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Collaborative Management of Migratory Waterfowl along the Pacific Flyway

By

AVIV KARASOV-OLSON

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

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OFFICE OF GRADUATE STUDIES

of the

UNIVERSITY OF CALIFORNIA, DAVIS

Approved:

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ABSTRACT

The movement of waterfowl across the Pacific Flyway creates ecological interdependencies across the entire landscape. However, management of waterfowl is fragmented between individuals and organizations operating at various scales, in different sectors, and within multiple jurisdictions creating a need for cross-boundary collaboration. The goals with this body of work are to (1) elucidate how collaboration leads to successful management of waterfowl, (2) identify what motivates and presents barriers to collaboration, and (3) explore organization and system levels drivers of collaboration nested within regional Migratory Bird Joint Venture partnerships.

I used a mixed methods approach to address these goals using qualitative and quantitative methods for data collection and analysis. I conducted semi-structured interviews with 32 key informants. Interview questions were designed to first develop a robust understanding of various roles in management and the goals and issues in regions across the flyway. Then, several questions focused explicitly on collaboration, while others addressed topics such as successful management and use of science. Semi-structured interviews were followed by web-based surveys of 645 participants identified through purposive and snowball sampling resulting in 220 responses (34% response rate). The survey instrument was designed to (1) collect key professional affiliation attributes about respondents, (2) identify professional connections and categorize those relationships, and (3) evaluate involvement in and perceptions of Migratory Bird Joint Ventures (Joint Ventures hereafter). Joint Ventures are the predominant formal partnerships designed to advance regional habitat management for waterfowl. Identification of professional connections was accomplished using a free recall name generator approach. Relationships were categorized by activities (sharing resources, implementing projects,

collaborative decision-making) and management focus (population, habitat, human dimensions). Each chapter pulls from these extensive datasets to explore different dimensions of collaboration.

In chapter one, I investigate how waterfowl management practitioners define success and the ways in which collaboration contributes to success by analyzing interviews using grounded theory and thematic analysis. A recurrent theme is the multi-dimensionality of waterfowl management. Practitioners defined waterfowl management in multiple ways including a focus on population and harvest management, habitat management, and human dimensions. Management goals, actions, and metrics of success mirror these three elements. Interview participants identified key ways in which collaboration contributes to successful management, dependent on each of these elements. Collaboration contributes to population management by facilitating whole lifecycle or whole flyway level thinking. Interorganizational relationships can increase capacity for habitat management work, which is particularly resource intensive. Success defined by public and partner satisfaction is enhanced by collaboration because engaging partners broadly can increase buy-in and support for management actions. There was broad agreement that Joint Ventures are successful at regional management, but slightly less successful at advancing flyway level management. Additionally, by analyzing survey data on Joint Ventures with ordinal logistic regression, I quantify how Joint Venture involvement leads to a significant increase in perceived success.

Identifying key barriers to collaboration within this system can help practitioners find ways to strengthen existing partnerships and to engage new partners as needed. In chapter two, I explore the specific roles of partners in different sectors, and their motivations for and barriers to collaboration. Specifically, funding was identified as both a motivation for and the primary barrier to collaboration. Partnerships were formed to increase overall funding by leveraging

economies of scale. However, funding restrictions, such as the inability to spend money on developing or maintaining collaboration and match requirements present key barriers. There are also siloes within waterfowl management that present barriers, such as that between population and habitat management, and competing approaches and goals within the broader waterfowl management enterprise. These barriers are present across many, if not all, sectors, and some organizations are more well-suited to overcome these challenges. This qualitative analysis does not present novel collaborative governance challenges. Rather, I present issues specific to waterfowl management across the Pacific Flyway in order to recommend specific ways to improve collaboration.

Within the multiscale management of migratory waterfowl, interorganizational relationships are nested within larger regional partnerships. In chapter three, I create a directed management network between organizations to examine cross-sector and regional patterns of collaboration. Engagement within larger collaborative forums is theorized to increase individual collaborative relationships. Furthermore, when management networks operate within complex social-ecological systems across large landscapes, we expect collaboration within such forums to align with ecological patterns. I analyze the waterfowl management network using valued exponential random graph models based on types of collaborative activities in which organizations engage. I find that collaboration within waterfowl management is particularly driven by state agencies and organizations operating at a regional scale. Involvement in Joint Ventures significantly increases the likelihood that any organization will collaborate in the broader management network. There are also significant differences between collaboration within each Joint Venture region. Organizations working with the Central Valley are significantly more likely to engage in collaboration, which may be explained by alignment with ecological patterns, the high

concentration of wintering waterfowl, and the need for active, on-the-ground habitat management. However, there are other institutional dynamics at play. Larger Joint Venture regions that retain strong waterfowl priorities (e.g., Intermountain West) have more cross-boundary collaboration. The more recently established California Central Coast Joint Venture region has the highest intensity of collaborative ties, driven by regional actors with pre-existing relationships. This work reveals a more complex picture of social-ecological alignment, necessitating future research of nuanced ecological patterns and regional differences in management.

Together, these chapters further our understanding of the role of collaboration within a complex social-ecological system. Understanding the ways in which collaboration contributes to successful management can provide insight into pursuing more targeted collaborative efforts. Collaboration can be costly but is critical for large scale natural resource management. This work highlights the need to create clear objectives for collaborative partnerships because the benefits of collaboration are dependent on how we measure success. Additionally, results from these studies demonstrate the importance of Migratory Bird Joint Ventures. The ecological, institutional, and social dynamics within each region create different collaborative dynamics. Nonetheless, these formal regional partnerships present excellent opportunities to advance flyway level management of waterfowl. Waterfowl management presents a rich, multi-dimensional system in which to study collaborative dynamics, with countless additional avenues for research focused on cross-scale collaboration and social-ecological networks. Building upon existing and successful collaborative endeavors, I hope this work provides insight to the waterfowl management community that contributes to more effective partnerships moving forward.

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CHAPTER 1

LINKING COLLABORATION AND SUCCESS IN A COMPLEX SOCIAL-ECOLOGICAL SYSTEM

1.1 Introduction

Management of mobile species, particularly migratory species, requires a broad landscape approach that addresses the conservation of all elements important to the species life history (Kirby et al. 2008, Runge et al. 2014). For migratory species, their populations and habitats often cross jurisdictional boundaries and effective management requires collaborative governance and coordination across those boundaries (Boere and Piersma 2012, Runge et al. 2017). This type of large-scale conservation requires a multi-scale perspective, implementing conservation actions at the local level while also pursuing regional goals (Lindenmayer et al. 2008).

Large-scale conservation efforts are often driven by broad plans that outline shared goals and objectives and propose general approaches to achieving those goals (Pressey and Bottrill 2009). However, specific strategies may vary based on interests and management issues at the local level (Cash et al. 2006). Large scale conservation and management also involves many partners (e.g., public agencies, nongovernmental organizations, private entities, local landowners). These partners operate at different scales depending on the scope of their authority, interests, and influence. These differences in scale, geographies, and missions, while sharing overarching objectives create a need for cross-organizational coordination and communication and cross-boundary collaboration (Bergmann and Bliss 2004) that has been notoriously difficult to maintain (Agranoff 2012).

Collaboration in natural resource management can occur along a gradient of informal collaborative partnerships to formal governance regimes (Margerum 2011, Emerson et al. 2012), target multiple steps in the management process from planning and decision-making to

implementation (Margerum 2011), and operate at multiple levels from on the ground, operational management to overarching policy development (Margerum 2008). There is a robust literature describing the many benefits of a collaborative approach to environmental governance. Collaboration contributes to an increase in trust (Coleman and Stern 2018), enhanced cooperation (Hamm et al. 2016), legitimacy of management actions (Trachtenberg and Focht 2005, Cosens and Williams 2012), an increase in public support, and effective conflict resolution (Frame et al. 2004). Within natural resource management specifically, where funding is chronically limited, collaboration can be leveraged to achieve an economies of scale and increase capacity (Scott and Thomas 2017).

A successful collaborative process is key to achieving those benefits. Commitment, trust, and a shared understanding (Ansell and Gash 2008, Bothwell 2019), as well and an environment that fosters accountability, data sharing and learning (Koontz 2014, Plummer et al. 2017, Scott and Boyd 2023) are all needed for successful collaboration. Clear leadership (Ansell and Gash 2008), inclusivity (Rice and McCool 2022), and pre-existing relationships (Scott and Boyd 2023) lay the foundation for a successful process.

Successful collaboration can result in development of intermediate outputs as well as social and ecological outcomes (Koontz and Thomas 2006, Mandarano 2008, Emerson and Nabatchi 2015). However, as much as we know about establishing good collaborative processes, it is challenging to link collaboration to successful outcomes (Koontz and Thomas 2006). An emerging body of empirical research has evaluated the causal link between environmental outcomes (e.g., water and air quality) and the composition (Baudoin and Gittins 2021, Chen et al. 2023), funding (Scott 2016a), and process (Scott 2015, Ulibarri 2015) of collaboration, with one study linking an intermediate outcome (quota fulfilment) with attributes of collaboration in a

wildlife management context (Dressel et al. 2020). However, the impact of collaboration varies for different metrics of an environmental outcome (Scott 2015, Baudoin and Gittins 2021). Therefore, when it comes to evaluating the impact of collaborative effort in natural resource management with complex, multidimensional outcomes (Agrawal and Chhatre 2011), it is critical to specifically identify the elements by which success is measured.

Here, we address the link between collaboration and conservation outcomes and how success is defined within the management of migratory waterfowl within the Pacific Flyway. Migratory waterfowl management is complex, encompassing the management of multiple species with different life history needs and covering a broad geographic scope. Additionally, migratory waterfowl management is designed to be collaborative, particularly through the Migratory Bird Joint Venture management system. In 1986, the United States and Canada created the North American Waterfowl Management Plan (NAWMP); Mexico later signed on in 1994. This plan established the Migratory Bird Joint Ventures (Joint Ventures, hereafter), where North America is subdivided into ecologically-relevant regions (U.S. Department of the Interior et al. 2012). These joint venture partnerships (Cohn 2005, National Joint Venture Communications Education and Outreach Team 2013, Giocomo et al. 2015), are comprised of government agencies, non-governmental organizations, private entities, and individuals who work together to advance habitat management for waterfowl.

Due to the numerous benefits of collaboration identified above, we expect that collaboration within this system positively impacts conservation and management outcomes and contributes to, if not drives, successful management. In this paper, we specifically ask (1) how is success defined by practitioners within waterfowl management, and (2) how does collaboration within the waterfowl management community contribute to successful management? Our aim is not to

measure success or particular management outcomes directly, but rather understand how practitioners value collaboration and view the success of the collaborations they have. By exploring these questions, we will be better able to understand the value of collaboration in complex systems. Additionally, by developing a more nuanced understanding of what emerges from collaboration, managers may be able better evaluate the impact of the partnerships they have and develop more targeted and effective partnerships moving forward.

1.2 Methods

1.2.1 Study system

Millions of waterfowl migrate thousands of miles across the Pacific Flyway. The Pacific Flyway crosses seven Joint Ventures: Sonoran, Central Valley, San Francisco Bay, Pacific Birds Habitat, Intermountain West, Canadian Intermountain, and the recently established California Central Coast (Figure 1.1). These species cross a diversity of habitats with shifting management regimes, generally moving seasonally between rain- and snow- fed non-irrigated habitats in the north to often highly engineered systems with intensive water management and habitat manipulation for over-wintering birds in the south (e.g., the California Central Valley). Some management decisions are focused on individual managed wetlands and made by individuals operating at the local level (e.g., promoting growth of particular vegetation for waterfowl forage on a single refuge). Regional decisions may be focused on providing ample habitat for a particular period in a species' migratory journey. For example, the Central Valley Joint Venture identifies acreage goals for various habitat types (e.g., managed seasonal wetlands, managed semi-permanent wetlands, winter flooded rice) across the region, for subregions, and for different groups of species (e.g., non-breeding and breeding waterfowl) (CVJV 2020). The Intermountain

West Joint Venture identifies overall acreage goals for key regions, in addition to objectives for the number of birds of different species that should be using the regions at different times (IWJV 2013). Flyway level decisions typically focus on waterfowl populations where the U.S. Fish and Wildlife Service, in consultation with the Pacific Flyway Council, sets baseline harvest regulations, though individual states can set more restrictive regulations.

Various agencies and organizations are involved in making both habitat and population management decisions. Federal agencies are involved at multiple levels (e.g., USFWS National Wildlife Refuges are managed locally and the USFWS Migratory Birds Program operates at regional and national levels). The Pacific Flyway crosses 16 states, provinces, and territories, involving numerous state agencies in management decisions. Non-governmental organizations are frequently identified as critical partners, be it through large national NGOs or local partnerships. Private landowners also play a role in management; for example, approximately 66% of managed wetlands used by waterfowl wintering in the Central Valley are privately owned (CVJV 2020).

The current North American Waterfowl Management Plan establishes three continent-wide goals: (1) abundant and resilient waterfowl populations, (2) wetlands and related habitats sufficient to sustain waterfowl populations, and (3) growing numbers of waterfowl hunters and others to support conservation (U.S. Department of the Interior et al. 2018). Partnerships between waterfowl management entities form different modes of governance (Provan and Kenis 2008), depending on which goals are being addressed. The Pacific Flyway Council, comprised of representatives from each federal agency responsible for migratory bird management and participating state and provincial agencies, addresses decisions that contribute to population objectives through policy and harvest management, while the federal government is ultimately

responsible for migratory bird management and harvest regulations. Joint Ventures develop implementation plans that establish region-specific habitat objectives, which are addressed through several avenues in a more decentralized, networked approach. Currently, there is not a single entity or group responsible for defining and addressing regional objectives related to human dimensions goals identified in the 2012 NAWMP (U.S. Department of the Interior et al., 2012).

1.2.2 Data collection

The lead author interviewed 32 practitioners in waterfowl management in order to better understand how they viewed their role in waterfowl management, their relationships to others working in waterfowl management, and the value of the collaborations they have. A qualitative approach to the question of the role of collaboration provides a more nuanced exploration of the views held by practitioners than could be achieved through studying partnership lists, agency mission statements, and reports. Management challenges, objectives, and strategies vary across the Pacific Flyway and interviews with individuals in sectors and locations across this area can reveal how their unique perspectives and environments shape those elements of management.

We used purposeful sampling (i.e., deliberate and non-random sampling) and stratified interview targets across three dimensions: geography (Joint Venture), employer (federal, state, local, NGO), and management focus (habitat, population). We targeted key informants heavily involved in regional management and science. Heavy involvement was determined by repeated mentions in Joint Venture, federal, and state planning documents as well as primary authorship of key management plans. This method of identification was particularly useful for individuals working in federal and state agencies and NGOs operating at a regional level. Other interview participants were included because of their role in management at the local level of individual

protected areas in important migratory areas (e.g., Southern Oregon Northeastern California, IWJV 2013; Central Valley, CVJV 2020). Additionally, several interview participants, particularly those in local agencies and locally operating organizations not based in the California Central Valley, were identified through snowball sampling during the first several interviews. As a result of this selection process, the lead author contacted 34 individuals through email. Twenty-eight individuals agreed to participate, five did not respond, and one declined. Four interview participants invited a colleague who could provide a different perspective to join the interview. Ultimately, the lead author conducted 28 semi-structured interviews with 32 individuals between June 2021 and June 2022 (Figure 1.1, Table 1.1). This is consistent with the number of interviews used in many grounded theory studies to achieve theoretical saturation (Thomson 2011).

Semi-structured interviews were guided by 12 open-ended questions (Appendix A, Table A1.1). Questions were designed to first develop a robust understanding of different roles in waterfowl management and the management goals and issues in different regions across the flyway. Then, several questions focused more explicitly on collaboration and partnerships, while others addressed topics surrounding successful management and science. All interviews were conducted over Zoom. Interviews ranged from 37 minutes to 2 hours and 36 minutes and were conducted and transcribed by the lead author.

Investigation of the role of Joint Ventures as a collaborative forum was also supported by a web-based survey. We designed the survey instrument to (1) collect key professional affiliation attributes about respondents (e.g., years in the profession, management focus), (2) identify professional connections and categorize those relationships, and (3) evaluate respondents' involvement in and perceptions of the Joint Venture system (Appendix 1, Table A1.2). We used

the same purposeful sampling strategy as with the interview participants to develop an initial survey list and snowball sampling based on professional connections identified in the survey to expand the survey recipient list. Rather than just targeting key informants, as with the interviews, our goal was to reach all relevant organizations and agencies, including multiple programs within a single agency, involved in waterfowl management along the Pacific Flyway. The survey was distributed online through Qualtrics initially to 252 individuals. Two subsequent snowball rounds included an additional 393 individuals. Our overall survey response rate was 34.3%, producing 221 survey responses, representing 165 organization. There was considerable variation by actor type (e.g., high response rates from state agencies, low responses from tribes) and modest regional variation (Appendix 2).

1.2.3 Data analysis

To understand the link between the collaborative process and successful management, we used a modified grounded theory approach for qualitative analysis, which relies on inductive coding of interview transcripts (Glaser and Strauss 1967, Strauss and Corbin 1990, Fendt and Sachs 2008, Saldana 2009). Broad categories were determined deductively based on focus of the research (e.g., collaboration, management, success), while subthemes were identified deductively through open and axial coding. The first author conducted all line-by-line coding in consultation with all authors. We began with open coding to generate a list of first-order categories to identify concepts and ideas that emerged across all interviews. From these, we proceeded with axial coding to identify second- and third- order themes that group the first-order codes, and highlight ideas of greater importance, prevalence, or notable variation in the interviews. Within "collaboration", sub-codes were dedicated to the process and outcomes of collaboration. Within "management", codes were grouped by dimensions of implementing management such as goals,

definitions, actions, and metrics of success. Within these sub-codes, first-order codes were also grouped by themes that were primarily “ecological” or “social” in nature. We use the term participants when describing results from qualitative analysis of semi-structured interviews.

This qualitative analysis was supplemented with quantitative analysis of Likert-type survey questions focused on Joint Ventures. We used ordinal logistic regression (Agresti 2010) to analyze what factors, if any predict different levels of Joint Venture involvement and perceived success (Table 1.2). In addition to examining model coefficients, we calculate the odds ratios by exponentiating each coefficient. An odds ratio represents the multiplicative effect of an increase or decrease in the model parameter on a one step increase in the response variable (i.e., level of agreement that the Joint Ventures are successful). Goodness of fit for ordinal logistic regression models was evaluated using the Lipsitz test, where the null hypothesis is a well fit model and low p-values indicate problematic fit (Fagerland and Hosmer 2017). Differences in perceived success were analyzed using Cliff’s delta (Cliff 1993) as it was designed for ordinal data without assumptions about the underlying distribution. When explaining quantitative results based on survey data, we use the term respondents or survey respondents to identify the data source.

