Mediating Collaborations:
The Role of Participant Diversity in Watershed Governance

Yixin Liu

Abstract

Diversity and inclusion are key values in collaborative governance, yet their empirical impacts on environmental outcomes remain understudied. This research investigates whether participant diversity and the inclusion of nongovernmental actors mediate the effects of collaborative governance regimes (CGRs) on environmental outcomes. Drawing on data from 150 water quality monitoring stations, 59 CGRs (i.e., watershed councils), and over 18,000 restoration projects in Oregon spanning 1981-2021, I employ a staggered difference-in-differences approach with causal mediation analysis. Results reveal that CGRs, on average, improve water quality by 6 percent, with participant diversity serving as the mediator, especially through contributions from nongovernmental actors and citizen groups. Subgroup analysis further shows that CGRs reduce water quality disparities between underserved Black communities and more advantaged communities. These findings emphasize the importance of diverse, inclusive participation in enhancing environmental outcomes and offer guidance for public managers aiming to create equitable and effective socio-ecological systems.

Keywords: collaborative governance, participant diversity, watershed management, environmental justice

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1 Introduction

Collaborative governance is broadly acknowledged as a valuable approach for tackling complex environmental issues (Emerson and Nabatchi 2015a; Koontz et al. 2004). The theoretical rationale behind this is straightforward: managing cross-boundary natural resources, such as watersheds and forests, exceeds the capacity of any single organization or individual to coordinate effectively (Ostrom 1990). Collaboration among multiple policy actors across different sectors is necessary to establish "shared core goals" and to take actions that benefit the socio-ecological system (Bryson et al. 2016, 914). Building on this theoretical foundation, the development of collaborative governance theory has evolved in two directions. First, the scholarly community has shifted its perspective from viewing collaborative governance as a normative ideal to treating it as an instrumental tool for environmental management (Emerson et al. 2012; Koontz et al. 2004). Second, research on collaborative governance has progressed from understanding the formation of cross-boundary collaborations to examining the effectiveness of these collaborations in managing common-pool natural resources (e.g., Lee and Liu 2024; Liu and Tan 2022; Scott 2015, 2016).

However, three research gaps remain within these empirical directions. First, few empirical studies link the normative and instrumental values. Collaborative governance is normative because, by definition, it is a democratic process that involves diverse views and voices contributing to the decision-making process (Ansell and Gash 2008; Bryson et al. 2006; Emerson et al. 2012). Thus, the fundamental value of collaborative governance lies in fostering open and inclusive communication among participants from diverse backgrounds, integrating perspectives from both governmental and non-governmental actors in the decision-making process, and ultimately creating shared public values that transcend individual organizational goals (Bryson et al. 2016). This governance style embodies the spirit of a democratic society, and its inclusive values are essential for addressing institutional fragmentation in managing cross-border and cross-scale socio-ecological systems (Bodin 2017). Surprisingly, few studies have examined whether such democratic values serve as mechanisms driving the success of collaborations. Often, these values are overlooked, treated as implicit assumptions within the collaborative process.

Second, there is a lack of empirical research connecting the formation of collaborations with collaborative outcomes. Studies on the former often treat collaborations as dependent variables, while studies on the latter consider collaborations as explanatory variables for environmental outcomes. Bridging these two research themes is essential, as the process and structure of collaboration formation may influence the success or failure of these efforts. For instance, who joins the collaborative network, why they join, and how they enter may shape interactions among participants during the policy process, ultimately affecting the overall outcomes of cross-boundary collaborations (Bodin 2017). Thus, research should consider not only factors such as financial support for collaborative projects (Scott 2016), leadership within collaborative networks (Lee and Liu 2024), and legal mandates supporting collaborative actions (Bitterman and Koliba 2020), but also the composition of participants at the formation stage. By doing so, we can achieve a comprehensive understanding of collaborative governance, from its establishment to its completion.

Third, the scholarly community tends to focus on testing collaborative outcomes in terms of effectiveness and efficiency (e.g., Lee and Liu 2024; Liu and Tan 2022; Scott 2016), with relatively less emphasis on the equity dimension in environmental management. As Emerson and Nabatchi (2015b, 731) argue, "for beneficiaries of the targeted change, fairness, as measured by equity, will be a valued principle and broadly shared expectation." In environmental management, the equity dimension often aligns with the concept of "environmental justice," which examines whether communities of color and low-income populations face disproportionate exposure to environmental risks (Agyeman et al. 2016). Collaborative governance, as a policy implementation tool grounded in inclusivity and diverse representation in decision-making, should enhance distributional justice for underserved communities. Therefore, I recommend strengthening the investigation of causal links between collaborative governance, the value of diversity, and equitable environmental outcomes.

In this research, I ask three questions to fill these gaps: (1) Can institutionalized, long-term collaborative networks, as collaborative governance regimes (CGRs), effectively achieve positive environmental outcomes? (2) Do participant diversity and inclusiveness serve as key mechanisms that positively mediate the effectiveness of CGRs in achieving desirable cross-boundary environmental outcomes? (3) Can CGRs, through mechanisms of participant diversity, help mitigate the gap in environmental conditions between underserved and more advantaged communities? Here, I focus particularly on CGRs as a collaboration form because they engage cross-sectoral policy actors to jointly address issues across organizational and jurisdictional boundaries over an extended period, thus fostering positive changes within the socio-ecological system (Emerson and Nabatchi 2015b; Emerson et al. 2012).

I investigate these questions in the context of watershed management in the state of Oregon. Specifically, I construct a novel dataset combining 150 water quality monitoring stations from 1981 to 2021, establishment data for 59 CGRs (watershed councils), and over 19,000 collaborative restoration projects. My analysis proceeds in three stages. First, I employ a staggered difference-in-differences approach to establish a causal relationship between the establishment of watershed councils and water quality improvements, reflecting the overall impact of CGRs on environmental outcomes. Second, I use the same method to examine whether the establishment of watershed councils causally facilitates participant diversity by including more citizen groups and non-governmental actors in collaborative restoration projects. Finally, I conduct a causal mediation analysis to test whether the causal link between watershed council establishment and water quality improvement is positively mediated by participant diversity and inclusiveness. Additionally, I carry out this three-stage analysis for subgroups with higher and lower percentages of Black populations. The findings from this research not only test the impacts of collaborative governance on environmental management but also help connect core democratic values in collaborative practices, bridging the formation of collaborations with their effectiveness and equity outcomes.

2 Collaborative Governance Regimes

Collaborative governance involves institutional frameworks that integrate governmental and non-governmental actors across various sectors, levels, and jurisdictions, enabling them to work collectively in delivering public services and addressing complex policy challenges (Ansell and Gash 2008). Scholars and practitioners advocate for collaborative governance based on two primary perspectives: normative and instrumental (Bryson et al. 2015). The normative perspective highlights its role in promoting diversity in decision-making by incorporating a broad range of public and private interests (Fung 2015; Hong and Page 2004). This inclusivity fosters open communication, mutual trust, and norms of reciprocity, which in turn strengthen collaborative leadership, shared understanding, and commitment to service delivery (Ansell and Gash 2008; Thomson and Perry 2006).

From an instrumental perspective, collaborative governance serves as a practical approach for addressing complex issues that cross sectoral and jurisdictional boundaries. Effective collaborative governance institutions reduce transaction costs associated with collective action and discourage free-riding behavior among policy actors (Berardo and Scholz 2010). As Ostrom (1990) pointed out, when organizations manage natural resources independently, the benefits they achieve are often less than what could be attained through coordinated strategies.

To outline the actions and institutional arrangements that encourage collaborative behaviors, Emerson et al. (2012) introduced the concept of CGRs. Within this framework, each CGR represents a socio-ecological system in which multiple actors from diverse sectors work collectively, following both formal and informal rules, to resolve cross-boundary issues. Key institutional mechanisms within CGRs—such as financial support for network members, regular coordination meetings, representative participation, and oversight functions—enhance collaboration and reduce free-riding (e.g., Jager et al. 2020; Liu and Tan 2022; Mehdi and Nabatchi 2023; Scott 2016; Wang et al. 2019).

