable. For the explanatory variables, each model uses lagged nuclear protests, non-nuclear protests, and the average number of SMO organizations participating in protest events. So as not to over specify our model, we do not differentiate between extra-institutional and institutional protest in the nuclear versus non-nuclear models, as including the interactions terms between protest type and issue type would add an additional six variables to the model.

Models 3 and 4 use all environmental protest events as a dependent variable, over the full data length. These models investigate the distinction between *institutional* (e.g., lawsuits) and *extra-institutional* (e.g., rallies) events found by Olzak and Soule [38], focusing instead at a finer month time unit. For explanatory variables, Model 3 uses lags for all environmental protest events and an interaction between reported participation and extra-institutional events. We choose to focus on participation in extra-institutional events because the impact of participation is conceptually distinct between these categories of events. Within the institutional event variable, public participation is seen through lawsuit participants and participants for a petition or letter-writing campaign. The marginal impact of one additional lawsuit participant or one additional petition signatory is likely much lower than the impact of an additional person at an extra-institutional protest event. Model 4 uses lagged participation × extra-institutional, extra-institutional events, and institutional events. Fig. 1 shows the distribution of environmental protest events by type.

4.3. Network specification

We construct two different types of network specifications. One specification is the event network, where we plot the network as an undirected two node network in which: events are one type of node, SMO's are the other type of node, a tie represents an SMO participating in an event, and ties can only occur between event and SMO nodes. We model these networks based on month-year time period t, such that each t has its own network. In this network we are most interested in predicting why ties form between certain events and SMO's. Notably, this network is sparse: as the number of organizations and events increase, the density of the network approaches zero. This attribute is a result of organizations having a limited capacity to attend events; in essence, organizations have resource constraints so their participation cannot scale 1:1 with the number of events in a given time period [41]. We discuss sparseness and its statistical limitations in our Model Constraints section, although this network characteristic is common in observed network data [41].

The other network specification is an organizational collaboration network, which is a weighted, projected one mode network obtained by collapsing along shared events to create links between SMO's. In this network all nodes are SMO's and a tie represents two SMO's co-participating in an event at a certain time period t. Tie weights correspond to the simple sum of co-participations in the time period t. Our interest in this network is purely descriptive, as we lack insufficient information on the sampled SMO's to make valid inferences.

4.4. Dyadic regression specification

Our dyadic regression seeks to predict the likelihood of an SMO participating in an event, and we adapt our model to address a key selection problem. It is both theoretically and computationally important to differentiate between SMO's that are candidates for participation, or more specifically between SMO's that are repeat actors in protest events and SMO's that are one-off participants. Including SMO's at a time period during which, for an external reason, they never intend to participate would bias event-level predictors of participation towards zero and bias our tie-lag predictors upwards. Event-level predictors would be biased towards zero since including non-active SMO's would induce many observations where $0 = y(x > 0)$. Tie-lag predictors would be biased upwards due to the inclusion of many observations where $0 = y(x = 0)$. We can divide the source of this bias into two parts: (1) some SMO's may never intend to participate more than once (at least at a scale that will covered by the NYT) and (2) SMO's may be functionally active or inactive at specific time periods. This is a particular problem for our nationally aggregated dataset, in which some SMO's may be local and thus have little likelihood of participating in most of the observed protest events. With sufficient information on each organization, we could ideally run a selection model for which SMO's are likely to be potential participants. However, our dataset does not collect SMO data beyond reported participation, and we know of no reliable source of data on all of the observed SMO's, which include potentially local and/or informal organizations.

In order to address the SMO selection issue *across* time periods, we first differentiate between one-off and repeat SMO's based on their observed number of event participations: one-offs are only observed once and repeats are observed two or more times.[3] This solution is not perfect, as it excludes SMO's which are, in reality, repeat SMO's, but only happened to be observed participating once. We use repeat SMO's as our analysis unit j, in combination with a given event i in a given time period t. This distinction also allows us to leverage one-off SMO's as a source of peer influence that is not captured in j. In this specification, the counterfactual is a repeat SMO *not participating* when they are observed participating, and vice versa. In this sense, we are also comparing repeat SMO's that participate *less* to repeat SMO's that participate *more*. We show the most observed repeat SMO's in Table 2, as well as the distribution of observed ties involving repeat SMO's in Fig. 2.

Another component of the selection issue is that SMO's may turn on and off with time. We address this issue by specifying a window around each organization based on their observed activity. We set the left-bound of the window at the first recorded instance of the SMO participating in an event, and the right bound is one year after the last record instance of the SMO participating in an event, matching our maximum

[3] Another issue is that only a maximum of four SMO names were coded for each event. 25 out of 1074 sample events had truncated SMO names, with a total of 60 SMO names not being coded in total. This omission is small compared to the total 840 recorded names in the sample.