1.3 Results

Participants defined ‘waterfowl management’ differently from one another. When asked explicitly how they would define ‘waterfowl management’, some participants presented a narrow definition focused specifically on management of waterfowl populations through harvest management (e.g., setting bag limits), while others defined ‘waterfowl management’ as managing habitat for waterfowl. A few participants described a broader field that encompasses population management, wetland management and conservation, and human dimensions,

mirroring the pillars of waterfowl management established in the 2012 NAWMP revision (U.S. Department of the Interior et al. 2012). While these broader topics all impact waterfowl, many participants acknowledged that management is still quite siloed:

> "*Each one of those has this different circle of people that are being corralled into the conversation on maybe more frequent basis. Inevitably, eventually it might all overlap, but in the, in sort of the moment… I'm very rarely talking to those same people about [different] issues.*"

For most participants, there was not a clear correlation between their view of 'waterfowl management', the sector in which they work (e.g., federal agencies vs. non-governmental organizations), and their perceived role in waterfowl management broadly. For example, a participant who stated that 'waterfowl management' was strictly population management acknowledged that their responsibilities, which focused on habitat management, still contributed to waterfowl management. Additionally, many participants who defined 'waterfowl management' in the context of habitat management acknowledged that their initial reaction, often influenced by early hunting experiences or training in school, was to define 'waterfowl management' solely in the context of population management and harvest regulations. In contrast, geographic location and ecological setting were clearly related to definitions of 'waterfowl management'. In southern portions of the Pacific Flyway, and particularly in arid regions, 'waterfowl management' was defined as centering around managing habitat for waterfowl. In northern portions of the flyway, where natural wetlands are more abundant, 'waterfowl management' became focused on population management and human dimensions. One participant who worked in different regions of flyway throughout their career, explicitly described how their definition of 'waterfowl management' expanded as they moved. While these differences in interpreting terminology did not seem to inhibit question clarity or discussions during the interviews, they certainly have implications for understanding the role of collaboration in waterfowl management

and how practitioners view their role and those of their partners in collaboration. Therefore, for the purpose of this paper, we use a broader definition of 'waterfowl management' unless explicitly stated otherwise.

1.3.1 Definitions of success

In order to understand the value of collaboration within this system, it is important to first describe what participants think constitutes successful waterfowl management. Nine participants stated that success was directly related to waterfowl populations (e.g., having healthy waterfowl populations, could be measured by stable or increasing population numbers, defined as "*no net loss*" in populations or species). Seven (21.9%) participants defined success in terms of habitat metrics (e.g., "*keeping wetlands wet*"; acres protected, restored, or acquired). Six (18.8%) participants discussed success in the context of human dimension goals (e.g., providing hunting opportunities/hunter satisfaction, public support for conservation, impactful education). These varied definitions of success mirror the goals outlined in the 2012 North American Waterfowl Management Plan "connecting people, waterfowl, and wetlands" and subsequent 2018 Update (U.S. Department of the Interior et al. 2012, 2018), as well as the variation present in participant definitions of waterfowl management. However, the waterfowl management definitions presented by interview participants did not always perfectly align with their respective definitions of success. Interestingly, some interview participants described a fourth determinant of success that falls outside of the traditional NAWMP goals. Twelve (37.5%) participants described success in relation to partnership and collaboration, stating that success is when partners are satisfied with management outcomes, flyway-level collaboration occurs, or there is an increased desire to engage in collaboration.

There was an overarching theme that success in waterfowl management is difficult to determine. Indeed, several participants explicitly acknowledged that asking them to define success was a "*tough question*" and did not ultimately provide response. The categories of success described above are not mutually exclusive, and several participants defined success in multiple ways. Additionally, some participants discussed that even with a clear idea of what success should be, success can be difficult to measure, with one participant sharing "*I think we need to rethink how we measure success or get better at measuring the things that we're saying we're trying to do."*

1.3.2 Links between collaboration and success

An emergent theme from interview participants is that collaboration can lead to successful management of migratory waterfowl and is an important aspect of waterfowl management in general. This is supported by survey respondents, 55.2% of whom felt they spend an optimal amount of time on collaboration and 34.8% of whom reported that spending more time on collaboration would enhance their job. Only 2.2% of respondents reported that they spend more time than necessary on collaboration.

The specific contribution of collaboration differs depending on how success is viewed. There are numerous benefits of the collaboration, and certain aspects of the collaborative process appear to be more important than others for different dimensions of success as described above. Many interview participants described how collaboration can facilitate regional thinking or consideration of full lifecycle management. A few participants highlighted this in the context of limiting factors for a given population:

> "*If I want to be most effective in helping a population or species, do I have any control over the limiting factor or does somebody else [have it] elsewhere on that species range? ... am I really*

addressing what's limiting or am I just throwing money at something that doesn't have that broad an effect?"

Others described the importance of full lifecycle management as a means to "*build resilience in the landscape"* because local issues have consequences that ripple throughout the flyway as birds move around. In this way, interview participants are linking collaboration as an avenue to broaden the scope of thinking to successful management of waterfowl populations. This applies to research related to population management as well. Multiple interview participants pointed out that many localized, species-specific projects ultimately lead to broad collaborations:

"If they aren't already thought about full annual cycle, they turn in in the full annual cycle type [question]…, as an example, we got a project on the ground about 10 years ago to answer a [localized] question, and it has turned into a West wide project."

When successful management is framed by habitat management goals, collaboration can contribute to success by increasing capacity, as one participant stated, "*we accomplish more together than we can do alone"*. Habitat management for waterfowl is particularly resource-intensive, requiring ample funding, time, equipment, and people to do the work. Participants agreed that an increase in financial capital, available expertise, and people is a useful outcome of collaboration in this context. Collaboration, or at least widespread coordination, is also beneficial for achieving broader habitat management goals and improving connectivity by "*bring[ing] those standalone one entity efforts together for a collaborative bigger picture body of work that ultimately gets at saving habitat levels of the support for waterfowl populations."*

Participants also alluded to ways in which collaboration contributes to success as determined by public and partner satisfaction. However, because participants had a more difficult time describing how success in this way could be measured, the impact of collaboration was less explicit. Engaging partners broadly can increase buy-in and support for management actions.

One participant noted that engaging partners early and often can help prevent "*roadblocks and stalemates*". Additionally, while not truly collaborative management, some interview participants mentioned that outreach, being open to feedback, recommendation processes, and open public meetings can help avoid litigation and lead to an overall feeling of success by reducing complaints from public constituencies.

1.3.3 Joint Ventures as a critical forum for successful collaboration

Interview participants viewed Joint Ventures as critical forums for collaboration within waterfowl management. They were initially created specifically to advance habitat conservation and management for waterfowl and most participants agreed that they are broadly successful at achieving that aim. When asked to elaborate, a more complex picture formed. There was a shared sentiment that Joint Ventures with a longer legacy of waterfowl work were more effective, especially where stronger co-benefits exist between waterfowl and private interests. However, as some Joint Ventures move towards an 'all birds' model, where the Joint Venture mission is expanding towards the conservation of all migratory birds, participants described challenges with maintaining the waterfowl-specific successes while advancing broader goals, and without spreading resources too thin.

> *"This is not a knock on JVs… joint ventures were originally developed for waterfowl management based off of NAWMP... I would say that as they've moved towards more of an all-bird type of JV, which I think is a good thing, the habitat side is not working as well."*

Furthermore, interview participants also stressed the need for expanding towards a 'whole life cycle' approach to waterfowl, and while Joint Ventures have been quite successful at focusing on one part of a species' annual cycle *within* a given region, there is room for improvement for collaborative *across* regions to advance flyway-level management.

"I think some joint ventures are doing a better job than others... [there's] such a big geography with so many other issues going on... I think most people are gonna probably tell you that they're both working fine or good or well, but... there's no connection, I don't think, when it comes to habitat management at the full flyway scale."

This sentiment was somewhat supported in larger survey effort, in which survey respondents were asked the degree to which they agreed with the statement that Joint Ventures were successful at advancing regional or flyway level management. More survey respondents strongly agreed that Joint Ventures are successful at regional management (32%) compared to flyway level management (20.4%) and this difference in perceived success is modestly significant (Cliff's d = -0.158).

Interview participants who worked more extensively with Joint Ventures generally agreed that Joint Ventures are successful with respect to regional management. This is supported by the broader survey effort. Several models of the influence of professional attributes of survey respondents on their perceived success of the Joint Ventures were examined (Table 1.3). For perceived regional success, the most parsimonious model with the best goodness of fit included parameters for level of involvement in the Joint Ventures, management scope, and working within the Central Valley Joint Venture region. As overall involvement in Joint Ventures increases there is a significant increase in perceived regional success of Joint Ventures (Table 1.4). The odds of respondents indicating stronger agreement with regional success of Joint Ventures is 6.03 times greater for each one step increase in overall involvement. There is a moderately significant non-linear relationship between management scope and perceived regional success of the Joint Ventures (Table 1.4). The Central Valley was the only region with a significant impact on perceived regional success. Respondents who worked within the Central Valley – irrespective of actual involvement with the Joint Venture – are 2.3 times as likely to

indicate strong agreement with regional success of Joint Ventures (Table 1.4). Actor type, management scope, and years of experience did not significantly predict perceived regional success.

Results are similar for perceived flyway success. The model that best explained survey respondents' level of agreement that Joint Ventures are successful with respect to flyway level management includes parameters for level of Joint Venture involvement, years of experience in the profession, and working within the Central Valley region (Table 1.3), though the influence of years of experience is not significant (Table 1.4). The odds of respondents indicating stronger agreement with flyway success of Joint Ventures is 2.91 times greater for an increase in overall involvement (Table 1.4). Respondents who work within the Central Valley are 2.1 times as likely to indicate strong agreement with flyway success of Joint Ventures (Table 1.4).

1.4 Discussion

Natural resource management has shifted towards structured decision making, planning, and emphasizing a need for defining performance metrics at the outset of any project, (Gregory et al. 2012, Robinson et al. 2019, Hemming et al. 2022). This shift acknowledges that clear performance metrics have not always been a part of natural resource management in the past, particularly in light of growing call to address the social dimensions of management as well as the ecological (Bennett et al. 2017, Robinson et al. 2019). The numerous definitions of success held by participants, as well as instances where participants struggled to define success, demonstrate the benefit of having clearly defined goals. Definition is a critical component of principled engagement in any collaborative governance regime (Emerson et al. 2012) wherein participants not only clarify their objectives, but come to agreements on terminology and

identifying shared criteria to assess outcomes (e.g., see Pahl-Wostl et al., 2007). Our results also illustrate that there is room for improvement with respect to performance metrics that are shared among natural resource managers. However, multiple definitions of success are not unique to this system (e.g., Leach et al., 2002) nor does it necessarily represent a problem. Similar to other collaborative management endeavors (e.g., Rudeen et al., 2012), waterfowl management practitioners defined success in terms of desired outcomes as well as a successful collaborative process. In a social-ecological system as large and complex as the Pacific Flyway with the number and diversity of actors and organizations, a variety of goals is inherent (Poteete 2012), and achieving all goals may not be necessary for the process to be considered successful (Innes and Booher 1999). Furthermore, when partners in a collaborative effort are open to and accepting of multiple goals and objectives, there are more opportunities for engagement and possibly an increase in overall success (e.g., Schoon et al., 2021). This multiplicity of goals is a clear characteristic of waterfowl management. Some of these goals have a history of clearly defined objectives (e.g., adaptive harvest management of waterfowl; Johnson et al., 2015), while others, such as human dimensions goals, have room for development.

Many participants clearly expressed that waterfowl management has been generally successful and that collaboration contributes to this overall sense of success. However, the exact mechanism for how collaboration leads to success differed and was dependent upon how each participant defined success. Further, the numerous definitions of success held by participants highlights the importance of not only defining management goals, but also a need to more explicitly identify how those goals can be measured. This is not an easy fix. There are challenges with directly measuring some of the overall goals for waterfowl management. As one participant directly stated: "*We need to think differently about what success looks like. As an example, we*

are not amazing at measuring bird populations, but that's what we want to impact… So, we need to rethink how we measure success or get better at measuring the things that we say we're trying to do." Additionally, as noted in Thomas and Koontz (2006), it is difficult to demonstrate the causal link between environmental outcomes and collaborative efforts specifically, as opposed to other exogenous factors. Restoration projects, policy changes, and land acquisition and protection, are good examples of environmental outputs that may be measured to assess the success of waterfowl management. The challenge lies in first, developing explicit performance metrics and objectives that are measurable, and second in linking these outputs to environmental outcomes at a regional or flyway level.

Through this study, we have identified possible mechanisms for how collaboration leads to success for specific goals within waterfowl management. Previous work has shown some support for the hypothesis that systems level thinking results from greater collaboration between diverse actors (collaborative heterogeneity; Bodin et al. 2017). That is clearly at play when waterfowl management practitioners with diverse expertise from across the flyway collaborative to reach population goals. Collaboration focusing on waterfowl population management facilitates social-ecological alignment by expanding connections and perspectives of managers to match the scope of how waterfowl rely on areas across the Pacific Flyway.

Collaboration can increase the capacity for achieving habitat goals by increasing financial, human, and physical capital needed for resource-intensive work. The Joint Ventures were created with this aim in mind (Cohn 2005). Participants also acknowledged this and discussed how Joint Ventures positively contributed to ecosystem level science and management within each region. However, some participants also noted that there could be more collaboration and coordination

between regions. This presents an opportunity for scaling up habitat management goals to align with flyway-level, whole life-cycle population goals.

Human dimensions are the most recent addition to management plans (U.S. Department of the Interior et al. 2012) and participants that discussed them stressed their importance. In response to a decline in waterfowl hunting, many agencies have programs dedicated to the R3 initiative to recruit, retain, and reactivate hunters (Schummer et al. 2020, Rubino and Serenari 2022) as there is concern over a decline in funding for waterfowl management and wetland conservation (Vrtiska et al. 2013). However, this is only one part of the issue. Researchers are beginning to examine multiple facets of what drives engagement in waterfowl and wetland management (Rutter et al. 2022), and other solutions to the issue of declines in funding (Larson et al. 2021). Interview participants emphasized that by committing to human dimensions goals and engaging with broader constituencies beyond just the hunting community, practitioners may be able to more effectively leverage collaborative partnerships to obtain greater public support, and possibly resources, for waterfowl management. Despite this acknowledgement, there is considerable uncertainty for how to achieve these aims. As stated earlier, there is not currently an entity or group taking leadership in developing and addressing regional objectives related to human dimensions goals, as one participant stated: "*I think people are really struggling with what that means in terms of, how do we do that? Who does that? And is that really my job? Or is that someone else's job to do?"* This points to a need to first identify leadership before developing clear, measurable objectives.

The siloed nature of waterfowl management contributes to a broader challenge. Collaborative natural resource management is more successful when participating individuals have control over the outcomes they wish to impact (Rice and McCool 2022). However, what many

practitioners ultimately want to impact – healthy waterfowl populations – is not what they may have control over (e.g., habitat management). Taking advantage of existing network structures and collaborative partnerships (Bryson et al. 2006), such as the Joint Ventures, may provide an opportunity for addressing the fragmented nature of management. Joint Ventures are viewed as a central form of collaboration. While practitioners who are more involved in Joint Ventures describe a more nuanced picture including the challenges and weaknesses of the system, heavy involvement in the Joint Ventures is correlated with an increase in perceived success. Joint Ventures were initially developed to address regional habitat management goals for waterfowl, but this mission is changing in three ways: addressing broader waterfowl management issues, incorporating other guilds, and expanding the geographic scope of impacts. Some Joint Ventures frame habitat management goals by how many birds they want in certain regions (e.g., IWJV 2013) or develop region-wide species-specific objectives (e.g., CIJV 2020) and others are beginning to develop human dimensions goals and participating in the NAWMP Planning Committee and National Flyway Council Human Dimension Working Group (e.g., PBHJV 2020, CVJV 2020). Joint Ventures are also expanding their goals laterally beyond just waterfowl towards an all migratory birds perspective. Continuation of the regional success highlighted in this study is dependent on continuation of clear objective setting. The expansion to 'all birds' may change the objectives and not just add new ones. Many interview participants expressed the goal for Joint Ventures to have a more central role in advancing flyway management. Flyway-level management requires some degree of consistency across regional goals. However, every Joint Venture exists within different social, ecological, and political contexts. Further, there are already regional differences in perceived success. The relationship between Joint Venture involvement and success is similar for most regions, except the Central Valley, where work in the

Central Valley significantly increases likelihood of thinking management is successful. This calls for further case study investigations comparing features of Joint Venture collaboration with metrics of success.

This study sets the stage for such work. Multiple definitions of waterfowl management, that are influenced by geographic variation, merit future research focusing on how regional differences in management issues and social and ecological context impact management goals actions. We have identified some regional differences in perceived success that suggest the benefit of an in-depth study characterizing differences in collaborative processes and structures between Joint Ventures. The mechanisms identified here for how collaboration leads to different elements of success present testable hypotheses about how different types of relationships in networked collaboration impact different management outcomes. First, as interview participants highlighted that collaboration facilitates whole life-cycle management, we suggest that collaboration with diverse partners, that span broader geographies, and involve substantial communication and/or data sharing will lead to better population outcomes. Second, we posit that regions with greater resource sharing and joint implementation of projects will have better habitat outcomes. Third, we postulate that regions where more actors collaborate on decision-making will have greater public and partner satisfaction.

In conclusion, most waterfowl management practitioners acknowledge that collaboration is important for their work. However, there do not always seem to be clear objectives for why and when collaboration happens. Through this study, we identified several connections between the benefits of collaboration and management outcomes. Collaboration across the Pacific Flyway can facilitate flyway-level and systems thinking, increase capacity for management action such as habitat restoration, and improve buy-in and support from managers and the public for

management decisions. These connections can serve as the basis for collaboration goals, and why and when collaborative partnerships are formed or used. Clearly defining success and performance metrics at the outset can make individual partnerships within the broader management enterprise more effective. And in natural resources where time and money are frequently limiting, collaboration goals and performance metrics can be used to determine whether time and money is being spent effectively and efficiently. Further, development of explicit objectives for the ways in which waterfowl management goals are expanding will ensure that the successes seen in the past for waterfowl population management will continue.