CGRs are distinct in their sustained engagement, enabling actors to collaborate over extended periods, unlike temporary partnerships (Emerson and Nabatchi 2015a; Mehdi and Nabatchi 2023). While short-term collaborations may disband once specific goals are achieved, CGRs address ongoing policy issues with a broader, long-term focus, providing a foundation for local governance. This study builds on the CGR framework to explore the role of these regimes in achieving positive environmental outcomes and examines how participant diversity within these regimes contributes to effective governance.

Recently, examining the outcomes of CGRs has become a major research focus in collaborative environmental governance. Scholars have demonstrated the effectiveness of CGRs in managing common-pool natural resources across various policy contexts, such as renewable energy networks (Lee and Liu 2024), urban waterways (Liu and Tan 2022), and national forests (Emerson and Nabatchi 2015b). Building on these findings, I propose the first hypothesis of this research, which serves as a pre-condition for further discussion of the mediating effect of participant diversity in the following section.

H1: The establishment of CGRs will improve cross-boundary environmental outcomes.

3 Participant Diversity

3.1 Two Competing Arguments

There are two competing arguments regarding the impact of participant diversity on collaborative environmental governance. On the positive side, participant diversity offers several benefits. First, it makes decision-making more effective by incorporating a broad range of information and knowledge from diverse perspectives (Burby 2003; Innes and Booher 1999). This is important because the purpose of collaboration is to gather participants with sufficient knowledge about the local context of the policy issue they aim to address (Geissel 2009; Newig et al. 2018; Sirianni 2009). Their knowledge should be both diverse and specialized, particularly when collaborations encounter challenges in complex socio-ecological systems (Margerum 2011; Yaffee and Wondolleck 2000). Second, participant diversity facilitates a representative decision-making process that is more responsive to stakeholders and local communities (Anderson et al. 2013; Kim 2024; Lee and Liu 2024). This concept is well supported in the representative bureaucracy literature, which indicates that enhanced responsiveness occurs when policy actors actively represent groups with whom they share key social identities, using their discretion to promote more equitable outcomes (e.g., Hong 2017; Meier 2019; Nicholson-Crotty et al. 2011). Third, participant diversity can effectively reduce conflicts among groups with differing interests and foster mutual trust over the long term (Ansell and Gash 2008; Provan and Kenis 2008). This aspect is particularly relevant to environmental management, as improving environmental conditions often requires long periods and relies on trustworthy, stable, and sustainable collaborations (Berardo and Scholz 2010; Koontz et al. 2004).

However, on the negative side, some scholars are concerned that participant diversity may lead to delays and inefficiencies in the decision-making process (Maglio et al. 2020; Siddiki et al. 2017). This is because greater diversity often brings a wider range of perspectives, interests, and values, which can complicate negotiations and make consensus harder to achieve (Ansell and Gash 2008). In highly diverse groups, conflicting goals and competing interests can slow down the pace of decision-making and may even lead to gridlock if disagreements cannot be resolved (O'Leary and Amsler 2007). Additionally, a diverse range of stakeholders can create coordination challenges, as different parties may have varying levels of influence, knowledge, or commitment to the collaborative process (Huang 2014). The complexity of integrating diverse viewpoints can require additional resources and time to build mutual understanding and develop shared goals (Emerson and Nabatchi 2015a). Furthermore, when participant diversity is not managed effectively, it can lead to fragmentation, power imbalances, and even a lack of trust, ultimately undermining the effectiveness of collaborative efforts (Sabatier et al. 2005).

Nevertheless, disentangling this debate is crucial for understanding collaborative environmental governance, as there are limited studies that directly test the impact of participant diversity on managing common pool natural resources. Instead, scholars often treat participant diversity as a default assumption for forming collaborative networks, directing their focus towards other factors that influence collaborative outcomes (e.g., Bitterman and Koliba 2020; Lee and Liu 2024; Liu and Tan 2022; Scott 2016). There are, however, a few exceptions. Mehdi and Nabatchi (2023) found that representational diversity among participants in collaborative watershed projects did not consistently enhance cost-effectiveness. Similarly, Scott (2015) underscores that the benefits of stakeholder representation in government-sponsored watershed groups may be limited due to the constrained scope of their activities. Thus, participant diversity remains more of a normative ideal within the theory of collaborative governance than a consistently effective practice in actual policy implementation.

This research aims to extend the debate on the competing arguments above and empirically link collaborative governance, participant diversity, and environmental outcomes in a new direction. I argue that we should not test the impacts of participant diversity in isolation but instead view it as a mediating mechanism between collaboration formation and outcomes. This is because participant composition can differ greatly depending on the collaboration form and its intended purpose. For example, ad hoc collaborations are often formed to address immediate, specific problems, bringing together participants with a narrow, task-oriented focus who disband once the objective is met (Mehdi and Nabatchi 2023). In contrast, CGRs involve longer-term, sustained partnerships with a diverse and stable participant base to address complex and interconnected environmental issues (Emerson et al. 2012). Therefore, we should see the dynamic pattern of participant diversity before and after the formation of CGRs and their further impacts on collaborative outcomes. Accordingly, I present the mediation hypothesis as follows.

H2a: Participant diversity positively mediates the impact of CGRs on environmental improvement.

3.2 Government and Nongovernmental Participants

To further study participant diversity in collaborative networks, I also examine the subgroups of participants and their impacts. As Ansell and Gash (2008, 544) define it, collaborative governance is "...a governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process." Disentangling the roles of different levels of government agencies and nongovernmental participants, such as nonprofits and community-based organizations, in collaborative actions is essential for developing a deeper understanding of how participant diversity mediates collaborative outcomes. This is because it is important to move beyond a superficial understanding of overall diversity to examine and compare the efforts of governments' top-down management with grassroots participants' bottom-up engagement, as both jointly contribute to constructing democratic values within the collaborative process (Bryson et al. 2016).

Government agencies contribute political and financial resources to the process of environmental treatments (Scott and Thomas 2017; Span et al. 2012). Their legal authority can mobilize other participants within collaborative networks to collectively address common problems (Hui and Smith 2022). However, government agencies may lack sufficient local knowledge and the ability to foster norms within diverse communities. In contrast, nongovernmental organizations often have fewer resources but are more likely to represent local interests. Research has demonstrated that when organizations reflect the demographic composition of the communities they serve, their actions are perceived as more legitimate and trustworthy over time (Kettl 2015). Consequently, the participation of nongovernmental actors in collaborative networks enhances social equity in environmental management (Krzeminska and Zeyen 2017; Vermeiren et al. 2021). Since the mediation effect of participant diversity has not been thoroughly tested, comparing the mediation effects of government and nongovernmental participants is a valuable empirical endeavor. Therefore, I present the following hypothesis with competing directions.

H2b: The mediation effect of nongovernmental participants on environmental improvement is stronger (or weaker) than that of government participants.

4 Environmental Justice

There are two primary research streams in the study of environmental justice. Much of the existing literature emphasizes identifying and analyzing unequal distributions of environmental benefits and burdens, often revealing how race, ethnicity, and income levels contribute to disproportionate environmental risks (Agyeman et al. 2016; Bullard 1996). Abundant studies demonstrate pervasive environmental injustices affecting underserved communities across various policy areas. For example, the illegal dumping of polychlorinated biphenyls in predominantly Black Warren County, North Carolina (Banzhaf et al. 2019). Similarly, Memmott et al. (2024) highlight how utility disconnections in California disproportionately affect Black and Hispanic households, underscoring disparities in energy access. Konisky and Reenock (2017) identify regulatory enforcement biases against minority communities, while Liang (2016) documents persistent racial disparities in air pollution exposure and enforcement under the Clean Air Act. Furthermore, tribal facilities face less rigorous enforcement and higher rates of water violations under the Clean Water Act and Safe Drinking Water Act (Teodoro et al. 2018).