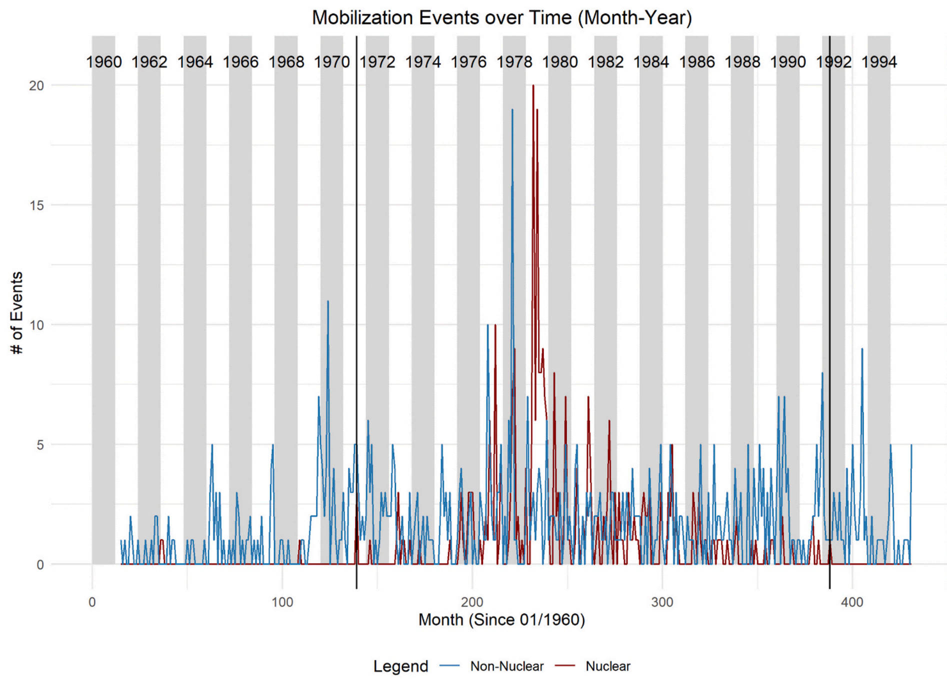

Fig. 1. Environmental Mobilization Events over Time (Month-Year). Non-nuclear environmental protest events are shown in blue, while nuclear protest events are shown in red. The black lines bracket the nuclear-movement regression data range (08/1971–05/1992).

Table 2
Descriptive statistics for top 10 repeat SMO's.

SMO name	# Observed ties	Window start	Window end
Sierra Club	46	10/1966	12/1996
Natural Resources Defense Council	35	4/1970	12/1996
Environmental Defense Fund	19	12/1967	12/1993
Friends of the Earth	19	8/1970	1/1993
National Audubon Society	18	10/1966	5/1986
Greenpeace	17	2/1982	12/1996
Clamshell Alliance	16	5/1977	8/1980
National Wildlife Federation	11	6/1971	5/1994
Solar Action Inc	10	6/1978	6/1979
Wilderness Society	10	9/1981	1/1991

lag length of one year. By including starting points where ties are observed but tie lags are zero as well as ending periods where ties are not observed but lags are positive, we conservatively bias lag effects towards zero.

4.5. Model

We employ a dyadic logistic regression model to estimate the likelihood of a repeat SMO participating in an environmental protest event, using the two-mode event network. In this specification, a dyad is a tie y_{ijt} forming between an event node i and an SMO node j at month since the start of 1960 t, where:

$i \in 1\ldots967; j \in 1\ldots84; t \in 65\ldots431.$

We estimate the following model:

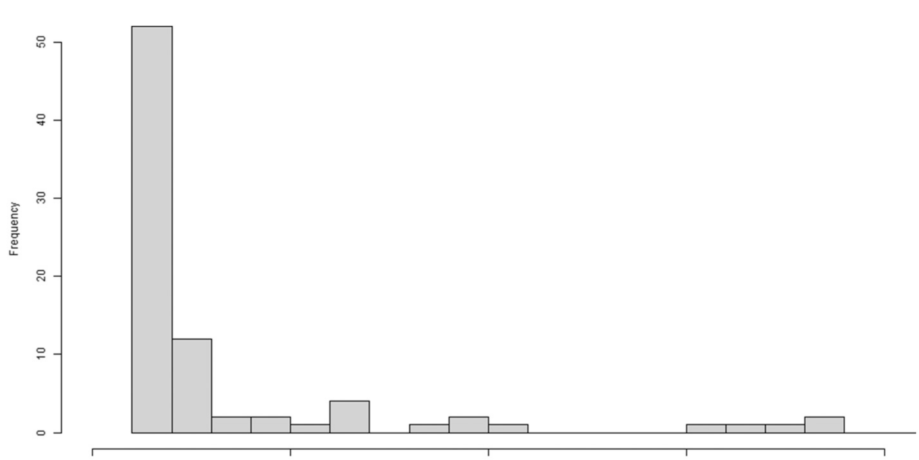

Fig. 2. Histogram of observed ties from repeat SMO's. Top two repeat SMO's omitted for visualization (Sierra Club, NRDC).

$$Pr(y_{ijt}|X_{it}, Z_{jt}, D_{jt}) = \frac{exp(c)}{1 + exp(c)}$$

$$c = \beta_1 X_{it} + \beta_2 Z_{jt-1} + \beta_3 \sum_{\tau=t-2}^{t-6} D_{jt}(\tau = t) + \beta_4 \sum_{\tau=t-7}^{t-12} D_{jt}(\tau = t) + \alpha_m + b_r + \varepsilon_{ijt}$$

where X_{ij} is a vector of attributes for event i at time t, Z_{jt-1} is a vector of attributes for SMO j at time t, and D_{jt} is a vector of attributes for SMO j at time period t evaluated over two-to-six and seven-to-twelve month lags, respectively. Additionally, a_m is a month fixed effect and b_y is a year fixed effect. Events are discrete, such that each event only occurs in a single t.