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1.6 Figures

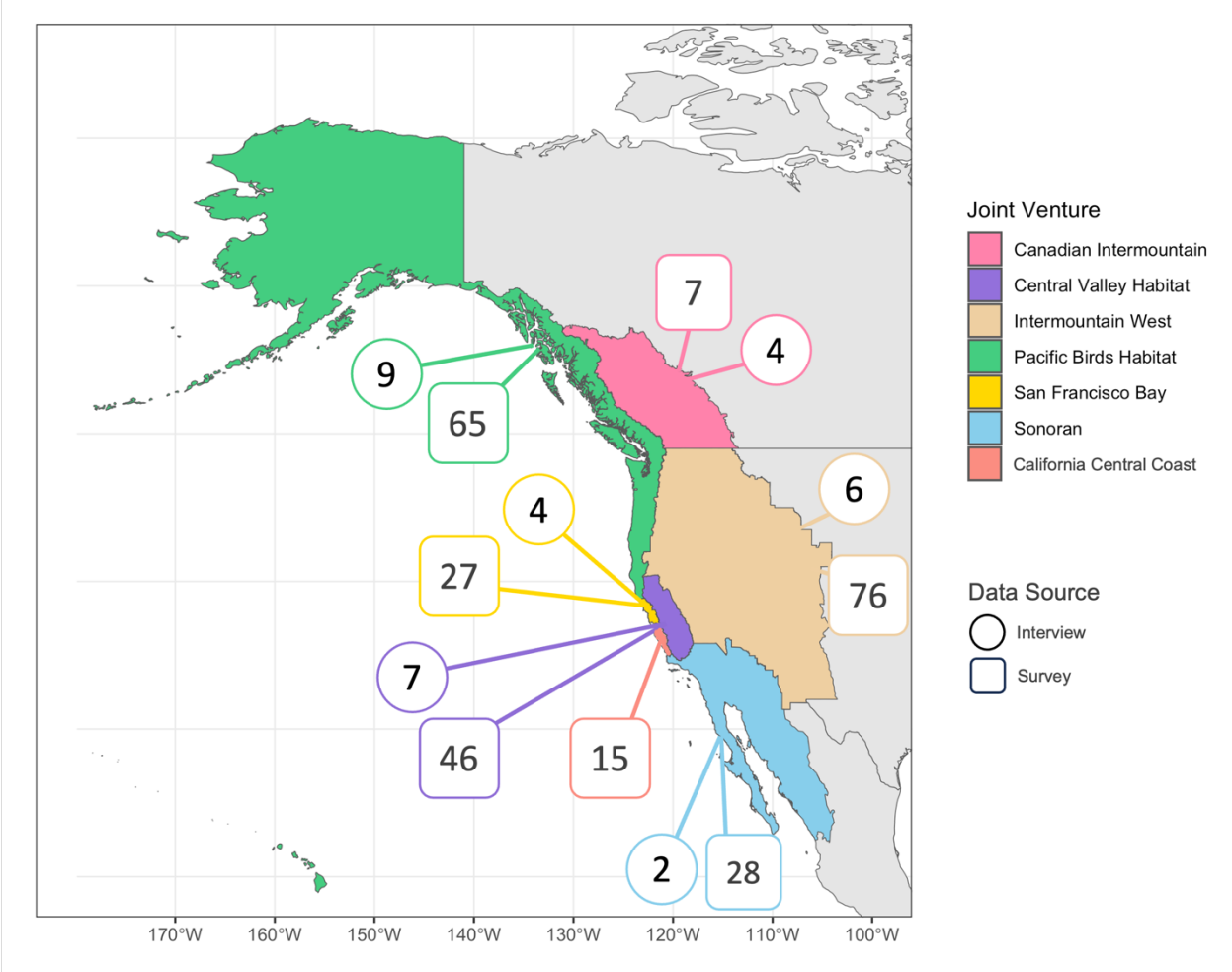

Figure 1.1 Pacific Flyway Migratory Bird Joint Venture regions. Number of interview participants per region displayed in circles. Number of survey respondents per region displayed in squares. Some survey respondents work across multiple Joint Venture regions and are therefore counted twice. However, survey totals still depict relative coverage of each region.

1.7 Tables

Table 1.1 Professional attributes of semi-structured interview participants and Waterfowl Collaborative Management survey respondents.

Professional attribute	Number of interview participants (frequency)	Number of survey respondents[a] (frequency)
Type		
Joint Venture	8 (0.25)	5 (0.03)
Federal agency	9 (0.28)	68 (0.38)
Tribal government or organization	1 (0.03)	3 (0.2)
State agency	6 (0.19)	48 (0.27)
Local agency	1 (0.03)	13 (0.07)
Non-governmental organization	7 (0.22)	36 (0.20)
Other entity	1 (0.03)	8 (0.04)
Management Scope		
National (+international)	4 (0.13)	19 – 10.4%
Regional[b]	17 (0.53)	110 – 60.8%
Local	7 (0.22)	52 – 28.7%
Years of Experience		
< 5	2 (0.06)	32 – 17.7%
5-10	5 (0.16)	31 - 16.9%
10-20	11 (0.34)	54 – 29.8%
> 20-30	14 (0.44)	63 - 34.8%

[a] Counts of survey participants only include complete survey responses (n = 181).

[b] Sub-state, state-wide, and multi-state survey responses are grouped here into a regional management scope.

Table 1.2 Descriptions of variables used in ordinal logistic regression. Data from Waterfowl Collaborative Management survey.

Variable	Value	Number of responses (Freq)	
Dependent variables			
Perceived success[a]		Regional[a]	Flyway[a]
	Strongly agree = 0	58 (0.32)	37 (0.20)
	Somewhat agree = 1	62 (0.34)	63 (0.35)
	Unsure = 2	48 (0.27)	64 (0.35)
	Somewhat disagree = 3	5 (0.03)	6 (0.03)
	Strongly disagree = 4	1 (0.01)	3 (0.02)
	No response	7 (0.04)	8 (0.04)
Independent variables			
Joint Venture Involvement	Not involved = 0	67 (0.37)	
	Little involvement = 1	30 (0.17)	
	Somewhat = 2	40 (0.22)	
	Heavily = 3	44 (0.24)	
Actor Type	Levels in Table 1; baseline = "Federal"	See table 1.1	
Management Scope	Levels in Table 1; baseline = "Local"	See table 1.1	
Years of Experience	Levels in Table 1; baseline = "0-5 yrs"	See table 1.1	
Joint Venture Region[b]			
Sonoran	Dummy Yes = 1, No = 0	28[b]	
Central California Coast	Dummy Yes = 1, No = 0	15	
San Francisco Bay	Dummy Yes = 1, No = 0	27	
Central Valley	Dummy Yes = 1, No = 0	46	
Pacific Birds Habitat	Dummy Yes = 1, No = 0	65	
Intermountain West	Dummy Yes = 1, No = 0	76	
Canadian Intermountain	Dummy Yes = 1, No = 0	7	
Other[c]	Dummy Yes = 1, No = 0	24	

[a] Measured as agreement with: Joint Ventures are successful at advancing regional/flyway-level management.

[b] Indicates work within Joint Venture region, not involvement with the Joint Venture. Many survey participants work within multiple Joint Venture regions. The sum of responses within listed Joint Ventures is therefore greater than the total number of survey responses (n = 181) and frequencies are not calculated.

[c] Some survey respondents could not be attributed to any Joint Venture region(s)

Table 1.3 Goodness of fit for ordinal logistic regression models of professional attributes influencing perceived success of Joint Ventures. Data from Waterfowl Collaborative Management Survey.

Model	AIC	McFadden R^2	Cox and Snell R^2	Nagelkerke R^2	Lipsitz statistic	p[a]
Perceived regional success ~						
Involvement	396.02	0.101			7.861	0.548
Involvement + Type	401.51	0.116	0.247	0.270	9.553	0.388
Involvement + Scope	394.47	0.119	0.252	0.276	6.092	0.731
Involvement + Experience	395.66	0.120	0.255	0.279	7.0037	0.637
Involvement + CVJV + IWJV + SFBJV + SJV + PBHJV + CIJV[b]	402.33	0.114	0.243	0.267	14.525	0.105
Involvement + Scope + CVJV	391.75	0.134	0.280	0.306	1.999	0.992
Perceived flyway success ~						
Involvement	426.58	0.048	0.113	0.123	7.754	0.559
Involvement + Type	433.74	0.059	0.138	0.150	6.434	0.696
Involvement + Scope	429.29	0.060	0.140	0.152	13.342	0.148
Involvement + Experience	425.39	0.062	0.145	0.157	11.498	0.243
Involvement + CVJV + IWJV + SFBJV + SJV + PBHJV + CIJV	440.97	0.029	0.069	0.075	2.42	0.983
Involvement + Experience + CVJV	422.16	0.075	0.170	0.185	4.100	0.905

[a] H_o for Lipsitz is a model with good fit. Low p-values indicate a poor fit.

[b] Joint Venture (JV) acronyms: Central Valley (CV), Intermountain West (IW), San Francisco Bay (SFB), Sonoran (S), Pacific Birds Habitat (PBH), and Canadian Intermountain (CIJV)

[*] Model df = 9

Table 1.4 Parameter estimates from most parsimonious ordinal logistic regression models of professional attributes influencing perceived success of Joint Ventures. Data from Waterfowl Collaborative Management Survey.

Parameter	Estimate	Std. Error	Odds ratio
Perceived regional success ~			
Involvement (L)	1.797**	0.339	6.030
Involvement (Q)	0.045	0.309	1.046
Involvement (C)	0.18	0.322	1.198
Scope (L)	0.843	0.411	2.323
Scope (Q)	0.657	0.384	1.929
Scope (C)	-0.069	0.378	0.934
Scope (^4)	-0.867*	0.366	0.420
CVJV	0.844*	0.352	2.326
Perceived flyway success ~			
Involvement (L)	1.07**	0.292	2.914
Involvement (Q)	-0.098	0.299	0.907
Involvement (C)	0.414	0.325	1.513
Experience (L)	0.198	0.326	1.219
Experience (Q)	0.26	0.337	1.297
Experience (C)	-0.431	0.366	0.650
Experience (^4)	-0.601	0.378	0.548
CVJV	0.765*	0.337	2.149

**p < 0.01, *p < 0.05; Ordinal logistic regression estimates linear and polynomial parameters for categorical predictors: .L - linear, .Q - quadratic, .C - cubic, ^4 – quartic; CVJV – Central Valley Joint Venture

CHAPTER 2

OVERCOMING BARRIERS TO REGIONAL AND FLYWAY-LEVEL COLLABORATION IN THE MANAGEMENT OF MIGRATORY WATERFOWL ALONG THE PACIFIC FLYWAY

2.1 Introduction

Natural resource managers are increasing their use of collaborative approaches, particularly when management occurs at multiple scales with many partners (Kark et al. 2015). Coordination and collaboration are particularly important for migratory species, as their populations and habitats often cross jurisdictional boundaries (Boere and Piersma 2012, Runge et al. 2017). Because of the different scales at play in managing migratory species, coordination is necessary to achieve large scale goals when they are implemented at a local level and when management issues and actions at the local level have regional impacts (Cash et al. 2006). Cross-boundary coordination is important when goals are shared across management jurisdictions and issues cross multiple land tenures (Bergmann and Bliss 2004), as is the case for most migratory waterfowl. Our goal is to better understand how collaboration is advanced and hindered specifically within migratory waterfowl management along the Pacific Flyway in order to identify paths to overcoming barriers and improving collaborative efforts.

Collaborative relationships may serve a variety of purposes, particularly when management operates at different scales. Margerum (2008) organized collaborative efforts based on the goals of implementing change – through on the ground actions, organizations, and policy – and the associated relationships between typical partners. Collaboration in all of these forms can be beneficial for conservation actions in complex, multi-partner systems by increasing efficiency (Kark et al. 2015), reducing costs (Gordon et al. 2013), and improving environmental outcomes (Scott 2015, Dressel et al. 2020). Collaboration can also yield social benefits such as an increase

in social and political capital, improved learning, and changes in attitudes and behaviors (Connick and Innes 2003).

Collaboration itself, incurs costs and there are many challenges associated with collaborative management. Thus, resource managers are constantly balancing the costs and benefits of investing in communication and collaboration when allocating their time and resources. Collaboration is more successful when it is inclusive (Rice and McCool 2022), but also, conversely, when there are fewer actors within a partnership (Scott and Boyd 2023). Collaborative efforts are complicated further by issues of limited or unstable funding (Agranoff 2007, Margerum and Robinson 2016), unequal costs and benefits among participants (Margerum and Robinson 2016), and the potential for insufficient compromise or risk-averse management to impact outcomes (Agranoff 2007, Layzer 2008). Additionally, while efforts are also more successful when there are fewer goals (Scott and Boyd 2023), this is less common in complex social-ecological systems which have multi-dimensional outcomes (Agrawal and Chhatre 2011).

The formation of collaborative efforts can be driven by a shared purpose (Barrutia and Echebarria 2021), desire to increase legitimacy of management actions (Trachtenberg and Focht 2005), and a goal or need to share resources (Park and Rethemeyer 2012, Calanni et al. 2015). However, even with strong motivations to participate and deciding that the benefits outweigh the costs, there can be many barriers that inhibit involvement in collaborative efforts. Governance structures and processes are a common barrier, particularly when multiple agencies are involved at different levels (e.g., Jackson et al., 2019). High transaction costs (Margerum 2011), including time and money, can hinder participation by the public (Margerum and Robinson 2015) and management agencies (Thomas 2003, Koontz et al. 2004).

Migratory waterfowl management is designed to be collaborative. Flyway councils, established in 1952, are forums designed for the administration and coordination of waterfowl population and harvest management through engagement between the U.S. Fish and Wildlife Service and participating state agencies. In 1986, the United States and Canada created the North American Waterfowl Management Plan (NAWMP); Mexico later signed on in 1994. This plan established the Joint Venture management concept, where North America is subdivided into ecologically-relevant regions (U.S. Department of the Interior et al. 2012). These migratory bird joint venture partnerships (Joint Ventures hereafter; Cohn 2005, Giocomo et al., 2015; National Joint Venture Communications Education and Outreach Team, 2013), comprised of government agencies, non-governmental organizations, private entities, and individuals, set goals and design management efforts in their respective regions. Joint Ventures vary substantially in scope with some focusing on small regions (e.g., San Francisco Bay Joint Venture) and others covering a large expanse (e.g., Intermountain West Joint Venture covers 486 million acres). While NAWMP and Joint Ventures develop continent- and region-wide goals, management actions, particularly habitat management for waterfowl, often take place at a more local level, giving rise to numerous smaller collaborative relationships.

To further understand the role of collaboration in the management of migratory waterfowl, we ask three questions: (1) What roles do the various partners fill in managing migratory waterfowl and their habitat? (2) What are the perceived motivations for collaboration, and do they vary among actors across different sectors of management? And (3) what are the perceived barriers to collaboration within this system and do they vary among practitioners? By developing a more nuanced understanding of why partners choose to collaborate and the challenges of

collaboration they face, our aim is to help inform managers so they may be able to develop more targeted and effective partnerships moving forward.

2.2 Methods

2.2.1 Study system

Millions of waterfowl migrate thousands of miles across the Pacific Flyway. The Pacific Flyway crosses seven Joint Ventures: Sonoran, Central California Coast, Central Valley, San Francisco Bay, Pacific Birds Habitat, Intermountain West, and Canadian Intermountain (Fig. 1). These species cross a diversity of habitats with shifting management regimes, generally moving seasonally between rain-fed, non-irrigated habitats in the north to often highly engineered systems with intensive water management and habitat manipulation for over-wintering birds in the south. Coastal migratory routes, west of the Rocky Mountains, support very high densities of waterfowl, while interior regions receive lower numbers of Pacific Flyway birds but see a convergence with some Central Flyway routes.

Numerous agencies and organizations are involved in management. Federal agencies are involved at multiple levels (e.g., USFWS National Wildlife Refuges are managed locally and the USFWS Migratory Birds Program operates at regional and national levels). The Pacific Flyway crosses 16 states, provinces, and territories, involving numerous state agencies in management decisions. Non-governmental organizations are frequently identified at critical partners, be it through large national NGOs or local partnerships. Private landowners also play a role in management; for example, approximately 66% of managed wetlands used by waterfowl in the

Central Valley are privately owned (CVJV, 2020) as are 75% in the Southern Oregon – Northeastern California (SONEC) region (IWJV, 2013).

Management occurs at multiple scales from highly localized implementation of management actions to decisions made at the national and international scale of administrative flyways. Some management decisions are made individually, but there are also examples of collaborative efforts guiding management at all levels. For example, local management of individual managed wetlands (e.g., promoting growth of particular vegetation for waterfowl forage on a single refuge) can be made by individuals or single entities. However, there are also examples of collaborative local management, such as the consensus-based approach used at Malheur National Wildlife Refuge in southeastern Oregon (Malheur NWR Collaborative 2021). Management of waterfowl habitat is made up of a network of individual wetland projects and managed wildlife areas, but regional goals are established collaboratively through Joint Ventures. At the national level, the federal government sets harvest regulations for the entire flyway. The Alaska Migratory Bird Co-Management Council provides an avenue for consensus-based decisions and indigenous participation in setting harvest regulations.

2.2.2 Data collection

The lead author interviewed 32 practitioners in waterfowl management in order to better understand how they viewed their role in waterfowl management, and the motivations, challenges, and barriers associated with collaboration. A qualitative approach provides a more nuanced exploration of how individual perspectives and actions can drive collaboration and collaborative partnerships.

We used purposeful sampling and stratified interview targets across three dimensions: geography (Joint Venture regions), actor type (federal, state, local, and NGO), and management focus (habitat, population). We targeted key informants heavily involved in regional management and science. Heavy involvement was determined by repeated mentions in joint venture, federal, and state planning documents as well as primary authorship of key management plans. This method of identification was particularly useful for individuals working in federal and state agencies and non-governmental organizations operating at a regional level. Other interview participants were included because of their role in management at the local level of individual protected areas in important migratory areas. Additionally, several interview participants, particularly those in local agencies and locally operating organizations not based in the California Central Valley, were identified through snowball sampling during the first several interviews. As a result of this selection process, the lead author contacted 34 individuals through email. Twenty-eight individuals agreed to participate, five did not respond, and one declined. Four interview participants invited a colleague who could provide a different perspective to join the interview. Ultimately, the lead author conducted 28 semi-structured interviews with 32 individuals between June 2021 and June 2022 (Figure 2.1, Table 2.1). This is consistent with the number of interviews used in many grounded theory studies to achieve theoretical saturation (Thomson 2011).