This body of evidence highlights the urgent need for a second stream of environmental justice research that focuses on solutions to promote equitable environmental governance. For example, Liang et al. (2020) emphasizes the critical role of representative bureaucracy in advancing equitable policy outputs for racially and socially vulnerable communities by improving the distribution of environmental benefits and regulatory enforcement. Jenkins et al. (2020) discuss the transformative potential of energy justice initiatives that collaborate with marginalized communities to develop equitable energy solutions. Additionally, recent studies on air quality equity show that targeted reductions in emissions in communities of color can address longstanding pollution disparities when climate policy implementation prioritizes equity alongside emission goals (Polonik et al. 2023).

As a policy and management tool that prioritizes inclusive voices and represents the interests of diverse communities across political jurisdictions, collaborative governance holds significant potential to advance environmental justice. As discussed earlier, CGRs can mobilize diverse participation and engage more nongovernmental actors in decision-making processes. By increasing input from these participants, historically marginalized communities have greater opportunities to voice their concerns and influence policy implementation, potentially leading to more equitable outcomes (Fung 2015). For example, Dobbin and Lubell (2021) found that collaborative groundwater management in California improved representation for disadvantaged communities, although challenges persisted for the most marginalized. Similarly, Koebele et al. (2024) emphasized that engaging diverse actors in collaborative water governance can enhance equity, particularly when power imbalances are addressed. Additionally, Ahn and Baldwin (2022) demonstrated that collaborative processes can improve the equitable distribution of energy savings. In this research, I focus on linking CGRs with the mediating role of participant diversity to explore their joint efforts in reducing distributional disparities in access to clean water resources for underserved communities. Therefore, I propose the following hypothesis.

H3: CGRs, through mechanisms of participant diversity, will reduce disparities in environmental conditions between underserved and more advantaged communities.

5 Empirical Strategy

5.1 Context

I test hypotheses within watershed management in the state of Oregon, which is located on the Pacific Coast in the northwestern United States and is known for its thriving high-tech and fishing industries. Oregon's watersheds were once home to various species of salmon and steelhead. However, by the 1980s and 1990s, these watersheds had become severely degraded and polluted due to decades of overfishing and industrial pollution. Starting in the 1990s, local governments, community organizations, environmental nonprofits, local private firms, landowners, and other civic society organizations began collaborating to establish watershed councils throughout Oregon. All of these watershed councils are registered as nonprofit organizations. Their common goals are to improve watershed conditions and enhance their ecological environments.

In 1997, the state legislature enacted the *Oregon Plan for Salmon and Watersheds* (OPSW), which further supported watershed councils in promoting cross-boundary collaborations in watershed management. The OPSW authorized the Oregon Watershed Enhancement Board (OWEB), a state agency, to establish a database documenting all reported collaborative restoration and recovery projects in Oregon watersheds dating back to 1990. The OPSW encourages local actors to initiate projects and report them to the OWEB, while also enhancing collaborative efforts by providing financial and in-kind resource support.

This context offers an ideal scenario for studying my research questions. Watershed councils align with the definition of CGRs (Mehdi and Nabatchi 2023; Scott 2016) because they "engage people in their communities to participate in collaborative, voluntary restoration of watersheds" (OWEB n.d.a). These councils are sustained over the long term and focus on developing, executing, and evaluating multiple projects identified through assessment or planning processes, aiming to systematically address issues at the watershed or ecosystem level. By connecting the establishment of CGRs with changes in water quality, we can test H1.

Additionally, cross-sectoral participants contribute to collaborative projects and report them to the OWEB. Each watershed is managed by a single watershed council. Some projects were initiated and completed before the establishment of the watershed council in their respective locations, while others began after the councils were formed. This variation allows for the detection of watershed councils' impacts on project characteristics, such as changes in participant composition. Furthermore, the Oregon Department of Environmental Quality (ODEQ) provides water quality data spanning from 1981 to 2021 across different watersheds. Although watershed councils are multi-purpose CGRs, and their collaborative projects may pursue various goals, they all share a common objective: improving water quality in Oregon watersheds (OWEB n.d.b). Therefore, by connecting watershed council establishments, collaborative restoration projects, and water quality as the environmental outcome, we can analyze the mediation effects in H2a, H2b, and H3.

5.2 Data

We utilize data from multiple sources. Specifically, we use: (1) the Oregon Water Quality Index (OWQI), provided by the ODEQ, to measure environmental outcomes; (2) manually coded establishment data of watershed councils, along with their geospatial boundary information provided by the OWEB; (3) the OWEB's Oregon Watershed Restoration Inventory (OWRI) for data on restoration and recovery projects; and (4) climate data from the PRISM Climate Group at Oregon State University[1] and county-level demographic data from the U.S. Census Bureau.

The OWQI consolidates eight indicators (water temperature, pH, dissolved oxygen, biological oxygen demand, total solids, nitrogen, phosphorus, and bacteria) into a single index using the following equation (1), where SI_i refers to the i-th subindex (e.g., pH), and n denotes the number of subindices:

$$OWQI = \sqrt{\frac{n}{\sum_{i=1}^{n} \frac{1}{{SI_i}^2}}} \tag{1}$$

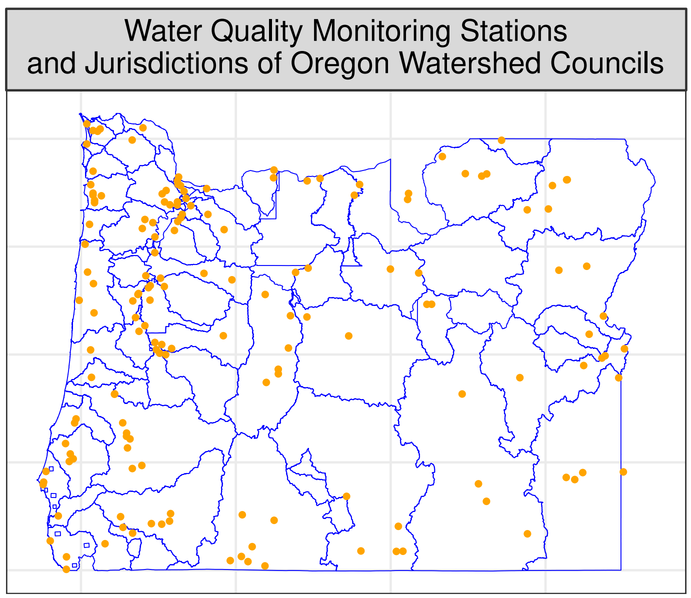
The OWQI scale ranges from 10, representing the poorest water quality, to 100, signifying the best possible condition. The ODEQ classifies these scores into five categories to reflect varying levels of water quality: 10-59 (very poor), 60-79 (poor), 80-84 (fair), 85-89 (good), and 90-100 (excellent). Water quality data collection occurs irregularly, with OWQI values obtained from 150 monitoring stations distributed across the state. Sampling is conducted intermittently on a monthly basis at each station, covering data from 1981 to 2021. To manage the irregularities in data collection and match with other datasets, I aggregate

[1] https://prism.oregonstate.edu/

the data into a station-year panel for longitudinal analysis.

I collected geospatial data on the jurisdictional boundaries of watershed councils from OWEB and manually coded their establishment years by visiting each council's website. Although OWEB documents a total of 88 watershed councils, only 59 of them have at least one water quality monitoring station within their boundaries. Therefore, this subset constitutes the observable sample for the analysis. Figure 1 displays the geospatial locations of our sample, where yellow dots represent water quality monitoring stations and blue lines delineate the jurisdictions of the watershed councils.

Figure 1: Research sample



The OWRI is a comprehensive dataset that encompasses information on all 18,689 watershed projects funded by OWEB or by local governments and other social organizations implemented between 1990 to 2021. All projects focus on watershed restoration and recovery in Oregon. The OWRI includes details such as project start and end dates, activities, geographic coordinates, costs associated with project activities, project goals, and land use. It also documents all project participants, provides their sectoral information.

To align with the station-year panel data, I aggregated the project information to the level of watershed councils and generated the following variables. First, I used project start dates and geographic coordinates to create a variable called *N-project*, which counts the total number of projects within a given watershed council jurisdiction in a specific year. Second, I measured *participant diversity* by counting the distinct types of participants based on the OWEB codebook. Third, I created count variables for *citizen groups*, *nongovernmental actors*, *local governments*, and *state agencies*, which represent the number of unique organizations in these categories participating in collaborative projects within a given watershed council jurisdiction each year. In Appendix A, I detail the participant categories from the OWEB codebook used to construct these variables. Additionally, I generated two variables: the number of OWEB *grantees* per project and *total costs* in the watersheds, to control the impact of OPSW on water quality. Finally, I created a variable, *goals*, to capture the average number of goals per project.