Event-level attributes X_{it} include *target*, *event type* (*extra-institutional* vs *institutional*), and *participation* interacted with *extra-institutional* type. One month lagged SMO-level variables Z_{jt-1} include total *event participation* in the past month, *cumulative event participation* in events of the same type as j, and *cumulative event participation* in events of a different type than j. The solve variable in the two-to-six and seven-to-twelve lagged SMO-level variable D_{jt} is *event participation*.

Additionally, we impose an organization-specific window to bound which potential dyad combinations y_{ijt} are analyzed. The left bound of the window for a given i is set at the earliest recorded dyad, and the right bound of the window is set at period $t + 12$. All possible dyads y_{ijt} within this window are included for that i. The resulting windows bound our dyad data between 5/1965 and 12/1995, and the distribution of windows and potential dyads can be seen in Fig. 3. Since our base data starts at 1/1960, we do not need to drop observations to ensure that there are values for the lagged variables for all event-time observations.

5. Results

5.1. Environmental protest event occurrence

Model 1 (Table 3) predicts the number of nuclear protest events over the time-span of most nuclear protest events, and finds that a non-nuclear protest in the prior month contributes an additional 0.083 nuclear protest events. Model 2 (Table 3) predicts the number of non-nuclear protests over the same timeline as Model 1 and finds a negative effect from 1 month lagged non-nuclear protests across all 12 months, but most strongly in the 2–6 month lag. On net, a single non-nuclear protest event has a cumulative effect of decreasing future non-nuclear events by −0.904 over the course of a year. Additionally, an average of one higher participating SMO in *all* events in the prior month

Table 3
Environmental mobilization event prediction regressions, nuclear vs non-nuclear: 08/1971–05/1992. All independent variables are grouped by time lag categories, based on the length of the lag: 1 month, 2–6 months, and 7–12 months.

	Nuclear		Non-nuclear env.	
	Estimate	SE	Estimate	SE
1 Month Lag (1–1)				
Nuclear Events	−0.044	(0.031)	0.017	(0.028)
Non-Nuclear Events	0.083*,**	(0.036)	−0.064*	(0.030)
Avg. Num. of SMO's per Event	−0.096	(1.240)	1.593*	(0.759)
2 to 6 Month Lag (t - 2):(t - 6)				
Nuclear Events	0.004	(0.011)	−0.010	(0.011)
Non-Nuclear Events	0.016	(0.028)	−0.102***	(0.020)
Avg. Num. of SMO's per Event	0.691	(0.675)	0.443	(0.395)
7 to 12 Month Lag (t - 7):(t - 12)				
Nuclear Events	−0.009	(0.014)	0.013	(0.013)
Non-Nuclear Events	−0.037	(0.028)	−0.055*	(0.023)
Avg. Num. of SMO's per Event	0.155	(0.089)	−0.130*	(0.058)
Intercept	−3.112*	(1.295)	2.654***	(0.776)
Month FE	Yes***		Yes*	
Year FE	Yes***		Yes***	
AIC	675		924	
Log-Likelihood	−589		−838	
N	250		250	

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.005$.

increases non-nuclear protest events by 1.59; however, 7–12 month lagged average SMO participation has a negative effect of −0.13 events.

Model 3 (Table 4) predicts the likelihood of all environmental protests for the whole data range. In this model, lagged environmental protest events have a slight negative effect of −0.021 and − 0.026 events for 2–6 and 7–12 month lags respectively. However, Model 4 (Table 4) breaks down the influence of lagged environmental protests by *extra-institutional* and *institutional* events. In this model, *institutional* events have a larger negative influence over the 2–6 and 7–12 month lags at −0.098 and 0.133 events respectively, while no other effects were significant. On net, a single institutional event led to a decrease of −1.288 events over the course of a year.

5.2. Dyadic organizational protest participation

Table 5 shows the average marginal effect (AME) results of the dyadic regression, and Appendix A reports two robustness checks. Note

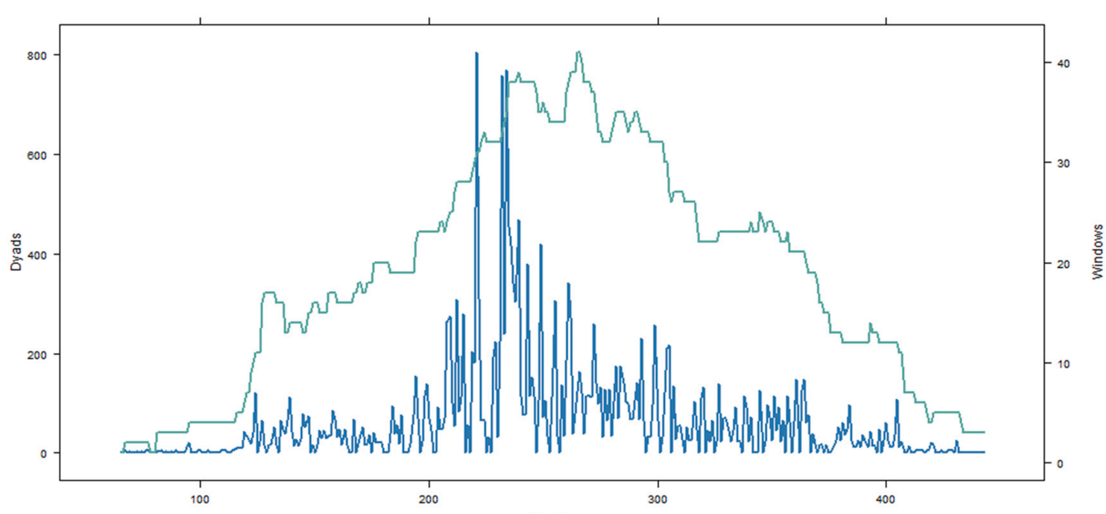

Fig. 3. Distribution of potential dyads (blue) and windows (green).