Semi-structured interviews were guided by 12 open-ended questions (Appendix 1, Table A1.1). Questions were designed to first develop a robust understanding of different roles in waterfowl management and the management goals and issues in different regions across the flyway. Then, several questions focused more explicitly on collaboration and partnerships, while others addressed topics surrounding successful management and science. All interviews were

conducted over Zoom and lasted 1 hour and 12 minutes on average. All interviews were conducted and transcribed by the lead author.

Investigation of collaboration within waterfowl management was supplemented by results from a web-based survey ("Waterfowl Management Collaboration Survey"). We designed the survey instrument to (1) collect key professional affiliation attributes about respondents (e.g., years in the profession, management focus), (2) identify professional connections and categorize those relationships, and (3) evaluate respondents' involvement in and perceptions of the Joint Venture system (Appendix 1). We primarily use responses from survey questions about management priorities, collaborative activities, and landowner communication (Table A1.2). We used the same purposeful sampling strategy as with the interview participants to develop an initial survey list and snowball sampling based on professional connections identified in the survey to expand the survey recipient list. Of the 645 individuals to whom the survey was distributed, we received responses from 221 individuals (34.02% response rate).

2.2.3 Data analysis

We approached this qualitative analysis using a grounded theory approach, which relies on inductive coding of interview transcripts (Glaser and Strauss 1967, Strauss and Corbin 1990, Fendt and Sachs 2008, Saldana 2009). Broad categories were determined deductively based on focus of the research (e.g., collaboration, management, success), while subthemes were identified deductively through open and axial coding. The first author conducted all line-by-line coding in consultation with all authors. We began with open coding to generate a list of first-order categories to identify concepts and ideas that emerged across all interviews. From these, we proceeded with axial coding to identify second- and third- order themes that group the first-

order codes, and highlight ideas of greater importance, prevalence, or notable variation in the interviews. First-order and axial codes were revisited iteratively as we proceeded through the coding process. Within "collaboration", sub-codes were dedicated to the process of collaboration and elements of working together including drivers of collaboration, barriers, and partner roles among others. Within "management", codes were grouped by dimensions of implementing management such as goals, actions, and targeted challenge.

Through the course of this work, we identified substantial variation in how practitioners define what constitutes waterfowl management. This variation includes managing waterfowl populations directly through harvest management, management of habitat used by waterfowl, and managing engagement with public constituencies interested in waterfowl (Karasov-Olson et al. *Chapter 1*). Therefore, for the purpose of this paper, we use a broader definition of 'waterfowl management' unless explicitly stated otherwise.

2.3 Results

2.3.1 What roles do various partners fill in managing migratory waterfowl and their habitat?

There are many different types of entities and organizations involved in managing migratory waterfowl, with a few discussed more frequently by interview participants. Federal and state agencies were described as having a prominent role in all management partnerships. Indeed, the federal government is mandated by law to determine whether migratory species can be hunted and regulate approved harvest. While the specific scope and mission of each federal and state agency differs, these agencies in general were described as filling similar roles. Participants described federal and state agencies as filling leadership roles in the planning and

implementation of management actions, as well as being a critical source of funding. It was also highlighted be several participants that the final authority for many management decisions lies with those agencies. For example, specific harvest regulations are firmly and finally set by federal wildlife agencies. This restricts the impact of collaboration within the system.

> *"The true definition of co-management is people having both having resources and money and knowledge and coming together and jointly managing… it couldn't be true co-management because the Feds obviously have management control over the birds… but [it is] something for all of us to strive towards."*

Additionally, because many of these agencies are mandated with that final authority, collaboration with federal and state agencies is voluntary and requires willing participation on the part of agencies to engage in collaboration beyond partnership.

> *"We have partnerships but… having a partner doesn't equate to collaboration."*

> *"We need to achieve through voluntary proactive conservation because it empowers people to solve problems, regulations tend to send people away."*

Non-governmental organizations (NGOs) involved in waterfowl management are variable. Some organizations have national reach (e.g., Ducks Unlimited, Inc.) while other are highly localized in scope (e.g., Friends of Malheur National Wildlife Refuge). Organization goals address multiple management dimensions including on-the-ground implementation of wetland projects, funding waterfowl-related work, research, and policy. Despite this variety, a few patterns emerged in how interview participants described the role of NGOs. NGOs were identified as a source for added capacity, whether through additional funding, human capital, or other resources. NGOs were also often described as facilitators, boundary spanners, and bridging ties between different partners. This was often by virtue of a single organization addressing

multiple dimensions of management. Their role as facilitators was highlighted as particularly important for private landowner engagement.

> *"Especially since we're a nonprofit, it's easier to get access to private lands, you know, cause you're not the government."*

Many interview participants described private landowners as critical to migratory waterfowl by virtue of the importance of their land. For example, waterfowl wintering in the Central Valley and staging in the SONEC region in the spring heavily use on flood-irrigated landscapes. This establishes a strong reliance on wildlife-friendly agricultural practices where private landowners fill an important role of on-the-ground management of habitat used by waterfowl. However, despite this critical role, interview participants frequently described partnerships with private landowners as external to core collaborative management efforts. That is not to say these separate partnerships were thought of as lesser than, they were simply described as distinct relationships, often driven by participation in incentive programs, singular projects, or land access, rather than integral to general collaborative management efforts.

> *"You're either calling them about donations or you're calling them about habitat or access. Ok. Farmers, it's more like you do you want to participate in the program.*

The frequency of communication with private landowners underscores this relationship, revealing strong variation in the frequency of communication. While only 8.3% reported never communicating with landowners, roughly the same percent of respondents indicate that they rarely, sometimes, and frequently communicate with private landowners (27.1%, 29.3%, and 34.8%, respectively). However, patterns emerge in the frequency of communication by the type of actor (Figure 2.2). Most non-governmental organizations and local agencies report frequent

communication with landowners and more federal agencies report rarely communicating with landowners. However, there is variation across state and federal agency responses.

2.3.2 What are the motivations for collaboration between partners?

The four most discussed motivations for collaboration were shared goals, funding, personal relationship, and project-specific context (Table 2.2). Shared goals, values, and interests between partners was identified as the most important driver of collaboration. This was described as not only motivating the formation of partnerships, but key to maintaining them.

> *"[We] really focus on common ground, shared vision conservation. They don't agree on every single thing about natural resources and environmental issues, but they focus on the things they can agree on and work really hard at it, developing some wonderful lasting relationships."*

Participants discussed three types of goals that motivate collaboration. The first is a common goal focused on a particular aspect of management, such as reaching a certain acreage of flood-irrigated alfalfa in the Intermountain West. These collaborations often involved a diverse suite of partners working within the same region. A second shared goal is to broaden the scope of management to pursue flyway-level or whole lifecycle management. This typically led to collaborations between regions, frequently with federal and non-governmental partners in large organizations. Thirdly, some participants described the desire for management to be a collaborative process as a motivation in itself. This was described as particularly important for collaborative efforts involving tribes and indigenous groups.

Half of the interview participants discussed funding as a driver of collaboration.

Collaboration is seen as an avenue to increase available funding in many ways. Collaborating with more partners expands the ability to find matching funds, as one participant stated with respect to combining funding between organizations:

"We can't do anything of grand significance without significant funding."

"Money can't buy love, but it can buy friendships."

Increasing the number and diversity of partners is perceived as increasing the likelihood of receiving funding.

"It's a little lower risk for funding when you know that there's many partners that think it's a high priority."

Working with entities who have distinct but overlapping goals (e.g., management of habitat for fish that can also be used by waterfowl) presents opportunities to tap into financial resources of related management sectors.

"We have a very, very long and strong tradition about partnering on everything. So, it's very much part of our DNA. I think it comes from the fact that for a very long time we were very small and very poor. And so, in order to get things done, we partnered with like-minded organizations, in order to accomplish what we were hoping to accomplish."

The importance of funding as a motivation for collaboration is supported by results from the survey effort. 67.4% of survey respondents reported engaging in collaborative development of grant and funding proposals. This was the second most common collaborative activity, second only to sharing data and information (87.3%)

Half of participants also alluded to personal relationships as a motivation for collaboration. This emerged through discussions of early connections made during graduate school, shared interests in hunting, identifying people who are fun to work or enjoy a beer with. Participants

described how the "*waterfowl world is a small world*" which can make it hard to disentangle the personal and professional motivations for working together. The influence of personal connections appeared agnostic to the type of agency or organization within which practitioners work. A few participants also described instances where the personal management interests (e.g., passionate about consumptive vs. non-consumptive management, excitement about a particular region along the flyway) of individuals, particularly in upper management positions, could impact the focus of collaborative efforts.

Lastly, a majority of participants highlighted that choice of partners and decision to collaborate was dependent on project- or issue- specific context. For example, implementing a project, action, or monitoring effort may necessitate collaboration with specific landowners or land management agencies or with individuals who fill a gap in expertise. For federal and state agencies, this contextual driver of collaboration could be due to agency mandates or overlapping jurisdictions.

One common motivation of collaboration was described less frequently than expected by interview participants. First, only two participants mentioned building trust as a motivation for collaboration and six participants described the importance of trust in maintaining successful collaborations, especially between private and indigenous partners and the federal government.

2.3.3 What are the barriers to collaboration?

Interviews with practitioners revealed four key categories of barriers to collaborative management of waterfowl (Table 2.3). Twenty-five participants described capacity issues as hindering collaboration. Primarily, participants discussed that time to spend on developing and

maintaining partnerships and engaging with partners was always limiting. Several participants described the importance of taking the time to build and nurture relationships.

> *"There's a lot to be said for that very old-fashioned spending time doing things together. Building that relationship that builds the trust so you don't leap to the wrong conclusions when you're reading something or seeing something."*

Survey responses support this notion that time is very valuable for collaboration as 55.2% of respondents indicated they spend an optimal amount of time on collaboration. However, survey results also reveal that timing for collaboration is limiting; 34.8% of respondents reported that spending more time on collaboration would enhance their job, implying that if more time were available, they would spend more time on collaborative activities.

Relatedly, the value of face-to-face collaboration is impacted by another capacity issue: funding restrictions. Spending on travel, venues for collaborative engagement, and developing forums for collaboration is often restricted. Also, as practitioners are broadening the scope of who they work with the scope of available funding can limit collaboration.

> *"We have more money but we have way more constraints around how we spend it. And so, it's super slow to move money. It takes us months to move money. That means that you cannot be dynamic and responsive to opportunity which harms relationships and harms partnerships."*

> *"The funders that we rely on, everybody's getting just more specific in what they want you to spend their money on. So, it's harder, collaboration faces a bit of a challenge that way."*

Thirdly, participants described an overall lack of funding, or underfunding, as a barrier to collaboration. All but one participant, who was affiliated with a private duck club, identified

funding as a key management challenge, though only 13 participants described limited funding as a barrier specifically to collaboration. This was described as a particularly strong barrier for smaller organizations and tribes and indigenous groups. For smaller organizations this can limit their capacity to collaborate when they are match requirements or calls for equal contributions from partners.

> *"I also think match requirements are very big barrier. Uh, I understand why they exist, but I think it's a big barrier for smaller organizations to participate in things if, because they just don't have that kind of capital sitting around."*

For tribes and indigenous groups, this can also limit capacity due to unequal compensation for engagement in collaborative management.

> *"Funding, especially for tribal partners is really important. And so, I think a barrier for great collaboration is just not having funding. Like we're expecting everybody to volunteer."*

Governance issues were the frequently identified barrier to collaboration, as one participant directly stated, "*it matters, governance matters*." Some participants described governance barriers in terms of structural issues including jurisdictional mismatch between partners, the separation of programs that impact waterfowl management within a single agency, and split jurisdictions where agencies have responsibilities for multiple administrative flyways. These issues mostly presented issues for federal and state agencies. Another subset of governance issues focused on institutional policies and "*regulatory peculiarities."* Participants discussed limitations that federal and state employees face with respect to what they can and cannot do and whether they can or cannot 'recommend' and 'advise' partners on particular actions. Several agency practitioners expressed concern that an increase in bureaucracy and paperwork may deter

partners from meaningful collaboration. These issues were also focused on federal and state actors, but present barriers to non-governmental partners in a collaborative setting. While there was a consensus that regulations and policies present barriers to collaboration, very few participants highlighted specific rules that presented barriers. One exception came from a participant who stated that counter to the Migratory Bird Treaty Act, *"some of our states still have ungodly language on the books that wildlife is the property of the states"* that can hinder multi-state and flyway-level collaborative management decisions.

About half of participants described barriers associated with the waterfowl management enterprise, or the ways in which waterfowl are managed and the issues that drive management actions and partnerships. As explained in the methods, waterfowl management can be a broad umbrella term for population management, habitat management, and addressing human dimensions of waterfowl. Within the waterfowl management survey, respondents were asked whether their work focused on waterfowl population, habitat, or human dimensions topics. The majority of respondents, 67.4%, reported working on habitat topics, while 37.0% and 27.6% work on population and human dimensions topics, respectively. Respondents were able to select multiple responses, but 71% of these respondents only selected a single focus, supporting the notion of siloed management. Several interview participants specifically described how these management siloes can impede collaboration.

> "*That's probably one of the issues we've had… two distinct groups, the group that's working on the waterfowl side of things and the group that's working on the wetland side of things. There's some overlap but probably not as much as there should be."*

Another divide present within waterfowl management is one that arises from different perspectives about the best approaches to management issues and actions. For examples, some

practitioners prefer preservationist approaches over more active management, or management driven by consumptive goals (i.e., hunting constituencies) versus non-consumptive goals (e.g., bird watching, ecosystem services).

> *"People are in their silos, and they have their territories and there's potential threat to that [collaborative effort] if they come to the table with that."*

A third way in which issues within the waterfowl management enterprise presents a barrier to collaboration is through engagement with non-waterfowl focused partners. Waterfowl exist on a landscape of natural areas, agriculture, and development and collaboration occurs across these sectors as a result. Collaboration with these other sectors can be very successful. For example,

> *"Rice grows in a way that aligns very well with the migratory patterns of waterfowl that arrive here and even how it grows in the summer can provide significant habitat for breeding ducks and, and other breeding birds. So, there's sort of a happy coincidence there."*

However, this alignment and culture of collaboration is not guaranteed everyone, as one participant opined, "*I think it is a one-off. I don't know that it happens anywhere else, like it has happened here*." Many participants discussed that competing goals can hinder collaboration with these other sectors when wildlife-unfriendly agriculture practices are common or more lucrative or when water needs of waterfowl come into conflict with human water uses and needs. These competing goals can even emerge within natural resources when different species (e.g., fish vs. waterfowl) pull apart collaborations. Most practitioners involved in waterfowl management do not exclusively manage waterfowl. Of all survey respondents, only 22.1% work exclusively with waterfowl, while 57.5% work with multiple guilds (e.g., waterfowl, shorebirds, waterbirds, songbirds) and 20.4% do not focus on any guilds. Wetland ecosystems can certainly be managed

to accommodate all species, but when resources and space are limited, differences in perspective and competing goals can hinder collaboration.

The fourth commonly acknowledged barrier to collaboration was the influence of strong personalities. Some participants described how strong negative personalities or loud voices can derail successful collaboration. A few participants also carefully stated that strong personal relationships, particularly involving "*hunting buddies*" can present a barrier to larger or more diverse collaborative efforts. Interestingly, there was very little overlap between participants who identified personal connections or individual personalities as a motivation for collaboration and those that identified them as a barrier.

Three barriers of note were identified as less prominent within waterfowl management or by fewer participants. First, only five participants discussed lack of trust posing a barrier to collaboration. Furthermore, lack of trust was only discussed in reference to private landowners and local communities possibly expressing mistrust of larger government agencies preventing their engagement in management, in parallel those that described trust-building as a motivation. Second, only two participants thought that geographic distance posed a challenge. Evidently, the geographic scope of the Pacific Flyway was not considered a barrier to collaboration across the Flyway. Third, a few participants described a barrier that may systematically affect a few large groups. These participants mentioned that it is difficult to collaborate with very large constituencies, including tribes and indigenous groups and private landowners. Given the numerous and diverse indigenous nations within each region, it is difficult to advance systemic collaboration.

> *"We have not been successful in working out workable mechanisms to have indigenous people participating … We try on the perspectives, but voices not so effectively."*

With respect to large agricultural private landowner groups, one participant supposed, *"in other ag industries, there's most or all of them are not as unified and engaged, I think, as the rice industry."* Another participant described how private duck clubs are somewhat of a black box and it is difficult to know who to contact or even where they are or how many exist. While the particular reason differs for each of these groups, a barrier for large groups seems to emerge because it is unclear to practitioners with whom they should engage, who is in a leadership position, or the time it would take to meaningfully engage broadly is too much.

2.4 Discussion

Governance and management in natural resources has significantly shifted toward collaborative approaches and responsibility sharing with public and private actors, growing out of community-based collaborative environmental management (Sabatier et al. 2005) and collaborative public management (Koontz et al. 2004). While collaborative governance can be focused on "consensus-oriented decision making" (Ansell and Gash 2008), broader collaborative management efforts do not end with making a decision, but carry through to collaboratively implementing actions (Margerum 2011). For long-term collaborations, such as those needed for addressing chronic complex environmental problems or ongoing management needs, efforts also carry through to maintenance and strengthening of collaborative partnerships. There is a robust literature on challenges within collaborative environmental governance (Margerum and Robinson 2016) and strategies, guidelines, and best practices for overcoming those challenges (Wondolleck and Yaffee 2000, Agranoff 2012, Innes and Booher 2018). In order to identify which approaches are best for particular issues, we need to understand how practitioners within the field perceive which barriers are strongest. Furthermore, specific pathways for overcoming

these barriers can be developed by combining information about the diverse roles of partners with an understanding of these barriers.