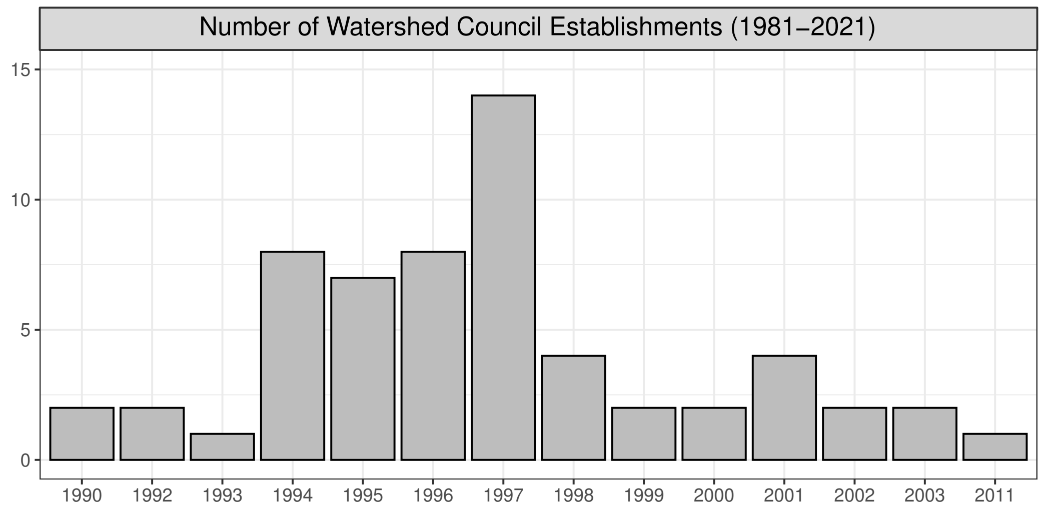
I also included two climate variables, *air temperature* and *precipitation*, collected from the PRISM Climate Group. I transformed their monthly raster image data into annual values for each water quality monitoring station. Additionally, I incorporated two county-level control variables from the U.S. Census Bureau: personal *income* per capita and *population*. In Appendix B, I report the descriptive statistics for all variables in the sample.

5.3 Identification

In this research, I employ two strategies to identify the causal relationships between the key variables. First, I use the difference-in-differences (DiD) method to determine the overall effect of CGRs (i.e., watershed councils) on water quality outcomes. Second, I combine the DiD estimators with causal mediation analysis to identify the mediation effects of participant diversity and the involvement of government and nongovernmental participants.

The DiD method is the most suitable approach for identifying the causal effects of watershed councils on changes in water quality. However, it faces two key challenges. First, watershed councils were established across various watersheds between 1990 and 2011. Figure 2 illustrates the establishment cohorts of watershed councils during the research period. Due to this staggered establishment pattern, the traditional two-way fixed-effects estimator in the DiD framework would produce biased results because of heterogeneity in treatment effects across watershed councils established at different points in time (Goodman-Bacon 2021; Roth et al. 2023). Second, there is no "never-treated" unit in the data, meaning that eventually, every watershed is managed by a watershed council. As a result, the control group in this design consists of the "not-yet-treated" observations.

Figure 2: Staggered establishment of watershed councils



To address both challenges, I use the heterogeneity-robust DiD estimator developed by (Sun and Abraham 2021), known as the "Sunab" estimator. This method accounts for treatment effect heterogeneity in staggered settings by applying flexible cohort-specific weighting to isolate and accurately capture treatment effects, mitigating bias. It also works well for datasets without a never-treated group by leveraging not-yet-treated units as controls. The following formula represents the average treatment effect on the treated (ATT) units. In the equation (2), g denotes the set of relative time periods since treatment, while C denotes the group of not-yet-treated units. The term $Treated^{l}_{i,t} = \mathbb{1}[t - \hat{t}_i = l]$ serves as the relative time indicator, where $\hat{t}_i$ indicates the treatment year for station i (Karaivanov et al. 2022). Under the parallel trend assumption, Sun and Abraham (2021) demonstrate that $\alpha_{i,l}$ is consistent for the station-year-specific treatment effect. consistently estimates the station-year-specific treatment effect. By incorporating interactions between relative time and cohort dummies, this estimator precisely weights each cohort's treatment effect, effectively accounting for heterogeneity in treatment timing.

$$ATT = \sum_{g \in C, l \neq -1} \sum_{i} \alpha_{i,l} \left(\mathbb{1}[i = g] \cdot Treated^{l}_{i,t} \right) \tag{2}$$

Next, I estimate the mediation effects of participant diversity and the involvement of government and nongovernmental participants on water quality outcomes through a structured three-step process (Imai et al. 2011). First, I apply the DiD model, using the "Sunab" estimator, to analyze the overall effect of watershed council establishments on the OWQI. Second, I repeat the DiD estimation but with the mediator as the dependent variable. Third, I include both the treatment variable (watershed council establishment) and the mediator in the regression to predict the OWQI outcome. The following equations show estimate in each step, in which $\mathbf{C}_{i,t}$ is a vector of control variables, and δ_i and θ_t are respectively station and year fixed-effects. $v_{i,t}$, $\epsilon_{i,t}$, and $\eta_{i,t}$ are error terms. Through these steps, I establish the causal effects of watershed councils on both the OWQI and the mediator. Therefore, we can also causally interpret the subsequent mediation analysis (Imai et al. 2011).

$$OWQI_{i,t} = \beta_1 Treated_{i,t} + \beta_{\mathbf{2}} \mathbf{C}_{i,t} + \delta_i + \theta_t + v_{i,t} \tag{3}$$

$$Mediator_{i,t} = \varphi_1 Treated_{i,t} + \varphi_{\mathbf{2}} \mathbf{C}_{i,t} + \delta_i + \theta_t + \epsilon_{i,t} \tag{4}$$

$$OWQI_{i,t} = \gamma_1 Treated_{i,t} + \gamma_2 Mediator_{i,t} + \gamma_{\mathbf{3}} \mathbf{C}_{i,t} + \delta_i + \theta_t + \eta_{i,t} \tag{5}$$

After these steps, I calculate the mediation effect of each mediator. I simulate values of the treatment-to-mediator effect (φ_1) and the mediator-to-outcome effect (γ_2) by drawing random samples from normal distributions centered around their estimated values from Equations (4) and (5), using their standard errors. The indirect effect is equal to: $\varphi_1 \times \gamma_2$. By repeating this process with 1,000 iterations, I generate a bootstrapped distribution of the indirect effect to compute the confidence intervals.

To obtain robust estimates of the quantities of interest, I include the following covariates $\mathbf{C}_{i,t}$ in each equation. First, I control for watershed-related variables, including the average number of goals per project, total costs spent by OWEB on projects within the watershed council's jurisdiction, the average number of OWEB grantee participants per project, and the total number of projects. Second, I incorporate two county-level variables: population and personal income per capita. Third, I include two climate variables: air temperature and precipitation. Additionally, I conduct Moran's I test for annual observations, which indicates spatial autocorrelation in water quality for some years (see Appendix C). Thus, I use the geographical coordinates of the stations to construct a distance-weighted matrix and generate a spatial lag dependent variable for inclusion in the models. Finally, I cluster standard errors at the watershed council level to account for within-group correlation over time.

6 Results

6.1 Watershed Councils and Participant Diversity on Water Quality (H1, H2a)

Model 1 in Table 1 presents the overall effect of watershed councils on OWQI using the "Sunab" estimator. H1 is supported: on average, the establishment of watershed councils improves water quality by 4.28 points. In relative terms, this represents a 6 percent improvement in water quality compared to the baseline mean outcome, indicating a substantial change. Beyond the average effects of watershed councils on water quality, I also illustrate the dynamic treatment effects over time. The left plot in Figure 3 displays the event-study analysis of OWQI, showing that while the effect is not significant in the first 10 years, after 20 years of implementation, watershed councils improve water quality by 10.39 points, equivalent to a 14 percent improvement relative to the baseline.