Table 4
Environmental mobilization event prediction regressions: 04/1961–12/1995. All independent variables are grouped by time lag categories, based on the length of the lag: 1 month, 2–6 months, and 7–12 months.

	Model 3: all environment		Model 4: all environment	
	Estimate	SE	Estimate	SE
1 Month Lag (1–1)				
All Env. Events	0.018*	(0.016)	–	–
Avg Participation × Extra. Events	0.006	(0.042)	0.021	(0.047)
Extra. Institutional Events	–	–	0.001	(0.025)
Institutional Events	–	–	0.004	(0.038)
Avg. Num. of SMO's per Event	0.328	(0.309)	0.188	(0.308)
2 to 6 Month Lag (t - 2):(t - 6)				
All Env. Events	−0.021**	(0.007)	–	–
Avg Participation × Extra. Inst. Events	−0.081	(0.078)	−0.056	(0.029)
Extra. Institutional Events	–	–	−0.016	(0.010)
Institutional Events	–	–	−0.098***	(0.022)
Avg. Num. of SMO's per Event	−0.178	(0.217)	−0.191	(0.214)
7 to 12 Month Lag (t - 7):(t - 12)				
All Env. Events	−0.026**	(0.008)	–	–
Avg Participation × Extra. Events	−0.155	(0.091)	−0.096	(0.076)
Extra. Institutional Events	–	–	−0.165	(0.090)
Institutional Events	–	–	−0.133***	(0.024)
Avg. Num. of SMO's per Event	−0.047	(0.037)	−0.021	(0.036)
Intercept	−0.205	(0.553)	−0.080	(0.544)
Month FE	Yes**		Yes***	
Year FE	Yes***		Yes***	
AIC	1579		1560	
Log-Likelihood	−1468		−1443	
N	419		419	

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.005$.

they do participate in tend to have greater public participation. Finally, repeat SMO's had a greater likelihood of participating in events which had a great *number of one-off SMO's*, although this effect is largely a control for peer effects and itself not directly interpretable.

In terms of SMO-level attributes, repeat SMO are more likely to participate in events that match their past *cumulative participation*. In other words, repeat SMO's are more likely to participate in institutional events if they have participated in more institutional events in the past, as well as participated in less extra-institutional events in the past. We can also visually see event preferences in the aggregate event network across time periods (Fig. 4). Highly connected SMO nodes tend to be connected to predominantly either extra-institutional or institutional events. In contrast, general participation lagged within a year did not impact the likelihood of participation in a given time period.[4] We report robustness tests in Appendix A.

5.3. Organizational collaboration

Lastly, we present exploratory descriptive results from the collaboration network (Fig. 3). Unsurprisingly, repeat organizations are more central in the aggregate network, in part since they are present in more time periods. However, we do observe a single dominant component in the network (bottom left of Fig. 5), in which repeat SMO's constitute the core. As a consequence, one-off SMO's do not appear to be bridging organizations between repeat SMO's and are in more peripheral positions.

6. Discussion

6.1. Environmental protest events occurrence

In comparing nuclear protest events to non-nuclear events, our results suggest that there are key differences between an environmental

Table 5
Organization participation in events: 5/1965–12/1995. Average marginal effects reported.

	AME	SE	z	p	lower	upper
Event Attributes						
Target: Government	0.0059	0.0025	2.4015	0.0163	0.0011	0.0107
Target: Industry	0.0010	0.0024	0.4091	0.6825	−0.0037	0.0057
Target: Other	−0.0290	0.0098	−2.9783	0.0029	−0.0482	−0.0099
Target: None or Not Clear (Reference)	–	–	–	–	–	–
Type: Extra-Institutional	−0.0197	0.0053	−3.7295	0.0002	−0.0300	−0.0093
Type: Other	−0.0025	0.0052	−0.4692	0.6390	−0.0127	0.0078
Type: Institutional (Reference)	–	–	–	–	–	–
Participation Level × Type: Extra-Institutional	0.0035	0.0013	2.6909	0.0071	0.0009	0.0060
# of One-Off SMO's	0.0030	0.0007	4.3338	0.0000	0.0016	0.0043
SMO Attributes						
Event Participation (1 Month Lag)	0.0010	0.0019	0.5146	0.6068	−0.0028	0.0048
Event Participation (2–6 Month Lag)	0.0009	0.0015	0.6072	0.5437	−0.0020	0.0038
Event Participation (7–12 Month Lag)	0.0011	0.0011	1.0366	0.2999	−0.0010	0.0033
Cumulative Participation: Same Event Type	0.0009	0.0001	6.7076	0.0000	0.0006	0.0011
Cumulative Participation: Different Event Types	−0.0007	0.0003	−2.3356	0.0195	−0.0013	−0.0001
Month FE	(Present, not reported)					
Year FE	(Present, not reported)					

AIC: 3702; N: 23393.

that while AME estimates are small in magnitude, even small effects are notable when applied over a large potential dyad set (N = 23,393) with a rare outcome ($y = 1$ for 0.0168 % of dyads).