Management of migratory species requires a broad landscape approach that addresses all elements important to the species life history (Kirby et al. 2008, Runge et al. 2014). Throughout their migratory journey, migratory waterfowl move through a complex social-ecological landscape necessitating coordination and ongoing, long-term collaboration. Understanding the motivations for and barriers to collaboration is key to maintaining the strong collaborative traditions of waterfowl management. Through thematic analysis of semi-structured interviews with waterfowl management practitioners, we identified several key barriers to collaboration. These barriers highlight challenges common to collaborative governance of natural resources, but also shed light on opportunities to improve management. The roles of each organization and agency involved in waterfowl management impact how and why they engage in collaboration. In some cases, organizations and agencies may be able to leverage these roles to overcome key barriers to the collaborative management.

Capacity issues were the most commonly identified barrier to collaboration in waterfowl management. In particular, practitioners highlighted how time availability limited their engagement in collaboration. This is a systemic issue for public agencies when there is conflict between time spent on collaborative activities versus those spent on core agency mandates (Thomas 2003, Koontz et al. 2004, Margerum and Robinson 2016). However, most waterfowl management practitioners expressed positivity about the time they spend on collaboration, with some seeing added benefit of spending more time. So, while there are few ways to overcome limited time, this barrier mostly presents a hinderance to collaboration, rather than one that prevents collaborative efforts. Reduction in overall funding and funding restrictions were also

identified as capacity barriers. Practitioners highlighted that restrictions on where, how, and when funds are used is a key barrier to broad collaboration. Funding is needed for developing and maintaining collaboration in many ways including travel funds, administrative costs associated with operating collaborative forums, unequal compensation for critical partners (e.g., tribes), and covering participation-related expenses for critical partners who lack sufficient funds. While overcoming each of these barriers requires a targeted approach, there are opportunities for systemically addressing these issues.

Non-governmental organizations (NGOs) have a strong presence within the waterfowl management enterprise and are well positioned to address many capacity issues. Given the abundance and diversity of NGO partners, there are many ways that NGOs can add capacity. Engagement of large regional or national NGOs, such as Ducks Unlimited Inc. or California Waterfowl Association, can increase the volume and scope of habitat conservation projects by providing more individuals to do the work and additional funds. Universities and research-focused organizations have also increased the capacity to pursue applied research through increasing human capital (e.g., graduate student labor), through increasing intellectual capital, and by filling research gaps that may be outside the management purview of an agency. As interview participants described, overall funding and funding restrictions have posed a barrier to collaboration. Given the role of NGOs to add capacity, they may be able to leverage collaborative relationships to overcome such funding constraints. Additionally, there is a need for funding agencies to become more open to funding collaborative processes, not just actions, as others have noted (Brondizio et al. 2016).

Governance structures, policies, and regulations pose barriers for large governmental agencies and other organizations wishing to collaborate with those agencies. Within many

elements of waterfowl management, state and federal agencies have the final authority on many decisions, and non-governmental partners acknowledge this. Harvest regulations, which predominantly drive population management, are by law set by the federal government. Habitat management decisions for wildlife areas, such as state wildlife management areas and federal national wildlife refuges, are made by the managing agency. These agency mandates mean that agencies must voluntarily engage in collaboration within this system. Indeed, voluntary engagement is a central tenet of environmental conflict resolution (Wondolleck 2010) and by extension collaborative environmental management. While very few participants explicitly described building buy-in and support for management as a motivation for collaboration, this difference in decision-making power between governmental and non-governmental partners implicitly suggests that collaboration on the part of governmental agencies can achieve this goal. Voluntary engagement in true collaboration can also be leveraged to overcome any barriers inherent in governmental structures and processes that prohibit true co-management and fair sharing of management responsibilities and decision-making (Olsson et al. 2004, Armitage et al. 2009, Kimengsi et al. 2019).

Migratory Bird Joint Ventures play an important role in collaboration and can help overcome jurisdictional mismatch and other governance issues that often pose barriers to collaboration. Each Joint Venture creates a forum within which smaller or more narrowly focused partnerships can form. Also, by setting regional objectives, Joint Ventures ensure that even local collaborative efforts can have impacts that contribute to regional goals. In this way, they facilitate broad landscape management and work within and across structural barriers present within governmental agencies. Participants acknowledged this particular role of Joint Ventures and discussed how they positively contributed to ecosystem level science and management within

each region. Furthermore, Joint Ventures can adapt to the evolving interests and shared goals of partners that are a strong driver of collaborative efforts.

There are several aspects of waterfowl management that may divide individuals and organizations and inhibit collaboration. There are siloes between different elements of management, different perspectives on management approaches, and competing goals between groups engaged in management. All of these represent fractures or divisions within the waterfowl management enterprise caused by a lack of a cohesive systems level approach to management or conflict within management efforts. Across many complex social-ecological systems, there is a need for a systems level approach to management to improve fit (Bodin 2017) Additionally, conflicts and disagreements may be common in cross-sector collaborations where partners have multiple objectives (Bryson et al. 2015). However, leaning into collaborative governance tools is a useful way in which practitioners, particularly within the public sector, can successfully span multiple sectors (Scott and Thomas 2017). NGOs can also facilitate a more systems level approach within collaborative partnerships and help bridge seemingly disparate goals. This may be particularly true of NGOs with broader missions, beyond waterfowl, that can tap into constituencies with diverse interests (e.g., multi-benefit wetland conservation, water conservation).

Waterfowl management occurs within a complex system that necessitates collaboration. Certainly, some management such as isolated management of a protected area or an individual state's hunting regulations could be achieved by a single agency or organization operating alone. However, a broad landscape approach is needed for waterfowl that addresses the conservation of all elements important to the species life history (Kirby et al. 2008, Runge et al. 2014). This type of flyway-level management requires engagement across multiple sectors including public

agencies, non-governmental organizations, and private individuals and companies. We identified several key barriers to such partnerships including limited capacity, incongruent governance structures, and divisions between partners. Still, practitioners highlight that there are strong motivations for collaboration within waterfowl management that often parallel these barriers as partners collaborate in order to increase capacity, overcome jurisdictional mismatch or constraints within single governmental agencies, and pursue shared goals. By leveraging these motivations and existing roles of organizations, there is a path forward for sustaining long-term collaborations and improving flyway level management.

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2.6 Figures

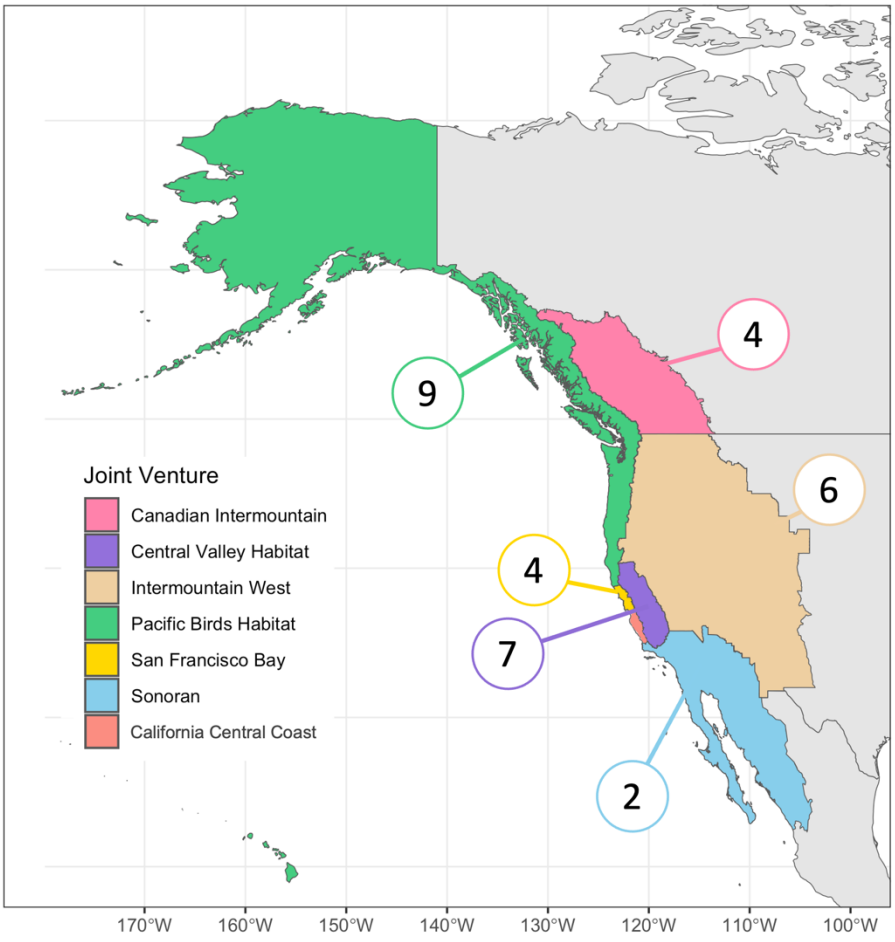

Figure 2.1 Pacific Flyway Migratory Bird Joint Venture regions. Numbers indicate number of interviews conducted in each region.

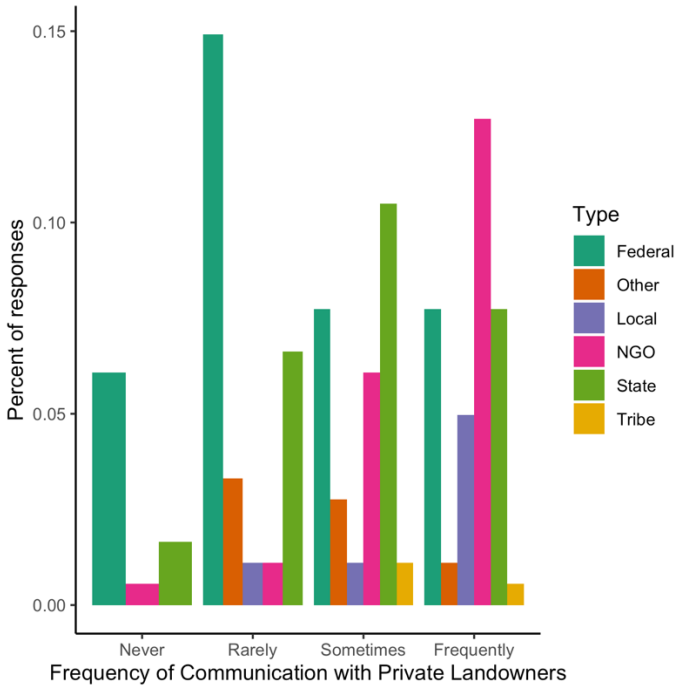

Figure 2.2 Frequency of communication with private landowners by entity type as self-reported in the waterfowl management collaboration survey.

2.7 Tables

Table 2.1 Professional attributes of participants contacted through semi-structured interviews about collaboration and migratory waterfowl management.

Professional attribute	Number of interview participants (n = 32)
Actor Type	
Joint Venture[b]	8
Federal agency	9
Tribal government or organization	1
State agency	6
Local agency	1
Non-governmental organization	7
Other entity	1
Management Scope	
National (+international)	4
Regional	17
Local	7
Years in profession	
< 5	2
5-10	5
10-20	11
20-30	9
> 30	5

[b] Joint Ventures may have multiple hiring and fiscal agents, some federal and some non-governmental; hence, they are identified separately

Table 2.2 Key motivations driving collaboration in the management of migratory waterfowl.

Category	Engagement in collaboration is motivated by:
Shared goals and interests (n = 22)	A shared interest in specific aspect or target of management
	A shared aim to broaden the scope of management and pursue flyway level or whole life cycle management
	A specific goal to engage in a collaborative process
Funding (n = 15)	A need or desire to increase overall funding by leveraging smaller funds, accumulating match funds, and/or increasing the likelihood of receiving funds through collaborative grants
Individuals (n = 15)	Personal connections whether the relationship is formed or reinforced by personal connections
	An individual's interest in some element of management
Context-specific factors (n = 17)	Location
	Filling gaps in expertise
	Multiple agencies' scope of work

Motivations identified through semi-structured interviews with 32 key informants in waterfowl management.

Table 2.3 Key barriers inhibiting collaboration in the management of migratory waterfowl.

Category	Collaboration is inhibited by:
Capacity (n = 25)	Funding restrictions
	Overall funding of partners
	Limited time to spend on developing, maintaining, and engaging with partners
Governance (n = 21)	Jurisdictional mismatch
	Regulations and policies
Waterfowl management enterprise (n = 14)	Siloed management between population and habitat management
	Different perspectives within waterfowl management about appropriate actions or approaches
	Competing goals with partners whose focus is not waterfowl management, but whose collaboration is required or sought to advance waterfowl management
Individuals (n = 8)	Individual personalities

Barriers identified through semi-structured interviews with 32 key informants in waterfowl management.

CHAPTER 3

DRIVERS OF COLLABORATION IN REGIONAL MANAGEMENT NETWORKS: A CASE STUDY OF WATERFOWL MANAGEMENT AND MIGRATORY BIRD JOINT VENTURES

3.1 Introduction

Cross-sector collaboration is increasingly practiced within natural resource management. Migratory species often cross multiple jurisdictions and land tenure where management may be fragmented. This creates ecological interdependencies between regions and habitats which compels the use of collaboration. Collaboration within a network governance system is particularly beneficial for the conservation of migratory species and the large landscape on which they depend (Scarlett and McKinney 2016). Collaborative governance and co-management can increase the resilience and adaptive capacity of social-ecological systems (Folke et al. 2005). Many factors drive collaboration in informal partnerships and formal collaborative governance regimes (Ulibarri et al. 2023). The drivers of collaboration can manifest at levels from individuals to organizations to multi-institutional systems (Lubell et al. 2012, Lubell 2015). Using a network focused on the management of migratory waterfowl across the Pacific Flyway, in which interorganizational relationships are nested within larger regional partnerships, we ask, how do organization and system attributes affect cross-sector collaboration and collaborative partnerships?

Migratory waterfowl are managed by a network of entities operating within different sectors, at different scales, and within different regions. Waterfowl management operates within a system of regional partnerships, Migratory Bird Joint Ventures (Joint Ventures hereafter). Joint Ventures are formal groups designed to facilitate collaboration at regional scales relevant for waterfowl management. Each Joint Venture covers a particular geographic region (Figure 1), though

engagement with Joint Ventures differs for organizations working within those regions. Therefore, the sector, scope, and region in which every organization works differentially impacts the likelihood of working together within a management network.

There are many types of governance networks including those focused on cooperation, coordination and collaboration (Mandell and Keast 2007, McAllister and Taylor 2015). Collaboration, specifically, is defined in different ways by several frameworks. Ansell and Gash (2008) view collaboration as a government-directed arrangement in which state and non-state actors engage in a "formal, consensus-oriented" decision-making process. The Pacific Flyway Council, directed by the U.S. Fish and Wildlife Service with representatives from each state, engage in such a formal, government-directed process to determine national harvest regulations. Emerson et al. (2012), by comparison, take a broader view where decision-making and management "engages [partners] constructively across the boundaries" of many sectors. This form of collaboration aligns more strongly with the self-directed Joint Venture partnerships. We use the terms collaboration and collaborative partnerships broadly to refer to formal and informal relationships between two or more organizations in order to achieve something that could not be accomplished individually (McNamara 2012). This allows for the discussion of collaborative partnerships between two entities that can measured as a tie in the whole management network, as well as discussion of a system of collaboration that facilitates large scale management goals of migratory species.

3.1.1 Collaborative governance and network theory in social-ecological systems

Network theory has long offered a way to conceptualize social systems, particularly with respect to governance and environmental issues (Janssen et al. 2006, Borgatti and Halgin 2011).

Social networks have been used to investigate the optimal social structures for collective action (Gould 1993), collaborative co-management (Olsson et al. 2004), and policy outcomes (Meek 2013). When representing these issues as a social network, the nodes may represent individual actors, stakeholders, or organizations, while the ties (edges) linking them can represent different types of relationships including knowledge sharing (Baggio and Hillis 2018), collaboration (McAllister et al. 2017, Sayles and Baggio 2017), trust (Hahn et al. 2006), and shared resources (Borgatti et al. 2009). Using network analysis, we can examine how node and edge attributes lead to the formation of collaborative ties.

3.1.2 Organization level drivers of collaboration

At an organization level, features of individual organizations, such as resource availability and management scope, impact their relationships to one another. In particular, the structure of partnerships and their members within cross-sector collaborations can affect the outcomes of such endeavors (Bryson et al. 2006). Resource Dependence Theory (Pfeffer and Salancik 1978) has been a critical theoretical advancement to help us understand interorganizational relationships. This theory presents the idea that in an interdependent and resource-limited system, interorganizational relationships are one way to reduce uncertainty surrounding acquisition of important resources (Pfeffer and Salancik 1978, Hillman et al. 2009). In other words, organizations that have higher uncertainty surrounding obtaining important resources are more likely to engage in collaborative efforts. This theory is supported in various policy networks (Park and Rethemeyer 2012, Calanni et al. 2015), where organizations are more likely to collaborate with other entities that have critical resources.

Federal and state agencies are charged with the management of public natural resources, including waterfowl and their habitat. As such, relative to other organizations in the field, they have the resources – both financial and human – with which to engage in management actions. Although having resources, these resources are limited and likely not fully sufficient (Echols et al. 2019). In contrast, local agencies, non-governmental organizations, tribes, and other smaller entities can work at a narrower scope, lack jurisdictional authority and/or have fewer available resources. Therefore, we expect that these latter organizations are likely to work more intensively with non-similar types of organizations across sectors.

> Hypothesis 1: In a management network, federal and state agencies are more likely to work with other federal and state agencies (exhibiting homophily of organization type in a collaborative partnership) compared to other entity types.

Organizations in all sectors operate at different scales and it is important to consider cross-scale dynamics, particularly within networked governance of larger systems (Wyborn and Bixler 2013). Interactions between organizations operating at one scale can impact governance at another scale, while the scale at which each organization works can impact the overall likelihood of collaboration. Organizations with larger management scopes may be more dependent upon partnerships and more likely to engage in collaboration in order to achieve their goals. Collaboration is critical when addressing large scale issues particularly when national and international management is achieved through implementation of actions at the local (Cash et al. 2006). For waterfowl management, some organizations and agencies focus on flyway-level management, such as harvest management through the Pacific Flyway Council, while others have a narrower focus, such as providing sufficient habitat within a particular region. National wildlife refuges, wildlife management areas, and other protected areas provide critical habitat for

migratory birds. These protected areas are managed at a highly localized scope, independently from one another and independently from other actors in the same agencies with more regional responsibilities. Therefore, we consider individual protected areas to be separate entities that collaboratively engage with other organizations in different ways.