Table 1: Watershed councils and participant diversity on water quality

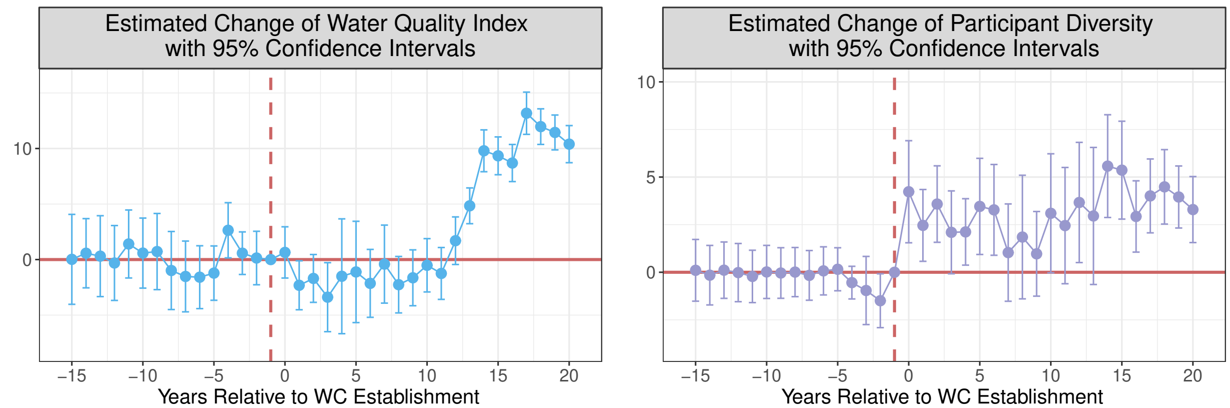
	(1)	(2)	(3)
Dependent variable	OWQI	Diversity	OWQI
Baseline mean	74.507	0.798	74.507
Treated	4.282	3.638	4.114
	(0.727)	(0.689)	(0.730)
	$p = 0.000$	$p = 0.000$	$p = 0.000$
Diversity			0.046
			(0.025)
			$p = 0.065$
Observation	4,735	4,735	4,735
Adj. R^2	0.892	0.829	0.892
Station FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Covariates	Yes	Yes	Yes

Notes: Standard errors are clustered at the watershed council level and are reported in parentheses, and p is the exact p-value. Baseline means are mean values of dependent variables for stations in pre-intervention periods.

Next, I combine the Model 1 to 3 in Table 1 to estimate the mediation effect of participant diversity. Model 2 suggests that the establishment of watershed councils significantly enhance participant diversity, by increasing 3.64 more unique categories of participating organizations in collaborative projects in average. Model 3 shows the direct effect of watershed councils on water quality improvement, by controlling the participant diversity as the mediator. Watershed councils directly contribute to 4.11 points increase of OWQI. Through the bootstrapped mediation analysis (see Figure 4), the H2a is supported: on average, an increase in participant diversity resulting from the establishment of watershed councils leads to a 0.17-point improvement in water quality through the mediation pathway.

Figure 3 also helps us evaluate the parallel trends assumption, which requires that differences in water quality for Model 1 and participant diversity for Model 2 between not-yet-treated and treated stations remain statistically indistinguishable from zero relative to the year before the establishment of watershed councils. The left and right plots in Figure 3 show little evidence of systematic differences in the pre-trend within our models. Thus, the parallel trend assumption is satisfied.

Figure 3: Event-study analysis of the dynamic treatment effects of watershed councils



6.2 Mediation Effects of Government and Nongovernmental Participants (H2b)

In Table 2, I apply the same method described above to evaluate H2b. Specifically, I treat citizen groups, nongovernmental actors, local governments, and state agencies as separate mediators and examine their respective mediation effects on water quality improvement. Notably, Model 1 in Table 1 serves as the common estimate for the total effect of watershed councils on water quality improvement, forming the basis for all mediation analyses presented in Table 2. I analyze the mediation effects of nongovernmental participants in Table 2: Panel A. Model 4 shows that the establishment of watershed councils increases the number of unique citizen groups in collaborative projects by an average of 0.82. The bootstrapped mediation analysis, combining estimates from Models 4 and 5, suggests that this increase in citizen groups leads to a 0.25-point improvement in water quality through the mediation pathway. Similarly, Model 6 demonstrates that the establishment of watershed councils increases the number of unique nongovernmental organizations in collaborative projects by an average of 2.20. The bootstrapped mediation analysis, combining estimates from Models 6 and 7, indicates that this increase in nongovernmental organizations results in a 0.21-point improvement in water quality through the mediation pathway.

Table 2: Government and nongovernmental participants as mediators

Panel A. Nongovernmental participants as the mediators				
	(4)	(5)	(6)	(7)
Dependent variable	Citizen	OWQI	NGA	OWQI
Baseline mean	0.089	74.507	0.484	74.507
Treated	0.816	4.031	2.198	4.073
	(0.195)	(0.719)	(0.381)	(0.720)
	$p = 0.000$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Citizen		0.307		
		(0.102)		
		$p = 0.004$		
NGA				0.095
				(0.036)
				$p = 0.010$
Observation	4,735	4,735	4,735	4,735
Adj. R^2	0.607	0.892	0.775	0.892
Panel B. Government participants as the mediators				
	(8)	(9)	(10)	(11)
Dependent variable	Local	OWQI	State	OWQI
Baseline mean	0.056	74.507	0.170	74.507
Treated	0.377	4.256	0.564	4.300
	(0.151)	(0.731)	(0.115)	(0.739)
	$p = 0.016$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Local		0.068		
		(0.106)		
		$p = 0.523$		
State				-0.032
				(0.100)
				$p = 0.754$
Observation	4,735	4,735	4,735	4,735
Adj. R^2	0.692	0.892	0.783	0.892

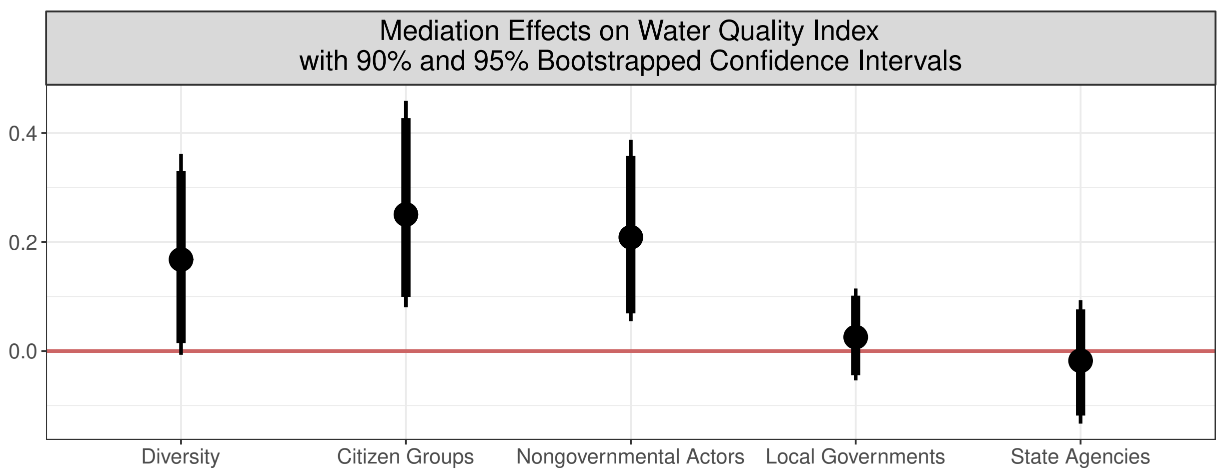
Notes: "Citizens" refers to citizen groups, and "NGA" stands for nongovernmental actors. Standard errors are clustered at the watershed council level and are reported in parentheses, and p is the exact p-value. Baseline means are mean values of dependent variables for stations in pre-intervention periods. Station and state fixed effects as well as covariates are included in all models.