In comparison to events that target *industry* or have *no clear target*, repeat SMO's are slightly more likely to participate in events that target US federal or state *government*, but are comparatively much less likely to participate in events which target the *other* category (including: university/school, foreign government, medical facility/organization, ethnic/racial group). Additionally, repeat SMO's are less likely overall to participate in *extra-institutional* events, but extra-institutional events

sub-movement and the wider environmental movement. We observe that nuclear event chance was minorly but positively (0.083 events)

[4] To explore the impact of the difference between events with SMO's and those without on our prior models, we ran a sensitivity analysis by rerunning Model 4 with SMO participating events as a dependent. The resulting model was negatively predicted by the number of past events with SMO participation. However, this is likely absorbing the variation from the institutional variable, since Table 4 indicates that non-extra-institutional protest and SMO involvement are highly correlated.

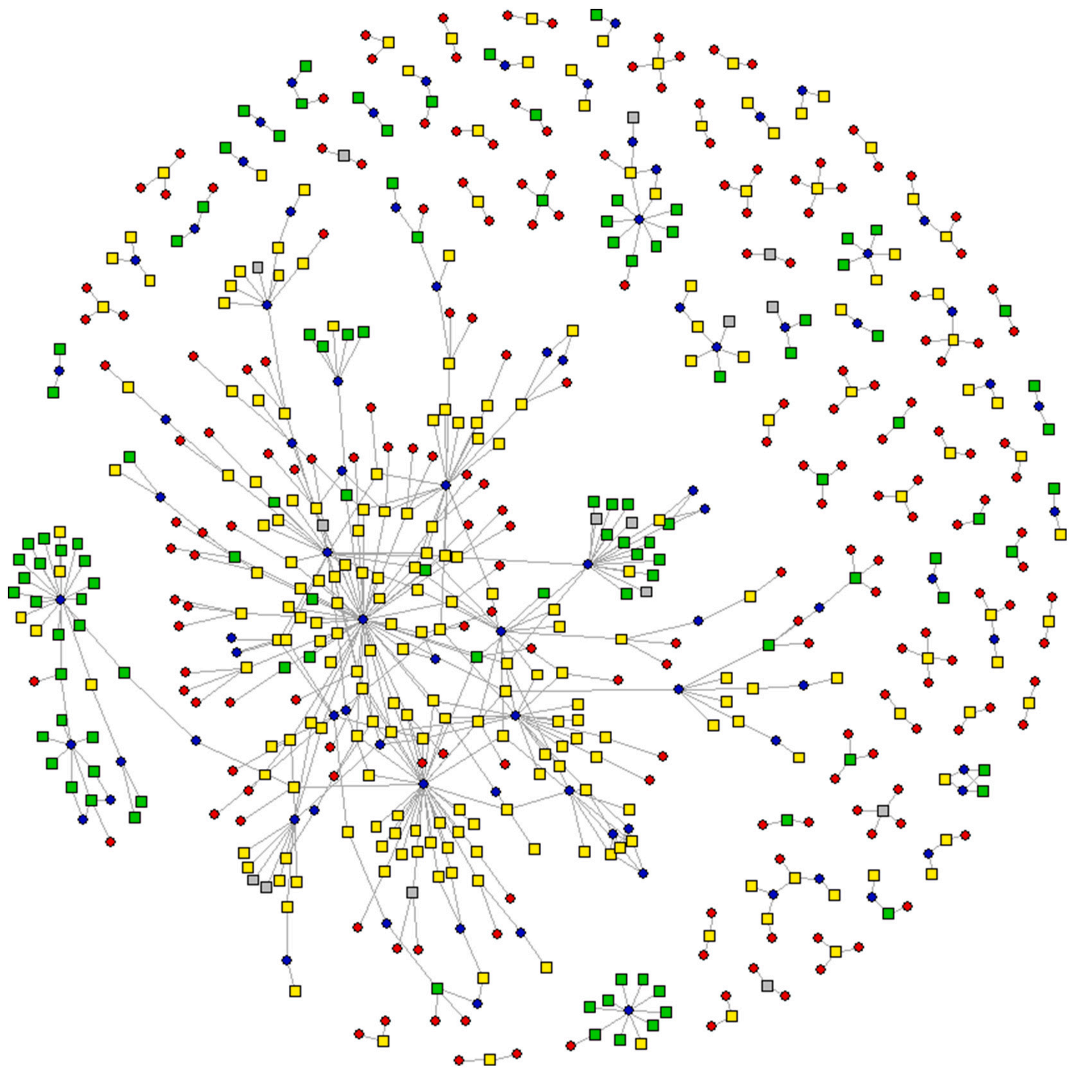

Fig. 4. Bipartite mobilization event network for 1960–1995. Protest events are represented by squares, where: green = extra-institutional, yellow = institutional, gray = other. Social movement organizations are represented by circles, where: blue = repeat SMO's and red = one-off SMO's.

influenced by non-nuclear events the month prior, but the resulting nuclear events did not have a clear impact on non-nuclear events. This trend implies that nuclear events slightly capitalized off the momentum of wider environmental protest but did not build momentum for more general protest events.