> Hypothesis 2: Entities with larger management scopes are more likely to collaborate relative to those with a narrower management scope, particularly management areas.

3.1.3 System level drivers of collaboration

Qualities of the social, political, and ecological environment at a systems level can also drive collaboration among organizations. Large regional and national networks can facilitate collaboration among local entities (Fünfgeld 2015, Picavet et al. 2023), which is critical when large scale issues are addressed at the local level (Cash et al. 2006). Overarching political systems with different decision-making processes and power structures (Metz and Brandenberger 2022) and the level of institutionalization within a system (Berardo and Lubell 2016) can also impact both whole network structures and interorganizational interactions. When organizations participate in larger collaborative groups, they are more likely to form individual collaborative relationships (Scott 2016). Joint Ventures are the dominant collaborative groups addressing waterfowl habitat management at a regional level and they are designed to facilitate collaboration among organizations. Therefore, we expect Joint Venture participation to lead to an increase in collaboration.

> Hypothesis 3: Organizations that are more heavily involved in Joint Venture efforts are more likely to form collaborative ties in the broader management network.

Ecological dynamics of a complex system also impact collaboration particularly for natural resource management. Effective management of complex social-ecological systems depends on institutional fit (Epstein et al. 2015) and the alignment between governance and ecological processes operating within the system (Bodin 2017). Scaling decision-making and management actions to characteristics of the ecological system can improve fit (Folke et al. 2007). Natural resource management is further improved when collaboration and social structures spatially align with the resources (Cumming et al. 2010). When organizations consider ecological dynamics when choosing to collaborate or participate in collaborative efforts, the overall collaborative network is more likely to demonstrate good social-ecological fit.

The Joint Ventures are social systems that were designed to align with waterfowl ecology, as they were developed around ecologically-relevant regions for waterfowl (Cohn 2005). Joint Ventures were established at different times, with a particular management focus in mind, and importantly, vary with respect to when and how intensively waterfowl use habitat within each region. We therefore expect the likelihood of collaboration to vary among regions based on their institutional characteristics and ecological patterns.

> Hypothesis 4: Organizations operating within regions with high concentrations of waterfowl are more likely to engage in collaboration, contributing to social-ecological fit.

3.2 Methods

3.2.1 Pacific Flyway Regions

Migratory Bird Joint Ventures (JVs) were established in the North American Waterfowl Management Plan (NAWMP). These Joint Ventures are comprised of government agencies, non-

governmental organizations, scientific institutes, private entities, and individuals who work together to advance habitat management for waterfowl (Cohn 2005, Giocomo et al. 2015). Joint Ventures are forums that facilitate collaboration among different entities. Each Joint Venture also employs several staff, including a coordinator and scientific coordinator and in this way are also entities unto themselves. Every 10-20 years, Joint Ventures aim to release regional implementation plans outlining key management issues and goals. These plans do not direct implementation of management actions, but rather serve as a guide for partnering organizations. Additionally, Joint Ventures were established around ecologically-relevant regions for waterfowl (Interior et al. 2018). Therefore, in this paper we define broad management regions based on the geographic boundaries of each Joint Venture.

The Pacific Flyway crosses seven Joint Ventures and spans from Alaska and British Columbia through Northwestern Mexico (Figure 3.1). These JVs vary in terms of management goals and institutional attributes. All JVs receive federal funding and while many JV staff are technically employed by the federal government, others are employed through separate nongovernmental organizations. There is variation in the composition and formulation of their boards, though most include some representation from governmental, nongovernment, and private entities. Given the migratory nature and broad range of waterfowl species, there are ecologically valuable areas within every JV region, though some are more critical for certain stages. We describe some of this institutional and ecological variation below.

The Central Valley Joint Venture (CVJV) was the first habitat Joint Venture established within the Pacific Flyway, in 1988. It originated as an exclusively-waterfowl focused JV, and though it has expanded its goals to include many migratory birds, it maintains a strong emphasis on waterfowl management. The California Central Valley supports 60% of all wintering

waterfowl along the Pacific Flyway (CVJV 2020). It also supports about 33% percent of North America's Northern Pintail (*Anas acuta*) population, which is one of few waterfowl species experiencing population decline. The emphasis on providing wintering waterfowl is partially driven by the substantial decline in habitat as the Central Valley has seen a 90% loss in wetlands (Frayer et al. 1989). While perhaps known for wintering waterfowl, the region also supports between 150,000 – 300,000 breeding waterfowl.

The Pacific Birds Habitat Joint Venture (PBHJV) was established in 1991 and covers the largest geographic region. The PBHJV covers coastal regions of northern California, Oregon, Washington, British Columbia, and all of Alaska, as well as the U.S. Pacific Islands. The Joint Venture is designed as a binational partnership, though maintains separate U.S. and Canadian coordinators. Furthermore, the British Columbia portion and U.S. portion operate separately at times, with the PBHJV – British Columbia partners releasing separate implementation plans (PBHJV-BC 2020). Additionally, while the Joint Venture includes the Pacific Islands, these partners are rarely engaged in continental waterfowl management. The PBHJV began as a waterfowl-focused JV and has since expanded to an all-birds model. While there is still a central goal of supporting wetland conservation for waterfowl, efforts have also extended into other migratory bird habitats. Given the very broad geographic scope of the Pacific Birds Habitat region, it is difficult to precisely quantify ecological value for the entire region. Alaska may support between 10-12 million breeding waterfowl (ADFG 2015). The British Columbia portion supports migratory waterfowl and 1 million wintering waterfowl (PBHJV-BC 2020), and coastal regions of California, Oregon, and Washington also support many waterfowl during migration.

The Intermountain West Joint Venture was established in 1994 and covers at least parts of 11 states in the western U.S. It maintains a strong focus on waterfowl management. While the scope

of the region is quite large, there are a few key sub-regions that support larger concentrations of waterfowl. The Great Salt Lake in Utah supports 2.8 million wintering waterfowl (IWJV 2013). The Columbia Basin in western Washington supports over 1 million birds, particularly Mallards (*Anas platyrhynchos*) during migration. The Southern Oregon Northeastern California (SONEC) region provides critical fall and spring habitat during migration for a high concentration of up to 4.9 million birds (IWJV 2013). Additionally, there are between 1.6 and 2.1 million waterfowl breeding in the IWJV region each year, amounting to 5% of the continental breeding population.

The San Francisco Bay Joint Venture (SBFJV) was established in 1996 and is the smallest region covering the San Francisco Bay and surrounding area. The key management priority for this region is restoration of the estuary and wetland ecosystems. While providing wetland habitat for waterfowl is an important goal, it is not the same driving force as it is in the earlier established Joint Ventures. Based on stepped-down population goals, the SFB region aims to support over 200,000 waterfowl (SFBJV 2022). As a coastal and estuarine region, the SFBJV is particularly important for sea ducks and diving ducks, where other regions support larger populations of dabbling ducks.

In 1999, all Joint Ventures began incorporating other migratory birds, in addition to waterfowl, into their conservation priorities. The Sonoran Joint Venture (SJV), established that same year, became the first Joint Venture to have an all-bird focus at the outset. The SJV is also a binational JV covering a large region including parts of southern California and Arizona and nine states in Mexico. The Sonoran JV board and staff have representation from the U.S. and Mexico and operate more as a single entity. The Sonoran region supports a large number of wintering waterfowl (upwards of 2.2 million) and provides critical habitat for a few key species (Beardmore 2007). Across a few key sub-regions including the California Salton Sea and the

Sonora-Sinaloa coast, the Sonoran region supports 80% of Pacific Brant (*Branta bernicla*), 70% of Redhead (*Aythya americana*), and 50% of Ruddy Duck (*Oxyura jamaicensis*) wintering populations along the Pacific Flyway (Beardmore 2007). The Sonoran region also provides wintering habitat for waterfowl that breed in the Central Flyway.

The Canadian Intermountain Joint Venture (CIJV), established in 2003, covers 123.5 million acres across central British Columbia and a small portion of Alberta. The JV has an all-bird focus and maintains strong waterfowl goals, given the importance of this region for breeding waterfowl. Between the CI region and the portion of the Pacific Birds Habitat region in western British Columbia, there is substantial overlap in the individuals and organizations working in regions, serving on the boards, and filling coordinating roles. However, the regions are ecologically distinct. The PBH-BC region has a stronger focus on wintering and migratory waterfowl, while the CI region is more important for breeding birds. The CI region supports 1.45 million breeding waterfowl, or about 5% of Canada's breeding population (CIJV 2020).

Lastly, the California Central Coast Joint Venture (CCCJV) recently established in 2020. This Joint Venture covers the last remaining region in the United States without a JV. Their board and staff seem to have stronger representation of nongovernmental organizations relative to other regions. The CCCJV has a strong all-birds focus with considerably less emphasis on waterfowl. The region supports thousands of sea ducks during migration, though the regional plans do not indicate specific waterfowl population goals (C3JV 2022).

3.2.3 Data collection

The Pacific Flyway management network for migratory waterfowl was developed using a web-based survey instrument. We used purposeful sampling to develop an initial survey list, with

participants stratified across three dimensions: Joint Venture regions, key sectors (e.g., federal, state, local, and NGO), and focus of management (e.g., habitat, population). Individual contacts for every entity were pulled from agency websites, waterfowl management documents (e.g., Joint Venture Implementation Plans), and from initial semi-structured interviews conducted by the lead author (Karasov-Olson *chapters 1 & 2*). We designed the survey instrument to (1) collect key professional affiliation attributes about respondents (e.g., years in the profession, management focus, management scope), (2) identify professional connections and categorize those relationships, and (3) evaluate respondents' involvement in and perceptions of the Joint Venture system (Appendix 1 Table A1.2).

We used a hybrid name generator approach (Henry et al. 2012) to develop the network by asking with whom respondents communicate about waterfowl management. The large number of individuals and organizations involved in waterfowl management across the Pacific Flyway meant that a roster-based approach would likely lead to a high degree of instrumentation bias, particularly for smaller organizations and those located outside of the California Central Valley where the authors are based. Creating free recall name generator categories based on entity type (e.g., federal agencies, state agencies, non-governmental organizations) can reduce recall bias (Henry et al. 2012) and help reduce the impact of only recalling strong, frequent ties that is common for free-recall elicitation of networks (Hammer 1984, Brewer 2000). We used a fixed-choice for each free-recall category to improve comparability between responses and reduce the processing load for survey participants (Jariego 2018) allowing respondents to list up to six connections for each entity type (Merluzzi and Burt 2013). We included two name interpreter questions posed question-wise, as opposed to alter-wise, to reduce respondent fatigue and non-redundancy effects which can lead to higher drop-out rates (Vehovar et al. 2008, Pustejovsky and

Spillane 2009). One name interpreter question focused on the element(s) of waterfowl management (i.e., populations, habitat, human dimensions) discussed with each connection. Semi-structured interviews with key informants in waterfowl management identified these distinct aspects of waterfowl management and revealed that practitioners perceive separation between those working on these three aspects of management (Karasov-Olson et al. *in prep*). For the second name interpreter question, participants were asked about the type or extent of collaborative relationship they shared with each connection: sharing resources (e.g., financial, technical; Alexander et al. 2017), implementing joint activities (e.g., Rathwell and Peterson 2012), and collaborating on decision-making. The survey was distributed online through Qualtrics initially to 252 individuals. Two subsequent snowball rounds included an additional 393 individuals. The survey was available July 2022 through February 2023. Our overall survey response rate for organizations was 34.02%, with modest regional variation (e.g., our highest survey response rates were in small California Joint Venture regions) and considerable variation by entity type (e.g., low response rates for tribes and local agencies, but a high response rate for state agencies; Appendix 2).

3.2.3 Data analysis

We analyze the influence of organization and systems level drivers on collaboration using exponential random graph models (ERGMs). Observations on the likelihood of forming a collaborative tie (or dyad) between any two organizations in network violates the assumption of independence required for more traditional regression because of the interdependence among ties in a network (Cranmer and Desmarais 2011). ERGMs allow for the simultaneous modeling of endogenous or structural features of a network alongside exogenous variables of interest

(Cranmer and Desmarais 2011), where the traditional ERGM estimates the degree to which network structures are the over- or under- represented in the empirical network relative to what is expected by chance (Robins et al. 2007, Lusher et al. 2013). Here we use the actor-oriented (not to be confused with stochastic actor-oriented models used as an distinct approach to network analysis; Snijders et al. 2010), or micro-level interpretation in which ERGM estimates represent the probability of observing a given tie in the network (Desmarais and Cranmer 2012). In a binary ERGM, this interpretation focused on the probability of the presence or absence of a tie is analogous to a logistic regression.

We extend this interpretation with the use of valued ERGMs (Krivitsky 2012), where the tie is weighted by the types of collaboration relationships between each organization. We use the different types of collaborative relationships (communication, sharing resources, jointly implementing projects, and collaborating on decision making) as the basis for a weighted edge in our valued ERGMs. The weight is based on the number of types of relationships (1-4) present between two nodes.

Within this network, nodes are grouped at the organization level for most entities. Two exceptions for this level of grouping are based on broad management scope and management focus. Federal agencies and national non-governmental organizations are split by division (e.g., U.S. Fish and Wildlife Services Migratory Birds is distinct from Ecological Services) and region (e.g., The Nature Conservancy California is distinct from The Nature Conservancy Alaska). Individual protected or management areas are identified as distinct nodes (e.g., a single Wildlife Management Area is a distinct node from its managing state agency). While this grouping obscures conclusions about inner-agency collaboration and collaboration targeted at the programmatic level, it allows for more robust analysis of inter-agency collaboration.

We analyze four categories of node attributes to test our four hypotheses: (1) entity type, (2) management scope, (3) level of JV involvement, and (4) JV region(s) of management. Table 3.1 outlines how each hypothesis is operationalized with these attributes. Entity types (Table 3.1) include federal, tribe, state, local, non-governmental organizations (NGO), and other, where other includes private individuals, private entities, universities, and forums.

Organizations in this network operate at different management scopes (Table 3.1). There are several available scales that represent the geographic scope of work for each node: (1) individual self-reported scope from the survey (local, substate region, state-wide, multi-state region, national/international), (2) organization wide scope (local, regional, national), and (3) number of covered Pacific Flyway Joint Ventures (1-7, 8 represents JVs external to the Pacific Flyway). Organization wide scope is determined by the following rules. Some organizations have local responsibilities at the city, county, or distinct level. Individual protected areas are also considered local in scope, even if they are managed by national organizations (e.g., U.S. Fish and Wildlife Service National Wildlife Refuges), as protected areas have designated management staff. Entities that have flyway-wide, national, and/or international responsibilities are all identified as national in scope. The precise scope for regional organizations varies and includes entities the focus on substate regions (e.g., California Central Valley), entire states, and multi-state regions (e.g., Southern Oregon Northeastern California region). Self-reported scope and organization wide scope are modestly correlated (Cramer's V = 0.5466). Differences occur due to grouping at the entity level where some individual survey respondents may work at a narrower scope within an agency that works at a larger scope. Organization wide scope and number of Joint Venture regions are also modestly correlated (Cramer's V = 0.5926). We are interested in modeling scope as an organization level attribute distinct from the Joint Venture systems and therefore use the

organization-wide categorization (local, regional, national) as the scope variable when modeling organization-level influence on collaboration.

The level of involvement with Joint Venture activities differs for every entity (Table 3.1). Survey respondents were asked to identify with which of the Pacific Flyway Joint Ventures they were involved. Subsequently, they reported their level of involvement with each Joint Venture ('little', 'somewhat', or 'heavily'; 'none' implied by no Joint Venture selection). These responses were grouped at the highest level of involvement indicated for any Joint Venture to create a single measure for Joint Venture involvement for each node. For example, an entity that reported little involvement in the Central California Coast Joint Venture and heavy involvement in the San Francisco Bay Joint Venture was coded as heavily involved in Joint Ventures overall. Current implementation of ERGMs cannot handle missing data for node factors. Therefore, in order to analyze the influence of Joint Venture involvement, a 'Missing' category was added for all missing data.

Each entity operates within a single or multiple Joint Ventures region(s) depending on their respective responsibilities, regardless of whether it is involved in Joint Venture activities. We created a dummy variable for each Pacific Flyway Joint Venture region indicating whether the entity does or does not work within the boundaries of each region (Table 3.1). Joint Venture regions differ with respect to ecological value for waterfowl. We use waterfowl populations and management focus within each region as proxies for ecological patterns (Table 3.2) and assess social-ecological alignment (H4) by evaluating the effect of region on patterns of collaboration.

When attempting to analyze all variables of interest simultaneously, we encountered issues with model degeneracy and the model would not converge. Therefore, we ran two separate models to evaluate our hypotheses: one focused on organization level drivers (H1 & H2) and one

focused on Joint Venture regions as systems level drivers (H3 & H4). Additionally, in each model we include structural terms for zero-inflation and transitivity (a friend of a friend is a friend) adapted for valued networks (Krivitsky 2012). Analyses were conducted using the `ergm.count` package (Krivitsky 2022) within the `statnet` family of packages (Handcock et al. 2008) in R (R Core Team 2023).

3.3 Results

3.3.1 General Network Descriptors

Based on the responses from the waterfowl management collaboration survey, we created a waterfowl management network comprised of 1153 entities (nodes) and 2141 connections (edges) between those entities (Figure 3.2). The distribution of nodes across types is similar for those who responded to the survey (egos) and those who were named connections (alters; Figure 3.3). Management areas account for 23.2% of all network nodes. Most organizations in the network operate at a local management scope (52.0%), while 38.1% and 9.9% operate at a regional and national scope, respectively. The Intermountain West and Pacific Birds Habitat Joint Ventures are most represented within the network (Figure 3.4A). The majority of entities – 73.5%– work within a single Joint Venture region (Figure 3.4B, 3.4C). Seven percent of nodes work across two Joint Ventures and 7% work across all seven Pacific Flyway Joint Ventures. Overall, the resulting waterfowl management network is quite sparse, with low transitivity, but modest eigenvector centralization (Table 3.3).