Next, I examine the mediation effects of government participants in Table 2: Panel B. Model 8 indicates that the establishment of watershed councils increases the number of unique local government agencies involved in collaborative projects by an average of 0.38.

However, the bootstrapped mediation analysis, using estimates from Models 8 and 9, suggests that this increase does not lead to an improvement in water quality through the mediation pathway. Similarly, Model 10 shows that the establishment of watershed councils increases the number of unique state agencies in collaborative projects by an average of 0.56, but the bootstrapped mediation analysis, combining estimates from Models 10 and 11, also suggests no improvement in water quality through this pathway.

Figure 4 visualizes the mediation effects of both government and nongovernmental participants, along with their 90 and 95 percent confidence intervals. The results support H2b in the direction that nongovernmental participants contribute stronger mediation effects than government participants in collaborative projects. Comparatively, the inclusion of more citizen groups yields the strongest mediation effect on water quality improvement. To ensure the robustness of these findings, I present event-study plots for each mediator in Appendix D and confirm that the parallel trend assumption holds in each mediator model.

Figure 4: The mediation effects on water quality improvement



6.3 Subgroup Analysis for Environmental Justice (H3)

In this section, I conduct a subgroup analysis on areas with higher and lower percentages of Black populations to examine and compare both the overall effect of watershed council establishments and the mediation effects of participant diversity on water quality improvement. I use the county-level median value of Black population percentage during the pre-treatment periods to separate the sampling stations into "lower Black %" and "higher Black %" groups. This comparison allows me to evaluate whether collaborative governance and participant diversity contribute more significantly to improving environmental conditions for underserved Black communities compared to other groups.

Table 3 compares the overall effects of watershed councils on water quality improvement between areas with higher and lower percentages of Black population. Models 12-14 jointly indicate that the establishment of watershed councils in areas with a higher percentage of Black residents improves water quality by 3.35 points, although the mediation effect of participant diversity is not statistically significant (see Figure 5). Conversely, Models 15-17 show that the establishment of watershed councils in areas with a lower percentage of Black residents does not significantly improve water quality, and the mediation effect of participant diversity is also statistically negligible (see Figure 5).

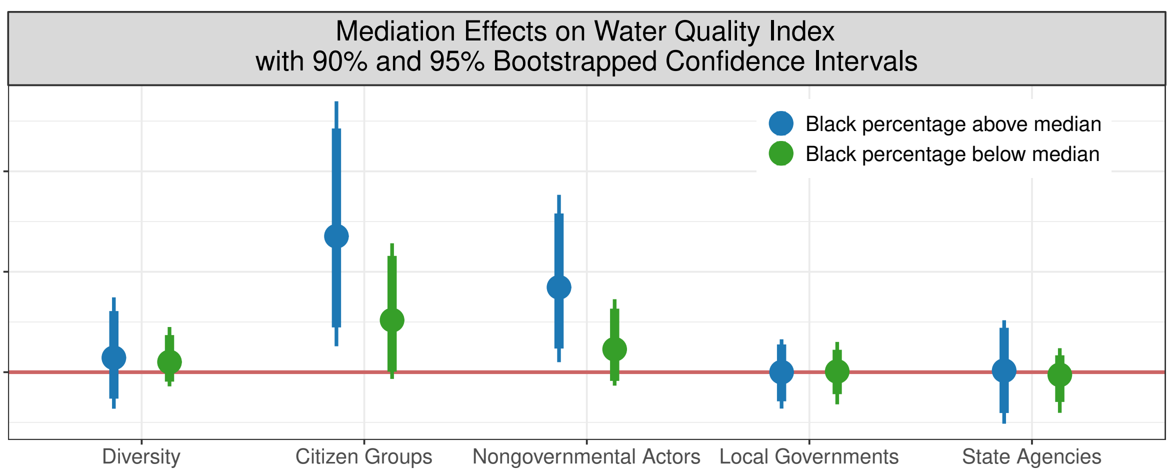
Table 3: Watershed councils and participant diversity on water quality (Black % subgroups)

	Higher Black % group			Lower Black % group		
	(12)	(13)	(14)	(15)	(16)	(17)
Dependent variable	OWQI	Diversity	OWQI	OWQI	Diversity	OWQI
Baseline mean	67.445	0.711	67.445	81.219	0.881	81.219
Treated	3.346	0.299	3.310	-0.329	1.653	-0.354
	(0.711)	(0.538)	(0.707)	(0.569)	(1.267)	(0.556)
	$p = 0.000$	$p = 0.583$	$p = 0.000$	$p = 0.569$	$p = 0.204$	$p = 0.530$
Diversity			0.120			0.015
			(0.043)			(0.016)
			$p = 0.010$			$p = 0.348$
Observation	2,006	2,006	2,006	2,308	2,308	2,308
Adj. R^2	0.926	0.867	0.926	0.712	0.865	0.711
Station FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are clustered at the watershed council level and are reported in parentheses, and p is the exact p-value. Baseline means are mean values of dependent variables for stations in pre-intervention periods.

Additionally, I compare the mediation effects of government and nongovernmental participants for both groups. Figure 5 visualizes the bootstrapped results of these analyses, with detailed regression models reported in Appendix E. In the "higher Black %" group, the inclusion of more citizen groups and nongovernmental actors positively mediates the effect of CGRs on water quality improvement. Conversely, none of these mediators in the "lower Black %" group have a significant impact on water quality improvement. Given that the pre-treatment average OWQI in the "lower Black %" group is 81.20, which is 13.77 points higher than the 67.45 score in the "higher Black %" group, these findings support H3. They indicate that CGRs and the involvement of nongovernmental participants can help reduce disparities in environmental conditions between underserved communities (i.e., those with a higher percentage of Black residents) and more advantaged communities (i.e., those with a lower percentage of Black residents).

Figure 5: Subgroup analysis of the mediation effects on water quality improvement



7 Discussion and Conclusion

This study contributes new evidence on the causal relationship between CGRs, participant diversity, and equitable water quality outcomes. Employing a heterogeneity-robust

DiD estimator, I demonstrate that the establishment of watershed councils in Oregon enhances participant diversity in restoration projects and leads to significant improvements in water quality over time. Importantly, participant diversity emerges as a crucial collaborative mechanism, mediating the positive effects of watershed councils on water quality. Subgroup analysis of areas with differing percentages of Black populations deepens our understanding of CGRs' capacity to address water quality disparities across communities. Furthermore, the findings underscore the critical role of citizen groups and nongovernmental actors as drivers in fostering environmental justice.

This research makes three theoretical contributions to the field of collaborative environmental governance. First, it empirically confirms that CGRs are effective in both improving environmental conditions and addressing the unequal distribution of environmental benefits and burdens, thereby enhancing environmental justice for historically marginalized communities. Following the classic question raised by Ansell and Gash (2008, 4), "Is collaborative governance more effective than adversarial or managerial governance?" the scholarly community has increasingly focused on studying the effectiveness of various collaborative governance models (e.g., Lee and Liu 2024; Liu and Tan 2022; Scott 2015, 2016). This research aligns with this theme by causally identifying the impacts of an institutionalized, long-term collaborative network model—CGR—on cross-boundary environmental improvement. Furthermore, it broadens the theoretical discussion of collaborative outcomes by exploring both effectiveness and equity dimensions (Emerson and Nabatchi 2015b). Existing literature has predominantly connected collaborative governance to procedural justice by improving representation, deliberation, and consensus-forming within collaborative networks (Dobbin and Lubell 2021; Dobbin et al. 2023; Koebele et al. 2024). Building on these foundational studies, I extend the connection between collaborative governance and environmental justice from procedural outputs to environmental outcomes. This connection is supported not by short-term cross-sectional data but by a 40-year longitudinal analysis of Oregon watersheds, which confirms that the positive impacts of collaborative governance on effective and equitable environmental outcomes are sustainable. To the best of my knowledge, this represents the longest research span on collaborative governance, aligning with the research focus on "…the achievement of cross-boundary environmental objectives over an extended period" (Lee and Liu 2024, 344).