In contrast, instead of seeing positive momentum effects in the non-nuclear event outcome, we see negative effects (demobilization) from lagged non-nuclear events. The exception to this is SMO participation: the more SMO's that are involved in events, the much greater the count of events in the following month. Consequently, non-nuclear events were most likely to occur following a period with few events that were also more heavily supported by SMO's. These findings support resource mobilization theory by demonstrating that momentum is tied to the participation of SMO's, which bring a variety of resources to social movements. Existing theories conceptualize SMO's as sources of information and framing for movements (e.g., [22]) and argue that the role of SMO's is to connect local grievances to mobilized action (e.g., [21]). Once an SMO scales back its participation, either all the way to zero as a one-off participant or simply through a less active role, it may leave the movement without the collective frame and/or resources, thus demobilizing the movement [42].

In assessing all environmental events, our results differ notably from Olzak and Soule [38] in that we find that past institutional events negatively predict future environmental events. In a yearly model, Olzak and Soule estimate that a single pro-environmental institutional event leads to an additional 0.05 events in the following year. In contrast in our monthly model, we find that while a single additional institutional event had no impact on the immediate proceeding month, it led to a net decrease of −1.288 events over the course of a full year, which is consistent with Chenoweth and Belgioioso's [19] model of mobilization momentum. We attribute the large disparity between our model and Olzak and Soule's model predominantly to year-variate omitted variables, which we account for. Although our study differs in that it includes both pro- and anti-environmental events and covers and additional five years of data (1991–1995), the minor definitional change is unlikely to be the source of the difference, since additional years of data should mainly serve to improve the accuracy of our estimates and anti-environmental event coding appears to have low reliability.

An additional possible mechanism for our results is that both organizations and the movements they help organize are subject to the issue-attention cycle [43]. A perceived or real environmental injustice or disaster appears to spark relatively short-term activation that fades with time. In addition to the issue attention cycle, mobilization is at least partially contingent on the perceived efficacy of participants [44]. Movements often have short term wins (i.e., a protest event has good turnout) that might motivate additional action, but these wins tend to fade over time as most mobilization events do not achieve their desired outcome of a policy change or a successful lawsuit or a halted siting

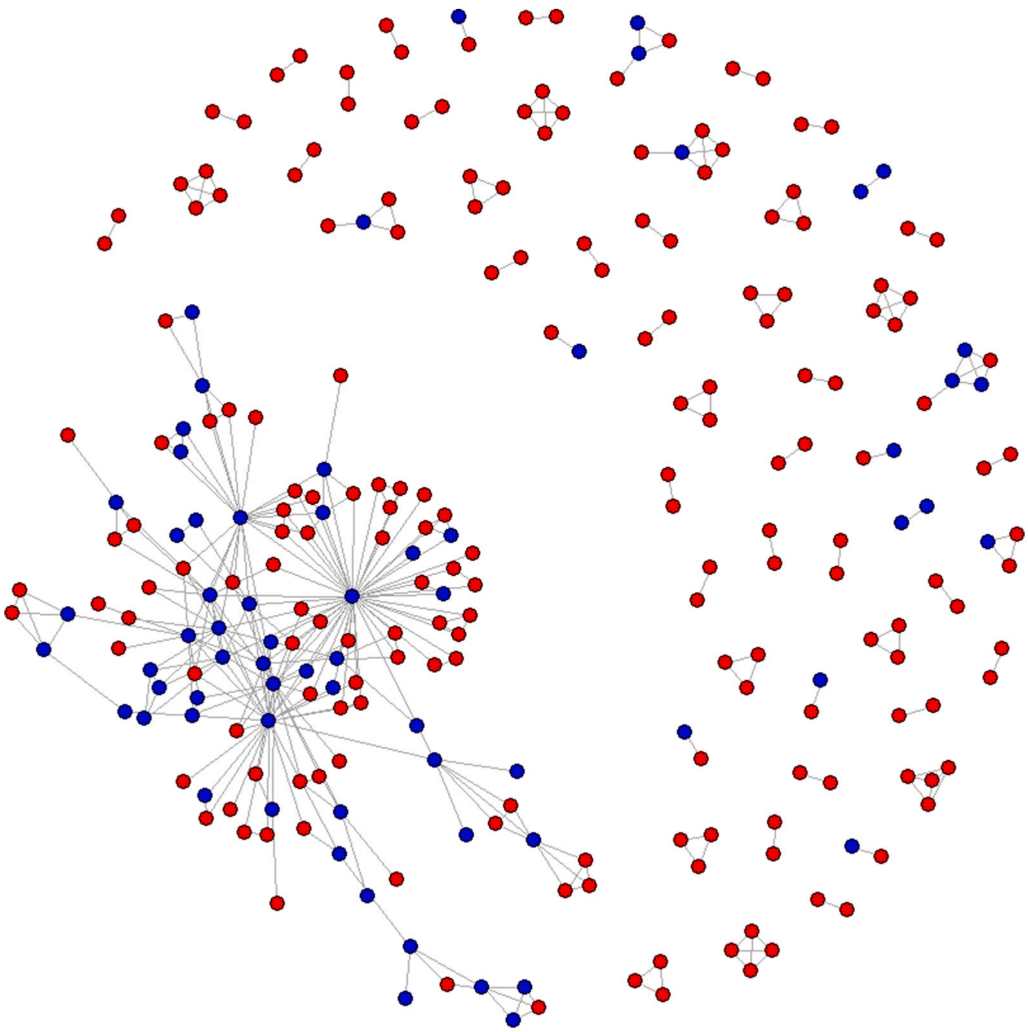

Fig. 5. Social movement organization collaboration network, aggregate across 1960–1995. Social movement organizations are represented by circles, where: blue = repeat SMO's and red = one-off SMO's. Tie weights not shown. Isolated nodes are omitted for visualization.

project [10]. On the other hand, mobilization events that do lead to positive outcomes may make activists feel as if their "work is done" if they succeed in a lawsuit or the local government concedes to (or agrees to hear out) their demands. In both cases, a feeling of efficacy or a lack thereof might make protest less likely over time. This helps to explain why institutional events (like lawsuits) negatively impact later mobilization, where activists may wait and see if the lawsuit is successful, slowing mobilization momentum [19]. The result of the lawsuit will likely have an impact on perceived movement efficacy, and organizations may also abandon the movement once the lawsuit is complete. In addition, Jung [44] finds that movements are often demobilized when their cosponsoring SMO(s) becomes professionalized, moving away from protest-like agitation and towards legal or legislative conflicts.