We ran two valued ERGMs to test the influence of (1) organization level drivers (H1, H2) and (2) system level drivers (H3 & H4) on the likelihood of forming a collaborative relationship

within the waterfowl management network. The number of collaborative activities in which entities engaged with other entities was used as the bases for the edge weights in the valued ERGMs. The types of collaborative activities used to categorize edges were derived from survey respondents. Survey respondents were asked to name organizations with which they communicate about waterfowl management. Therefore, every tie within the network represents communication. They were subsequently asked to identify with which of those organizations they participate in collaborative activities. This produced a network where 58.6% of edges also represent sharing resources, 55.9% represent joint implementation of projects, and 66.7% represent collaborative decision-making. The edge weights represent a count of the number of activities in which they engage (1-4). Only 8.9% of edges represent a single type of relationship, and 34.4%, 23.2%, and 33.5% of edges represent two, three, and four types of relationships, respectively.

3.3.2 Hypotheses 1 & 2: Entity Type and Management Scope

There is considerable variation in the positions of entities within the network by type and management scope (Table 3.4). State agencies have the highest mean degree and betweenness making them central to this management network, whereas tribes and local agencies have fewer connections on average and are more peripheral actors. Mean degree increases as the management scope of entities increases, though regional actors have slightly higher betweenness. Results from the valued ERGM focused on organization level drivers of collaboration reveal that both entity type and management scope significantly affect the likelihood of forming a collaborative tie (Table 3.5, Figure 3.5). In a valued ERGM, the intercept is designated by sum, and when the coefficient is exponentiated, represents the baseline for the expected number of

relationship types between any two nodes in the network based on the base level of node factors included in the model (see Table 3.1 for identification of base levels for each node factor). The expected number of collaborative activities for a federal entity operating at a local scope is on average 1.6. The highly significant negative estimate for the nonzero coefficient (Table 3.5) demonstrates that this network is highly zero-inflated with zero interactions between many nodes in the network. Additional parameter estimates when exponentiated can be interpreted multiplicatively from the baseline sum coefficient. Relative to federal agencies, only state agencies are more likely to form collaborative ties and likely to engage in 1.2 times as many collaborative activities (Table 3.1). "Other" organizations are significantly less likely to engage in collaborative activities. Relative to all other entity types operating at any management scope, tribes are likely to engage in the fewest number of collaborative activities. There is some evidence of homophily among entity types in this network, particularly for federal agencies and NGOs (Table 3.5), however the effect of homophily is of a lower magnitude and exhibits greater variation than the influence of an individual entity type alone (Figure 3.5).

The influence of scope is significant and appears stronger than the influence of entity type (Table 3.5, Figure 3.5). Entities with both regional and national management scopes are more likely to form collaborative ties relative to local entities. The effect of regional scope is marginally larger, leading to forming an average of 1.43 more collaborative ties compared to 1.38 more ties for entities with a national scope (Table 3.5). The estimate for protected areas is slightly positive, though not significant, indicating a possible, but insignificant increase in the likelihood of forming ties relative to other entities.

3.3.3 Hypotheses 3 & 4: Joint Venture Involvement and Region Differences

Mean degree and betweenness based on JV involvement is considerably higher for entities that are heavily involved in JVs (Table 3.4), demonstrating that JV involvement is correlated with a greater occurrence of collaborative relationships and more central organizations tend to be highly involved in JVs. The second valued ERGM demonstrates the significant effect of Joint Venture involvement and regional differences in the likelihood of forming collaborative ties (Table 3.6, Figure 3.6). As the level of Joint Venture involvement increases, the likelihood of forming collaborative ties increases (Figure 3.6). This effect appears nonlinear with heavy involvement having the strongest significant impact and leading to engagement in 1.4 times more collaborative activities (Table 3.6). There is also a significant influence of region on the likelihood of forming a collaborative tie. Entities working within the Central Valley or Central California Coast region are more likely to engage in collaborative activities. Entities working within the Sonoran or Canadian Intermountain regions, on the other hand, are significantly less likely to engage in collaborative activities (Figure 3.6). The base level of regional scope for this model are entities working exclusively within a single region. Organizations working within Joint Venture regions outside of the Pacific Flyway are less likely to form collaborative ties, while entities that work across multiple Joint Venture regions are likely to engage in 1.2 times more collaborative activities.

This pattern is reflected in examination of cross-boundary ties. Based on the regions within which each entity works, we determined which edges represented within region and cross-boundary collaboration. Most edges represent collaboration between entities working within multiple regions where at least one region is overlapping (58.2%). Additionally, 38.4% of edges occur between entities working exclusively within the same region. Only 3.4% of edges represent cross-boundary collaboration between entities that do not work within the same region.

This provides parallel support to ERGM results that entities working regionally collaborate more, particularly when management regions overlap.

We created separate regional networks for each JV region in order to further explore regional differences (Figure 3.7, Appendix 3). Regional networks were created by isolating nodes that work within a given region plus any alters identified by those nodes in survey responses. These regional networks are very similar across many descriptive network statistics (Table 3.7). However, a few key differences emerge. The Intermountain West, Pacific Birds Habitat, and Central Valley networks all have a relatively higher percent of within region collaboration between two entities working exclusively within the same region (Table 3.7). The San Francisco Bay and California Central Coast networks have the highest percent of edges between entities working in overlapping regions. The mean degree of entities working within these two regions is also highest relative to other regions (Table 3.7). The Pacific Birds Habitat and Canadian Intermountain regional networks have highest incidence of cross-boundary collaboration (Table 3.7). We modelled the effect of regional homophily and regional scope on collaboration within each of the regional networks, and results support our broader findings of collaboration in the whole network (Table A3.2). There was very little difference between the regional ERGMs, though entities working within multiple regions see a stronger increase in the likelihood of collaboration within the California Central Coast region (Figure A3.2). There are also some differences between the five highest degree nodes within each regional network (Table A3.3). For the whole Pacific Flyway network, the entities with the highest degree are the California Department of Fish and Wildlife (CDFW; state agency), U.S. Fish and Wildlife Service (USFWS) Migratory Birds Program (federal agency), California Waterfowl Association (NGO), Ducks Unlimited Inc. (NGO), and the U.S. Geological Survey Western Ecological Research

Center (federal agency). CDFW plays a critical role along Pacific Flyway, and indeed is the top degree node in all regional networks except the Canadian Intermountain regional network (Table A3.3). In the Canadian Intermountain network, Ducks Unlimited Canada is the highest degree node, followed by the Canadian Wildlife Service (CWS; federal agency).

3.4 Discussion

There are strong organization and systems level drivers of collaboration within the Pacific Flyway waterfowl management network. Results from the organization level valued ERGM mostly support our first two hypotheses about the effects of entity type and management scope on collaboration. Federal agencies exhibit significant positive homophily (i.e., federal agencies are more likely to work with other federal agencies), whereas local agencies, tribes, and other organizations do not. We expected federal and state agencies to exhibit the strongest homophily because they are less dependent on other organizations for resources necessary for management and have more autonomous authority over management actions. Conversely, NGOs exhibit more homophily relative to other entity types than expected. Many of the dominant NGOs working on waterfowl management issues, such as Ducks Unlimited, California Waterfowl Association, and The Nature Conservancy, are larger organizations. While they may not possess autonomous authority over some management decisions (e.g., harvest regulation), they may have greater capacity for other actions (e.g., wetland restoration). Additionally, the influence of homophily between state agencies is less than expected, and homophily overall is less significant compared to the effect of a single entity type alone. In particular, state agencies have the greatest significant effect on the likelihood of forming a collaborative tie (Figure 3.5).

With respect to management scope, entities with a regional or national management scope are significantly more likely to engage in collaboration, relative to those with a local management scope, supporting our second hypothesis (Figure 3.5). However, there is not a significant difference between entities operating at a local scope in general compared to managed protected areas specifically. Within a management network that operates at a scale as large as the Pacific Flyway, regional organizations can fill an important bridging role of guiding national efforts that are implemented at a local level. Regional actors can also facilitate knowledge transfer between key partners and across scales (Vantaggiato and Lubell 2022). Additionally, there is a strong correspondence between state agencies and entities operating at a regional scope.

These results illustrate that collaboration within the waterfowl management network is a state driven process, particularly when state agencies operate at the regional scale. We can see the influence of state agencies when examining particular nodes. There is substantial overlap between the key organizations working within JV regions. Indeed, the highest degree node in every region, except the Canadian Intermountain, is the California Department of Fish and Wildlife (CDFW). This is facilitated by the fact that all regions, except the Canadian Intermountain, are present within California. In the Canadian Intermountain region, the analogous state agency would be the British Columbia provincial government and relevant ministries. However, BC provincial ministries are conspicuously peripheral in this network. This is supported by previous interviews and qualitative analysis in which the province was identified as an important partner that was not very present in broader collaborative efforts (Karasov-Olson *Chapter 2*). Therefore, in the Canadian Intermountain region, with a smaller state presence, federal agencies and NGOs, such as Canadian Wildlife Service, Ducks Unlimited Canada, and

Birds Canada, are more central (Table A3.3). In larger Joint Ventures that cross multiple states, there are other state agencies (e.g., Alaska Department of Fish and Wildlife) that are among the highest degree nodes in regional networks (Table A3.3).

At the systems level, our results reveal significant differences among Joint Venture regions. Joint Venture involvement significantly and positively impacts the likelihood of engaging in collaborating activities (Figure 3.6). This supports other work that demonstrates that participation in collaborative forums leads to broader cooperation and coordination in environmental governance networks (Scott 2016) and can facilitate connections with additional actors and entities (Feiock 2013). While these results are significant, they may also be impacted by incomplete information. Inclusion of the nonzero parameter facilitates meaningful analysis and interpretation of the network as it accounts for the zero-inflated network driven by a low response and sampling rate. Nonetheless, follow-up survey efforts could improve analysis, in addition to analyzing the variability in involvement between Joint Ventures.

There are also significant effects of working within a given region, regardless of involvement with Joint Venture activities. Results from the regional valued ERGM show that entities working with the Central Valley and California Central Coast regions are significantly more likely to engage in collaborative activities (Figure 3.6). Examination of regional networks shows that some regions engage in more within region collaboration, while others have more cross-boundary collaboration (Figure 3.7, Table 3.7). These differences may be due to ecological and institutional dynamics.

We argue that there is some support for the hypothesis that the regional differences in collaboration are driven by ecological patterns. Using the reported numbers of waterfowl within each region as one possible proxy for ecological patterns (see Table 3.2), we can infer alignment

between regional collaboration and waterfowl during different stages of their lifecycle. For wintering waterfowl, we appear to see the greatest alignment where the boundary of the social system (Joint Venture) aligns with the geographic boundaries supporting waterfowl. The greatest concentration of wintering waterfowl occurs within the Central Valley of California, which supports 5.4 million birds or 60% of the Pacific Flyway's wintering waterfowl (CVJV 2020). Management for wintering waterfowl in arid regions in the southern extent of the Flyway, which have seen high levels of wetland habitat loss (CVJV 2020), is dependent on on-the-ground habitat management. These efforts require more localized or regional collaboration and can explain the more significant influence of the Central Valley region in our results and why we see a higher incidence of within region collaborative ties. The Intermountain West and Sonoran regions also see very high numbers of wintering waterfowl and accordingly a high incidence of within region collaborative ties. However, key areas for wintering waterfowl within those regions are less concentrated. For example, within the Intermountain West region, Southern Oregon Northeastern California (SONEC) supports 4.9 million migratory birds and the Great Salt Lake (GSL) in Utah supports 2.8 million wintering waterfowl (IWJV 2013). The Sonoran region supports 2.2 million wintering waterfowl among Salton Sea in California and the coasts of Sonora and Sinaloa in Mexico, among others. This dispersion of wintering populations may be why these regions do not significantly increase the likelihood of collaboration despite more within region ties.

Collaboration patterns differ for regions in the northern extent of the Pacific Flyway, specifically Pacific Birds Habitat and Canadian Intermountain, that support high numbers of breeding waterfowl. Alaska, which is located within the Pacific Birds Habitat region, supports 10-12 million breeding waterfowl (ADFG 2015) and the Canadian Intermountain region supports

1.45 million breeding waterfowl (CIJV 2020). Relative to regions in the southern extent of Pacific Flyway, there is a greater availability of existing wetland and nesting habitat within these two regions, creating less of a need for active habitat management. While working within these two regions does not significantly increase or decrease the overall likelihood of collaboration, their regional networks see the greatest incidence of cross-boundary collaboration with other regions. This type of cross-boundary collaboration is important for advancing large-scale conservation and management of species that cross jurisdictional boundaries (Kark et al. 2015). Interestingly, the Canadian Intermountain region and the Canadian portion of Pacific Birds Habitat in British Columbia share many entities and personnel.

Comparing population sizes within particular life stages is only a first step in examining ecological patterns across regions. Population sizes fluctuate year to year and the amount of time these birds reside within a region also differs. Additionally, even while some Joint Ventures have a primary management focus, most work on management issues across multiple stages. For example, the Central Valley has historically focused predominantly on wintering waterfowl, but there is a recognition that the region provides important breeding habitat as well. 60% of hunter-harvested Mallards and 49% of hunter-harvested Gadwall originated from resident birds breeding in the region (CVJV 2020). Therefore, these patterns of waterfowl populations only provide a partial explanation.

There is also a clear influence of institutional dynamics, especially for the California Central Coast region. The Joint Venture that covers the California Central Coast region was very recently established in 2020. Most of the entities working within that region at the time the survey was conducted were organizations that work across multiple regions, were already involved in waterfowl management, and/or had strong existing ties with other entities. After initiation of a

collaborative effort (or more formally a collaborative governance regime), there tends to be an increase in engagement where collaboration intensifies (Ulibarri et al. 2020). This intensification seems to be supported for the California Central Coast network which has the highest mean degree and ties formed between entities with overlapping regional responsibilities. The Central Valley, comparatively, is covered by a much older, more established Joint Venture. In more established, long-term ventures, collaboration can become the norm, creating a self-sustaining entity (Ulibarri et al. 2020, Imperial 2023). Indeed, the Central Valley, Intermountain West, and Pacific Birds Habitat, which have the oldest Joint Ventures that all began with a strong singular focus on waterfowl, have the highest incidence of within region collaboration but fewer collaborative relationships on average. Previous work has supported the theory that highly collaborative environments – such as those found in long-term stable efforts – can have lower network density and fewer but stronger ties (Ulibarri and Scott 2017). Furthermore, stronger and more successful collaboration can result from collaborative efforts focused on fewer goals or problems (Scott and Boyd 2023).

These patterns are indicative of a more complex view of social-ecological alignment that warrants further investigation. First, there is a need to more rigorously assess social-ecological fit by directly measuring the ecological network of waterfowl moving across the flyway and through use of social-ecological network analysis (Bodin and Tengö 2012). Given the extent to which collaboration in waterfowl management is a state and regionally driven process, this would also allow analyzing the relative importance of regional actors in facilitating social-ecological alignment (Kininmonth et al. 2015, Vantaggiato et al. 2023).

Second, we defined regions based on Joint Venture boundaries for this analysis due to the important role of Joint Ventures within continental waterfowl management. There are other ways

to define regions within this system, though, including based on governmental boundaries (e.g., states), geography, and ecology. In particular, many of the larger Joint Venture regions have ecologically important sub-regions (e.g., SONEC, GSL). Examining this system through alternative, ecologically defined sub-regions may reveal different patterns in regional collaboration be used to further examine challenges with social-ecological scale mismatch (Cumming et al. 2006).

Third, the different ecological needs of waterfowl throughout their life cycle and various supporting management approaches merits further examination within the collaborative management network. In this paper we use collaborative activities as the basis for ties in the network. These ties could also be operationalized by the focus of management (e.g., population vs. habitat management, breeding vs. wintering waterfowl), which would allow for a tightly coupled analysis of how ecological patterns impact collaborative networks.

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3.6 Figures

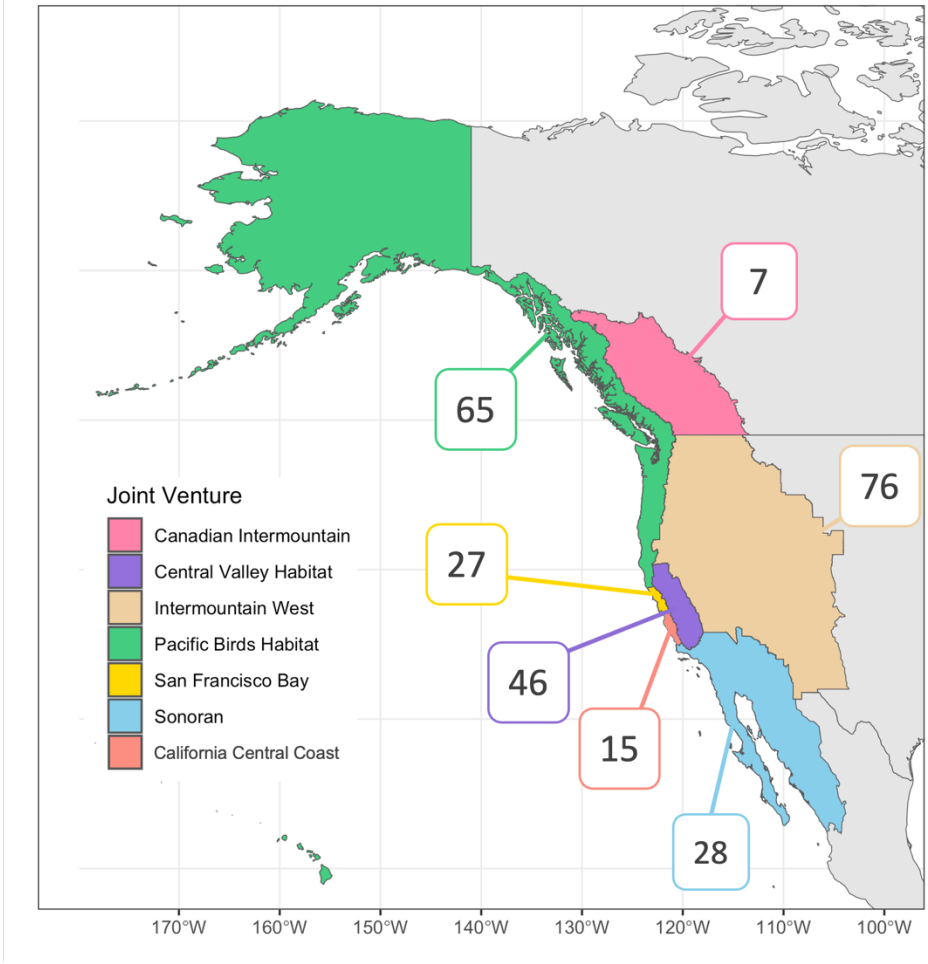

Figure 3.1. Migratory Bird Joint Venture boundaries. Numbers of survey responses per region indicated in squares. Organizations that work across multiple regions and are included in multiple totals. Region totals illustrate relative representation of each region by survey respondents.