The second contribution of this research is the causal linkage between one of the key mechanisms in collaborative networks—participant diversity—and collaborative outcomes in environmental improvement. While the above literature suggests that participant diversity can enhance representation within collaborative networks and potentially lead to better outcomes, questions remain about how this mechanism translates to cross-boundary environmental outcomes and whether this connection is causal or merely associative. These unanswered questions are crucial because, without addressing them, we cannot justify translating diversity and inclusion from normative values into instrumental governance tools. This study creatively combines DiD models with mediation analysis to establish causal links, answering these critical questions. I demonstrate not only the positive mediating effect of participant diversity between CGRs and their outcomes but also highlight that the inclusion of citizen groups and nongovernmental actors is particularly influential in driving environmental improvements, especially in areas with higher percentages of underserved Black communities. This study is the first to confirm the mediating role of participant diversity and the inclusion of nongovernmental participants in collaborative governance, reflecting recent developments in citizen engagement and nonprofit oversight in governing cross-boundary natural resources (Ambrose and Siddiki 2024; Anderson et al. 2019; Lee and Liu 2024). Effective environmental management cannot rely solely on top-down "command-and-control" regulations; motivating bottom-up participation to activate collaborative mechanisms is essential for successful policy implementation (Jager et al. 2020; Tang et al. 2020).

The unique data structure of Oregon watersheds enables this research to make the third contribution by bridging collaboration formation and collaborative outcomes. One of the challenges in studying collaborative and network governance is that participation data are typically available only after collaborative networks have been established or completed (Siciliano et al. 2021). As a result, it is often nearly impossible to observe changes in participant compositions and collaborative activities before and after the establishment of CGRs. However, the distinctive feature of Oregon watershed data, where many restoration projects began before watershed councils were established in their areas, provides a unique opportunity to assess the impact of watershed councils on participant compositions. The causal mediation analysis further connects collaboration formation (i.e., watershed council establishments) and collaborative outcomes (i.e., water quality improvement) through the solid mediating mechanism of participant diversity enhancement. As argued earlier in this article, the two streams of collaborative governance—who join in collaborations and whether they succeed—should be investigated together. This integrated approach helps deepen our understanding of how to organize collaborative efforts and addresses the critical question of how collaborative governance is encouraged and supported as a generic policy instrument (Ansell and Gash 2018).

Beyond its theoretical contributions, this research also offers practical insights for practitioners designing collaborative governance. Policymakers and public managers often stereotype citizen participation as a source of gridlock in the decision-making process, potentially delaying policy implementation (O'Leary and Amsler 2007). Even worse, some view citizens as lacking the necessary knowledge to offer constructive suggestions, or at best, regard their participation as merely symbolic (Moynihan 2003). This mistrust among public officials can lower their willingness to invite meaningful citizen involvement (Yang 2005). However, the results of this study demonstrate that citizen participation is fundamentally important for successful governance, even within complex, cross-boundary, and cross-sectoral collaborations over the long term. Therefore, public managers should strive to create an institutional environment that facilitates meaningful citizen participation and leverages the strengths of nongovernmental actors in contributing local knowledge, particularly to improve environmental conditions for underserved communities.

Finally, there are two limitations in this research that warrant attention for future studies. First, this study tests the hypotheses in only one policy area within a single state. Future research in the field of collaborative governance should broaden its focus to evaluate the findings of this study in more generalizable contexts (Ansell and Gash 2008; Yoon et al. 2022). Second, while this study establishes a link between participant diversity, CGRs, and their outcomes, it does not explore the processes through which participant diversity contributes to these outcomes. While this study establishes a sophisticated two-step causal link—from the treatment variable to the mediator and from the mediator to the outcome—it is necessary to further explore the additional links from participant diversity to action outputs, and from these outputs to outcomes. Connecting these variables and ensuring causal relationships at every step will advance the theory of collaborative governance. By addressing these gaps, future research can offer more comprehensive insights into designing equitable and effective socio-ecological systems.

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Appendix A Participant Coding Scheme

The following categorization table is officially provided by OWEB. I coded the variable "participant diversity" by counting unique participants based on participant type for each year within a watershed council's jurisdiction. If an organization participated in multiple projects within a watershed, it was counted only once. Using the same coding method, I also counted unique participants categorized as "nongovernmental actors", "citizen groups", "local government agencies", and "state agencies".

Participant Type	**Sector**
Citizen conservation group	Citizen Group
Consultant	Nongovernmental Actor
Contractor	Nongovernmental Actor
Educational institution	Nongovernmental Actor
Extension service	Nongovernmental Actor
Jobs program	Nongovernmental Actor
Leaseholder	Nongovernmental Actor
Local business	Nongovernmental Actor
Non-profit organization	Nongovernmental Actor
Private forest industrial landowner	Nongovernmental Actor
Private non-industrial landowner	Nongovernmental Actor
Research group	Nongovernmental Actor
Small woodlands association	Nongovernmental Actor
Tribal	Nongovernmental Actor
Utilities	Nongovernmental Actor
Volunteer	Nongovernmental Actor
Watershed council	Nongovernmental Actor
City government	Local government agency
County government	Local government agency
Local agency	Local government agency
Soil & water conservation district	Local government agency
State agency	State agency

Appendix B Descriptive Statistics

Table B.1: Summary statistics: Full sample

Variable	Mean	Min	Max
OWQI	78.89	16.68	97.65
Participant diversity	9.67	0.00	50.00
N of nongovernmental actors	5.27	0.00	38.00
N of citizen groups	1.18	0.00	16.00
N of state agencies	1.73	0.00	9.00
N of local governments	1.40	0.00	12.00
N of goals per project	2.79	0.00	20.00
Total costs (in $1000)	714.85	0.00	39603.01
N of OWEB grantee per project	0.18	0.00	2.00
N-projects	11.18	0.00	146.00
Black percentage	0.01	0.00	0.07
Income per capita	28630.71	7977.00	71537.00
Population	117237.28	1336.00	815871.00
Precipitation (mm)	1054.24	108.02	4039.73
Air temperature (℃)	10.94	4.96	14.75

Table B.2: Summary statistics: Higher Black percentage subgroup

Variable	Mean	Min	Max
OWQI	71.49	16.68	96.37
Participant diversity	7.29	0.00	48.00
N of nongovernmental actors	3.88	0.00	33.00
N of citizen groups	0.85	0.00	9.00
N of state agencies	1.24	0.00	6.00
N of local governments	1.22	0.00	12.00
N of goals per project	2.47	0.00	20.00
Total costs (in $1000)	467.27	0.00	24323.99
N of OWEB grantee per project	0.20	0.00	2.00
N-projects	7.06	0.00	86.00
Black percentage	0.01	0.00	0.07
Income per capita	28726.89	8562.00	71537.00
Population	184125.83	16069.00	815871.00
Precipitation (mm)	942.18	118.95	3158.79
Air temperature (℃)	10.93	5.84	14.02