6.2. Model constraints

Next, we discuss our results in consideration of suspected omitted variable biases: *the environmental disaster bias* and the *environmental attitudes bias*. In short, the most plausible biases indicate that our lagged coefficients should be upwardly biased, which further highlights the significance of our negative coefficients. Considering the following biases, our estimates are potentially upwards bounds on the true effects, meaning the true effects may indicate an even greater demobilization effect.

The main omitted variables from these models are time-specific occurrences which impact the likelihood of protest events *within* a one year time span, which we dub the *environmental disaster bias*. A clear example of such an event is an instance of salient environmental damage, such as an oil spill. An oil spill would increase the likelihood of protest events in the following months, and thus **upwardly bias** estimates for protests inspired both by the spill and past protests against the spill. For aggregate protest event data across environmental issues, addressing this bias would require some index of salient environmental damage events. If we assume that the salience of events fades with time, such as subject to the issue-attention cycle [43], we may expect that this bias would be stronger for shorter lags. Notably, the *environmental disaster bias* is not very credible for the influence of non-nuclear protest lags on nuclear protest since nuclear protests are responding to different environmental issues (nuclear ones) than non-nuclear protests.

Additionally, this model lacks a measure of environmental attitudes and thus may suffer from an *environmental attitude bias*. Our model accounts for shifts in attitudes in the general population over time through our year fixed-effects, as available measures of attitudes over the timescale are measured a yearly level, such as the Gallup poll used by Olzak and Soule [38]. However, our model does not cover changes in environmental attitudes by month. Monthly environmental attitudes may be correlated with protest event occurrence [45] as well as with lagged protest events, since the population may react to past events by shifting their opinions on environmental issues. As a result, a lack of variation may upwardly bias the lagged event coefficients. However, addressing this bias requires reliable monthly variation in environmental attitudes, of which there is little data at an aggregate scale.

6.3. Dyadic organizational protest participation

Next, we discuss the implications of our dyadic model of organizational participation in protest events. We should note here that our model is constrained by an uncertain direction of causality: do SMO's create events or do SMO's latch on to existing events? Both are likely true. However, our model does illustrate the tendencies of events which have more SMO sponsors.

We find that the type of mobilization event matters, specifically the target of the event. Our results show that repeat SMO's are more likely to participate in events that target federal or state government and are less likely to participate in extra-institutional events like rallies or civil disobedience. This may be partially explained by resources, where better-resourced organizations (i.e., Sierra Club or NRDC which are highly central in our networks) are both more likely overall to participate in a given event and also more likely to raise money from corporations, and they are therefore less likely to participate in events that are considered radical or disruptive. This claim is supported by the large negative effect that the *other* type has on SMO participation. *Other* contains more unconventional targets with may dissuade SMO's from participating for political reasons, including schools, universities, foreign government, medical facilities, and ethnic/racial groups.

Additionally, our model indicates that SMO preference or specialization influence what events they participate in. SMO's appear to sort into participating mostly in one type of protest event, more often *institutional* than *extra-institutional* events. SMO's which specialize may effectively build capacity and aggregate resources that increase their ability to participate in certain types of events, such as lawsuits (e.g., Earthjustice). Furthermore, when SMO's do participate in *extra-institutional* events, the events tend to have a larger amount of public participation. This effect could result from SMO's promoting or financing events, thus growing them in size. Alternatively, SMO's may latch onto events which are predisposed to have a larger expected public participation.

The results of our dyadic model are most consistent with resource mobilization theory, which argues that the existence, size, form, and orientation of movements are shaped by resource availability [14,15] and that discretionary resources determine the organizational form of the social movement sector [16][44]. Further, we find that organizations are more likely to lend their resources in areas in which they perceive political opportunity for success, consistent with Tilly [47][46] and McAdam [47] [48], including institutional lawsuits and extra-institutional protests in which there will be large attendance (or a large recruiting pool for them to mobilize).

6.4. Model constraints

The precision of our estimates is constrained by our limited ability to account for zero-inflation that results from the sparseness of our network (for a discussion of sparseness in networking modeling, see Butts [48] and Graham [41]). This sparseness is most notable within a given time period and across adjacent time periods, where organizations face a time-sensitive limit in their ability to participate (e.g. resource constraints). The addition of more events in a given time period, such as adding in events not sampled by NYT coverage, would bias estimates towards zero. Longitudinally, sparseness bias towards zero could manifest as future events introduce new SMO's that increase the sample size of repeat SMO's for a given time period. Notably, this bias is only the case if there is a theoretical justification for events having a constraint on the number of participating SMO's. We believe this bias to be minimal in our case, since we reduce the target SMO population with our windowing technique and focus on repeat SMO's. Recent methodological work has begun to explore biases induced by sparse networks and develop potential estimation solutions, although these strategies have yet to be widely adopted in applied work [48,41].