Table B.3: Summary statistics: Lower Black percentage subgroup

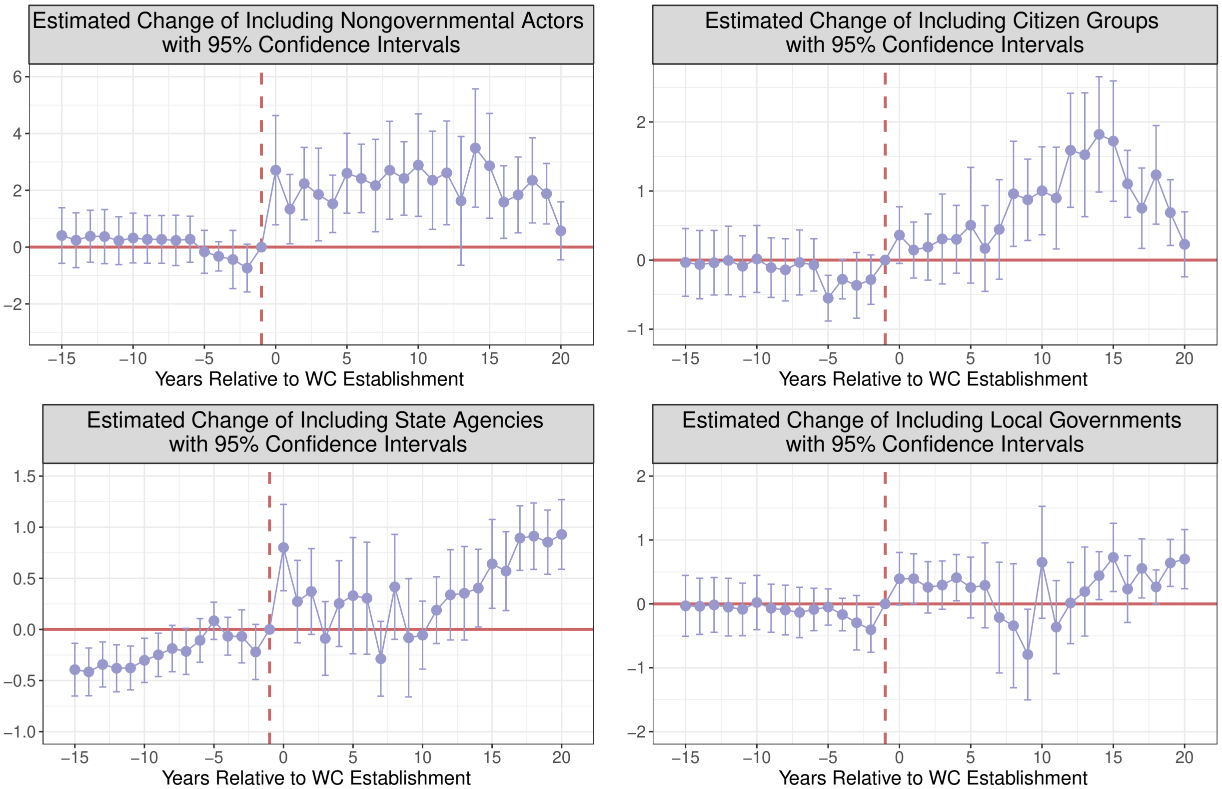
Variable	Mean	Min	Max
OWQI	84.86	22.86	96.96
Participant diversity	11.45	0.00	50.00
N of nongovernmental actors	6.38	0.00	38.00
N of citizen groups	1.49	0.00	16.00
N of state agencies	2.05	0.00	9.00
N of local governments	1.51	0.00	11.00
N of goals per project	2.89	0.00	19.33
Total costs (in $1000)	933.47	0.00	39603.01
N of OWEB grantee per project	0.15	0.00	2.00
N-projects	14.93	0.00	146.00
Black percentage	0.00	0.00	0.01
Income per capita	26832.18	7977.00	67743.00
Population	64000.06	1336.00	223734.00
Precipitation (mm)	1161.13	108.02	4039.73
Air temperature (℃)	10.99	4.96	14.75

Appendix C Moran's I Test for Spatial Autocorrelation

Moran test results for the years 1981-1989 are omitted here due to substantial issues with missing data. However, I still calculated the spatial lag OWQI for each unit observed during these years.

Year	Moran's I	Expected I	Z score	P-Value
1990	0.13	-0.07	1.47	0.07
1991	-0.08	-0.06	-0.20	0.58
1992	0.10	-0.06	1.35	0.09
1993	0.12	-0.06	1.37	0.09
1994	0.06	-0.06	0.95	0.17
1995	0.19	-0.05	2.14	0.02
1996	0.15	-0.05	1.87	0.03
1997	0.13	-0.05	1.88	0.03
1998	0.16	-0.05	2.04	0.02
1999	0.08	-0.05	1.15	0.12
2000	0.09	-0.05	1.62	0.05
2001	0.15	-0.05	1.98	0.02
2002	0.14	-0.05	1.81	0.04
2003	0.14	-0.05	1.92	0.03
2004	0.18	-0.05	2.48	0.01
2005	0.11	-0.05	1.48	0.07
2006	0.15	-0.05	1.82	0.03
2007	0.26	-0.05	3.22	0.00
2008	0.11	-0.05	1.52	0.06
2009	-0.00	-0.05	0.49	0.31
2010	0.24	-0.05	3.04	0.00
2011	-0.01	-0.04	0.54	0.30
2012	0.05	-0.04	0.96	0.17
2013	-0.04	-0.04	-0.03	0.51
2014	-0.00	-0.04	0.42	0.34
2015	-0.08	-0.04	-0.50	0.69
2016	0.00	-0.04	0.41	0.34
2017	0.02	-0.04	0.63	0.26
2018	-0.04	-0.04	-0.09	0.53
2019	-0.06	-0.04	-0.21	0.58
2020	0.07	-0.04	1.21	0.11
2021	0.02	-0.04	0.75	0.23

Appendix D Event-study Analysis of Different Mediators



Appendix E Regression Models for Subgroup Analysis

Table E.1: Higher Black population % group

Panel A. Nongovernmental participants as the mediators				
	(E1)	(E2)	(E3)	(E4)
Dependent variable	Citizen	OWQI	NGA	OWQI
Baseline mean	0.060	67.445	0.399	67.445
Treated	0.388	3.007	0.835	3.134
	(0.158)	(0.680)	(0.370)	(0.697)
	$p = 0.020$	$p = 0.000$	$p = 0.032$	$p = 0.000$
Citizen		0.872		
		(0.199)		
		$p = 0.000$		
NGA				0.253
				(0.062)
				$p = 0.000$
Observation	2,006	2,006	2,006	2,006
Adj. R^2	0.665	0.927	0.806	0.927
Panel B. Government participants as the mediators				
	(E5)	(E6)	(E7)	(E8)
Dependent variable	Local	OWQI	State	OWQI
Baseline mean	0.055	67.445	0.188	67.445
Treated	0.301	3.346	-0.310	3.342
	(0.129)	(0.723)	(0.079)	(0.705)
	$p = 0.027$	$p = 0.000$	$p = 0.000$	$p = 0.000$
Local		0.000		
		(0.130)		
		$p = 0.999$		
State				-0.012
				(0.198)
				$p = 0.950$
Observation	2,006	2,006	2,006	2,006
Adj. R^2	0.816	0.926	0.802	0.926

Notes: "Citizens" refers to citizen groups, and "NGA" stands for nongovernmental actors. Standard errors are clustered at the watershed council level and are reported in parentheses, and p is the exact p-value. Baseline means are mean values of dependent variables for stations in pre-intervention periods. Station and state fixed effects as well as covariates are included in all models.

Table E.2: Lower Black population % group

Panel A. Nongovernmental participants as the mediators				
	(E9)	(E10)	(E11)	(E12)
Dependent variable	Citizen	OWQI	NGA	OWQI
Baseline mean	0.117	81.219	0.564	81.219
Treated	1.005	-0.458	1.600	-0.386
	(0.371)	(0.516)	(0.790)	(0.531)
	$p = 0.012$	$p = 0.383$	$p = 0.054$	$p = 0.474$
Citizen		0.129		
		(0.074)		
		$p = 0.096$		
NGA				0.036
				(0.029)
				$p = 0.226$
Observation	2,308	2,308	2,308	2,308
Adj. R^2	0.684	0.712	0.827	0.711
Panel B. Government participants as the mediators				
	(E13)	(E14)	(E15)	(E16)
Dependent variable	Local	OWQI	State	OWQI
Baseline mean	0.057	81.219	0.154	81.219
Treated	0.027	-0.331	0.181	-0.322
	(0.298)	(0.568)	(0.224)	(0.574)
	$p = 0.928$	$p = 0.566$	$p = 0.427$	$p = 0.580$
Local		0.066		
		(0.096)		
		$p = 0.501$		
State				-0.037
				(0.125)
				$p = 0.771$
Observation	2,308	2,308	2,308	2,308
Adj. R^2	0.692	0.711	0.842	0.711

Notes: "Citizens" refers to citizen groups, and "NGA" stands for nongovernmental actors. Standard errors are clustered at the watershed council level and are reported in parentheses, and p is the exact p-value. Baseline means are mean values of dependent variables for stations in pre-intervention periods. Station and state fixed effects as well as covariates are included in all models.