7. Conclusion

Our study provides evidence for resource mobilization theory by demonstrating that SMO's play a key role in building and sustaining environmental mobilization momentum. SMO's serve the function of activating the dormant grievances of local populations, organizing them into mobilized action, and providing critical resources [20,21]. They also help to determine the form that activism takes, which can range from letter writing campaigns to disruptive civil obedience [23]. We find three key results: (1) nuclear protest mobilization received momentum from wider environmental protests, which in turn saw momentum only from heavy SMO participation; (2) past institutional protests create a strong negative effect on future protests, which we attribute to both the issue attention cycle [43] and shifts in perceived efficacy over time for both the social movement and the SMO; (3) SMO participation in environmental protest events favors institutional events, events targeted at government, extra-institutional events with greater public participation, and events which match their revealed preference and expertise.

These results suggest that modern energy mobilization efforts are likely to be short lived unless they are able to attract SMO participation to help sustain action. Incorporating SMO's may also push efforts towards institutional tactics and larger scale extra-institutional events. However, given that our analysis ends in 1995, a key question is: how have mobilizations changed due the rise of digital organization and protests? Social media has undoubtably transformed public engagement and may serve as a resource alternative to SMO's, potentially decreasing the transaction costs of information and messaging. Modern examples of social media driven environmental mobilization efforts include protests around the U.S. following the release of the anti-fracking documentary *Gasland* [49] and gas boycotts spread from social media calls to action in response to sustained high gas prices resulting from the war in Ukraine and global supply chain disruptions [50]. While these efforts did lead to participation in mobilization, they did not attract SMO involvement and did not lead to sustained mobilization.

Our study is not without limitations. The largest limitation of our study is that it is based on granular national data, and as a result it will tend to not capture smaller and less salient protest events. Any reporting preferences by The New York Times ultimately framed what events were included and what events were excluded. As a consequence, our data underrepresents the full temporal scale of local movements. We also note that our estimations of monthly event occurrence are likely upward biased due to *environmental disaster bias* and *environmental attitudes bias*. Additionally, our dyadic model is constrained by a selection problem in identifying active vs inactive SMO's across the event sample. Our window data addresses this concern within the limits of our data set but falls short of a well-specified selection model.

Future researchers should collect more granular data on the characteristics of both movements and organizations. Our ideal model of movement momentum would track SMO participation over the course of separable, local movements where a movement can be included as a unit of analysis. To do so, future studies should collect movement-specific event timelines in a way that is less constrained by salience than our dataset. Additionally, collecting organizational attribute data beyond participation would allow future researchers to draw connections between organizational type, structure, mission, resources, etc. and mobilization events.

Our study has important implications for the environmental movement. It suggests the environmental SMO's play a significant role in the momentum of mobilization events, and that one of the most meaningful challenges faced by the environmental movement is avoiding the demobilizing effects of the issue-attention cycle and resource exhaustion. Further, environmental SMO's are hesitant to lend their resources and organizational capacity to extra-institutional mobilization, especially if that mobilization does not have a large base of support. The orientation of SMO's and their importance in mobilization momentum will have a profound role in shaping the future of the environmental movement.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

Data availability

Data is publicly available at http://web.stanford.edu/group/collectiveaction/cgi-bin/drupal/node/21.

Appendix A

Robustness Checks for Dyadic Regressions, using Event-level and SMO-level Cluster Robust Models. Regression results are robust to the Event-level cluster, which accounts for peer effects between repeat SMO's. Not all coefficients are robust at the $p < 0.05$ threshold to the SMO-level cluster, which accounts for potential SMO preference correlation. Notably, the SMO Attributes aim to quantify SMO preference and past activity in the absence of SMO-level clustering.

	Estimate	Base		Event cluster (HC3)		SMO cluster (HC3)	
		SE	p	SE	p	SE	p
Event attributes							
Target: Government	0.368	0.152	0.016	0.178	0.039	0.264	0.164
Target: Industry	0.061	0.150	0.682	0.173	0.724	0.254	0.809
Target: Other	−1.813	0.603	0.003	0.621	0.003	1.298	0.162
Target: None or Not Clear (Reference)							
Type: Extra-Institutional	−1.229	0.325	0.000	0.336	0.000	0.567	0.030
Type: Other	−0.153	0.326	0.639	0.334	0.646	0.523	0.769
Type: Institutional (Reference)							
Participation Level × Type: Extra-Institutional	0.217	0.080	0.007	0.082	0.008	0.133	0.103
# of One-Off SMO's	0.186	0.042	0.000	0.054	0.001	0.068	0.006
SMO Attributes							
Event Participation (1 Month Lag)	0.062	0.121	0.607	0.104	0.551	0.151	0.681
Event Participation (2–6 Month Lag)	0.057	0.093	0.544	0.089	0.523	0.182	0.755
Event Participation (7–12 Month Lag)	0.071	0.068	0.299	0.070	0.313	0.158	0.654
Cumulative Participation: Same Event Type	0.054	0.008	0.000	0.010	0.000	0.014	0.000
Cumulative Participation: Different Event Types	−0.045	0.019	0.019	0.032	0.155	0.223	0.840
Month FE	(Present, not reported)						
Year FE	(Present, not reported)						

AIC: 3702; N: 23393.

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