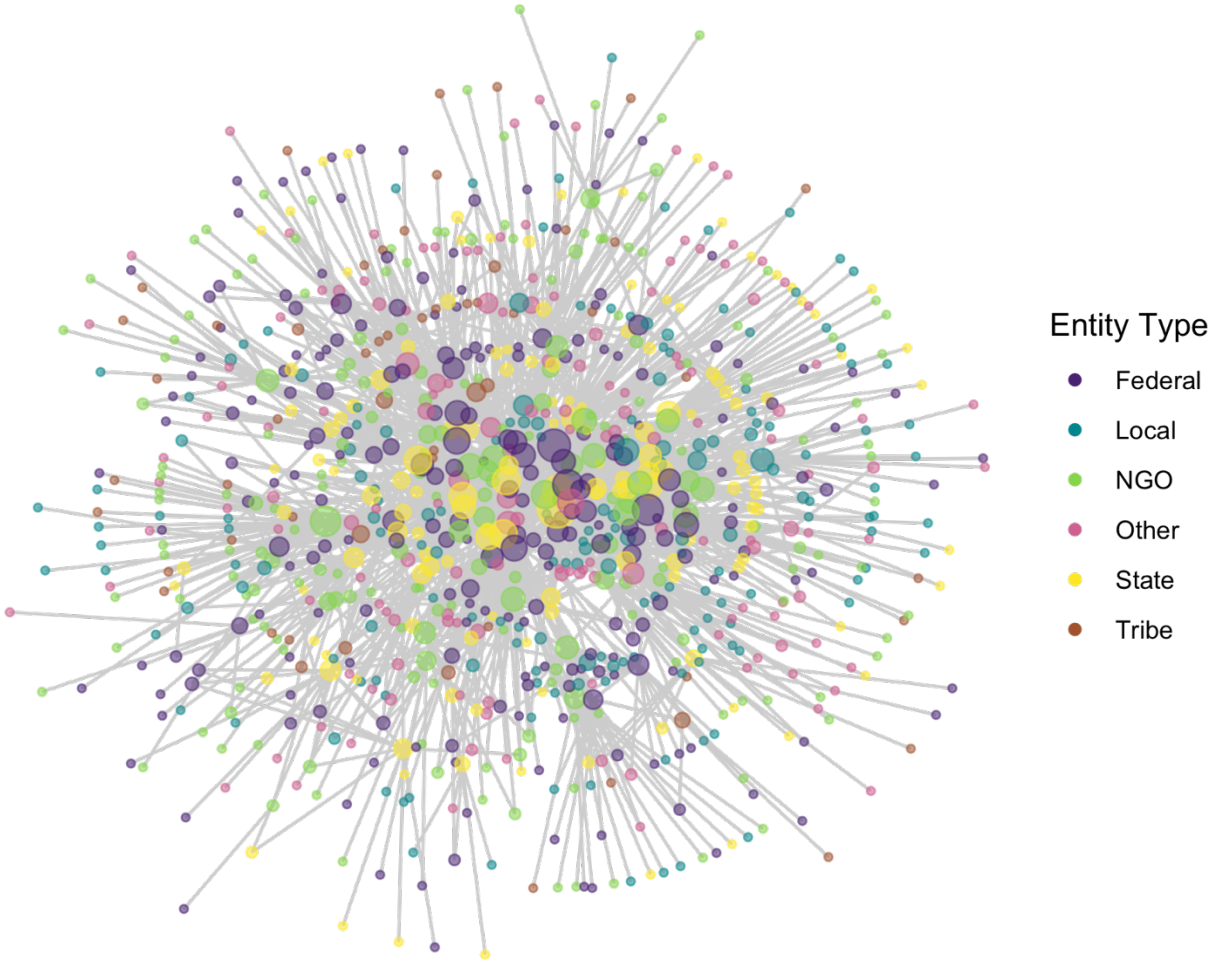

Figure 3.2 Waterfowl management network displayed using Kamada and Kawai spring-based algorithm. Isolates were removed for visualization but are retained for analysis. Nodes are colored by entity type and sized by degree.

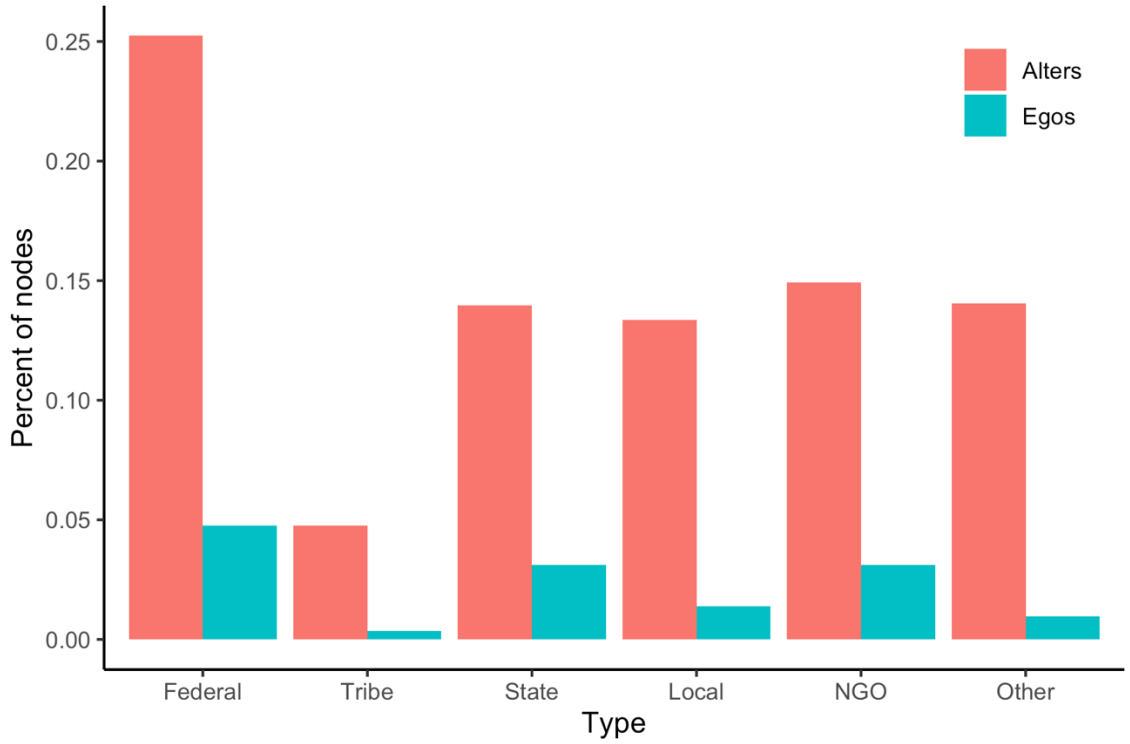

Figure 3.3 Entity types represented as percent of waterfowl management network. Egos (survey respondents) and alters depicted as separate bars.

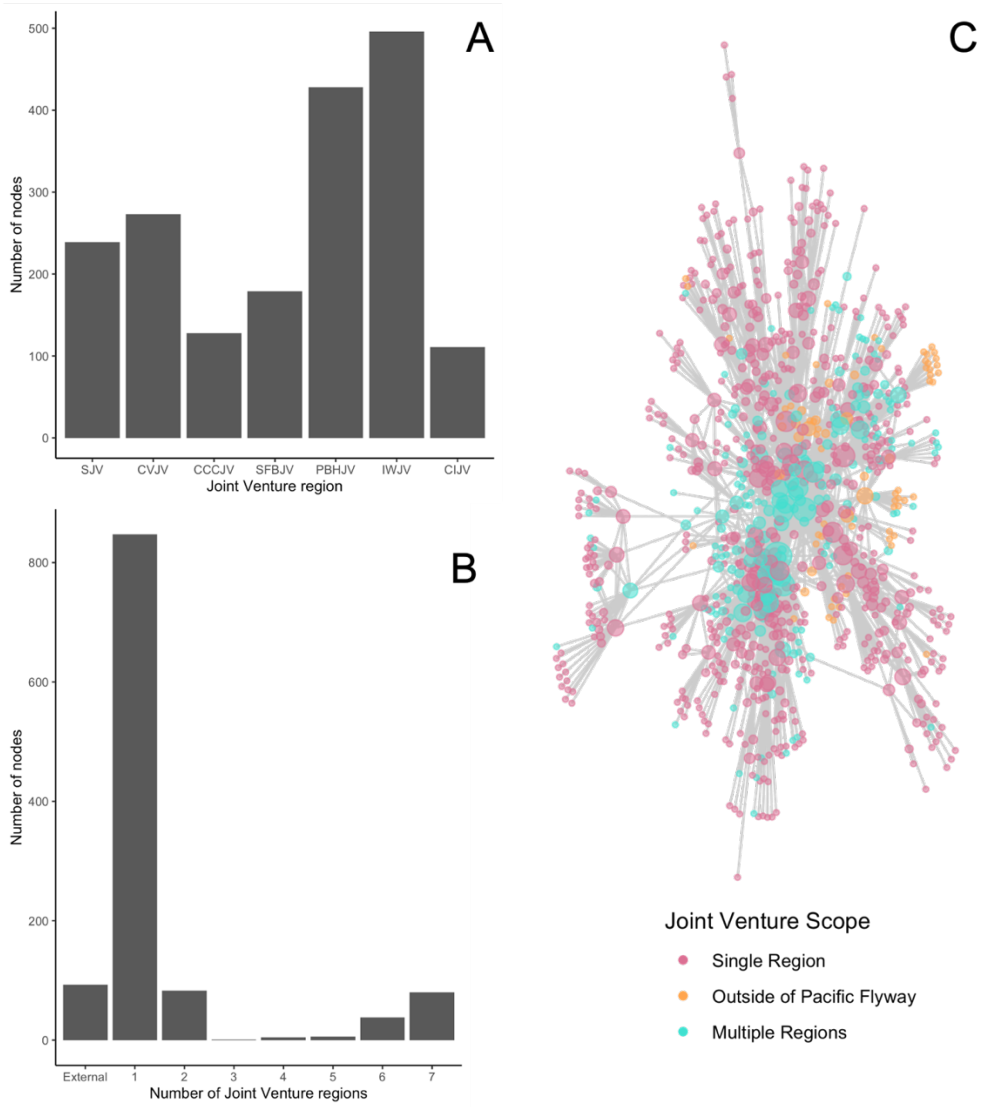

Figure 3.4 Joint Venture regional participation. (A) Number of nodes (organizations) operating within each Pacific Flyway Joint Venture. Some nodes work across multiple Joint Ventures and are counted multiple times in the total number of nodes. (B) Number of Pacific Flyway Joint Venture regions within which each node operates. External refers to nodes operating within Joint Venture regions not covered by the Pacific Flyway. (C) Waterfowl management network with nodes colored by management scope across JV regions ('Outside of Pacific Flyway' equivalent to 'External' in plot B). Isolates were removed for visualization but are retained for analysis.

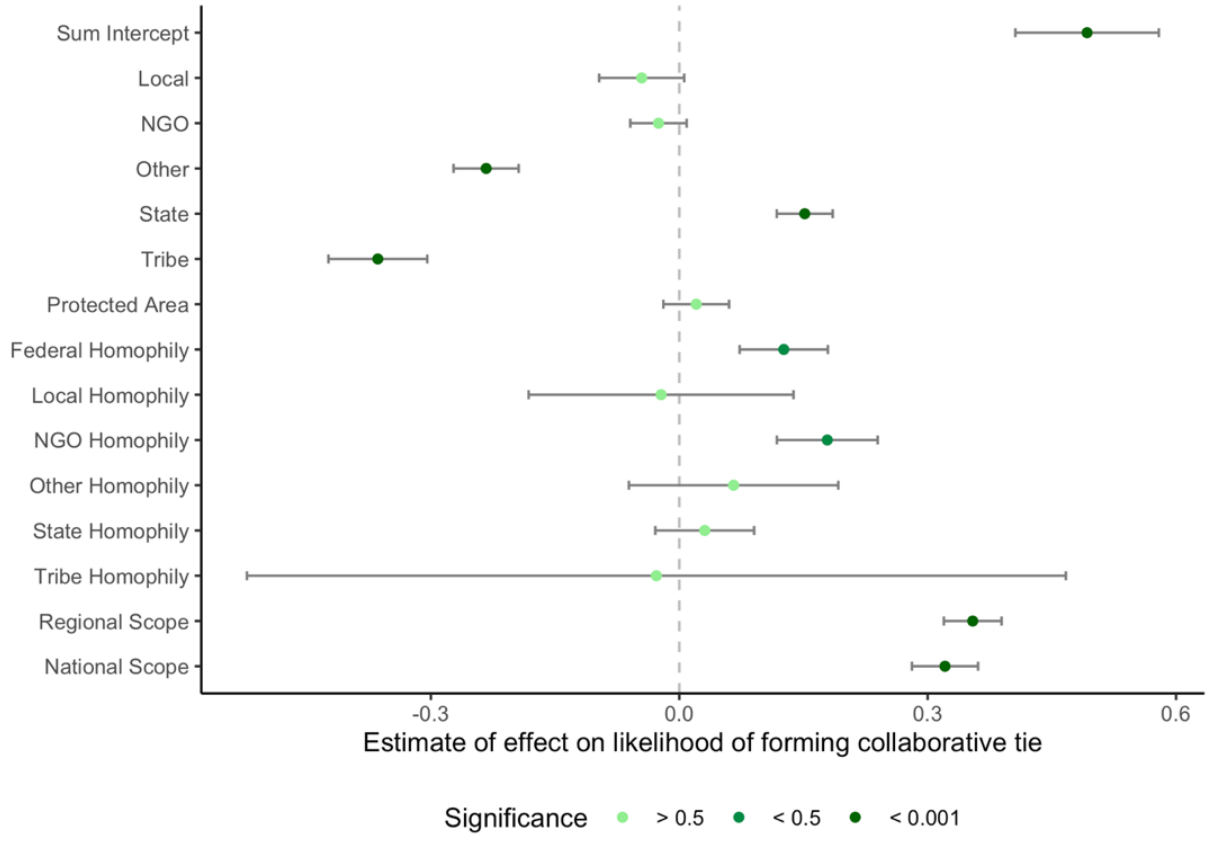

Figure 3.5 Coefficient estimates for valued ERGM of organization level drivers of collaboration in the waterfowl management network. Errors bars depict +/– 1 SE. Point estimates colored by level of significance. Estimate for zero inflation (-10.499) not depicted for improved visualization but included in Table 3.5.

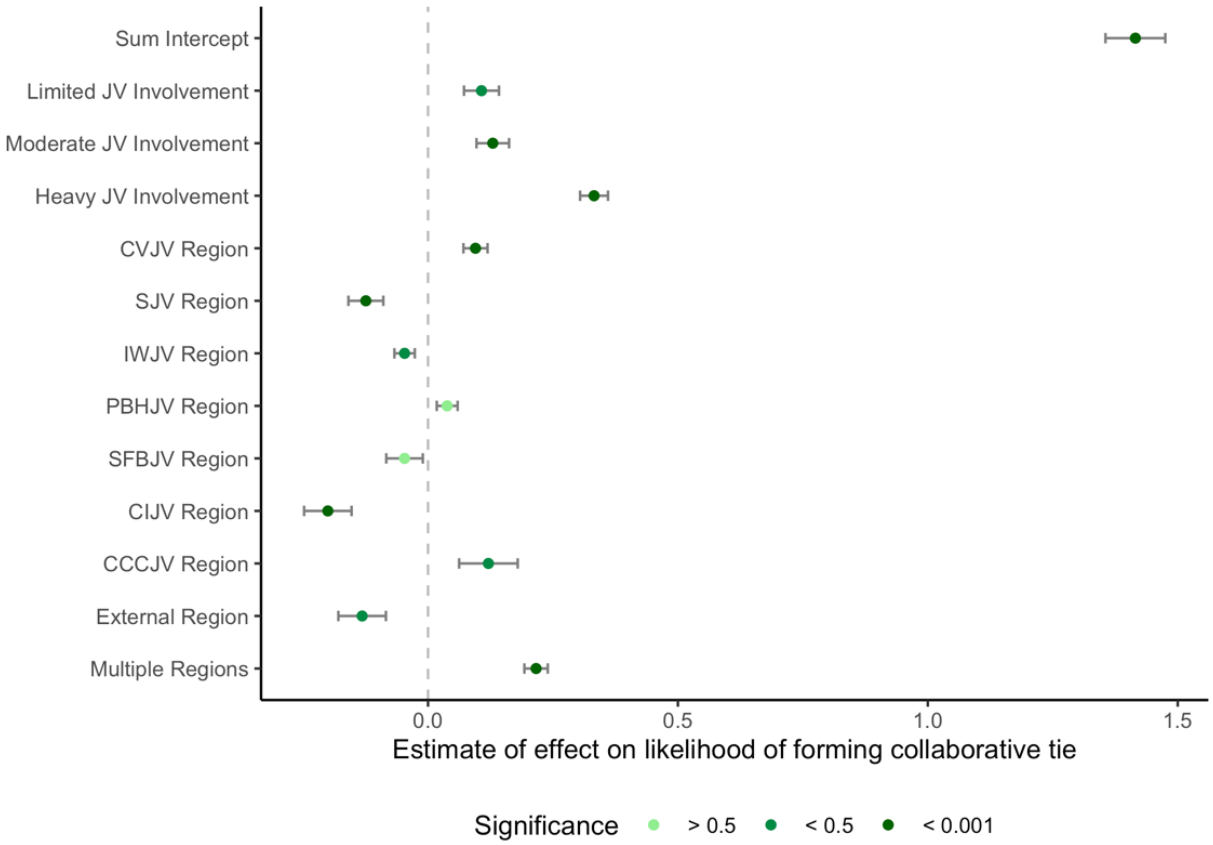

Figure 3.6 Coefficient estimates for valued ERGM of regional drivers of collaboration in the waterfowl management network. Errors bars depict +/– 1 SE. Point estimates colored by level of significance. Estimate for zero inflation (-9.658) and unknown Joint Venture involvement (-0.871) not depicted for improved visualization but included in Table 3.6.

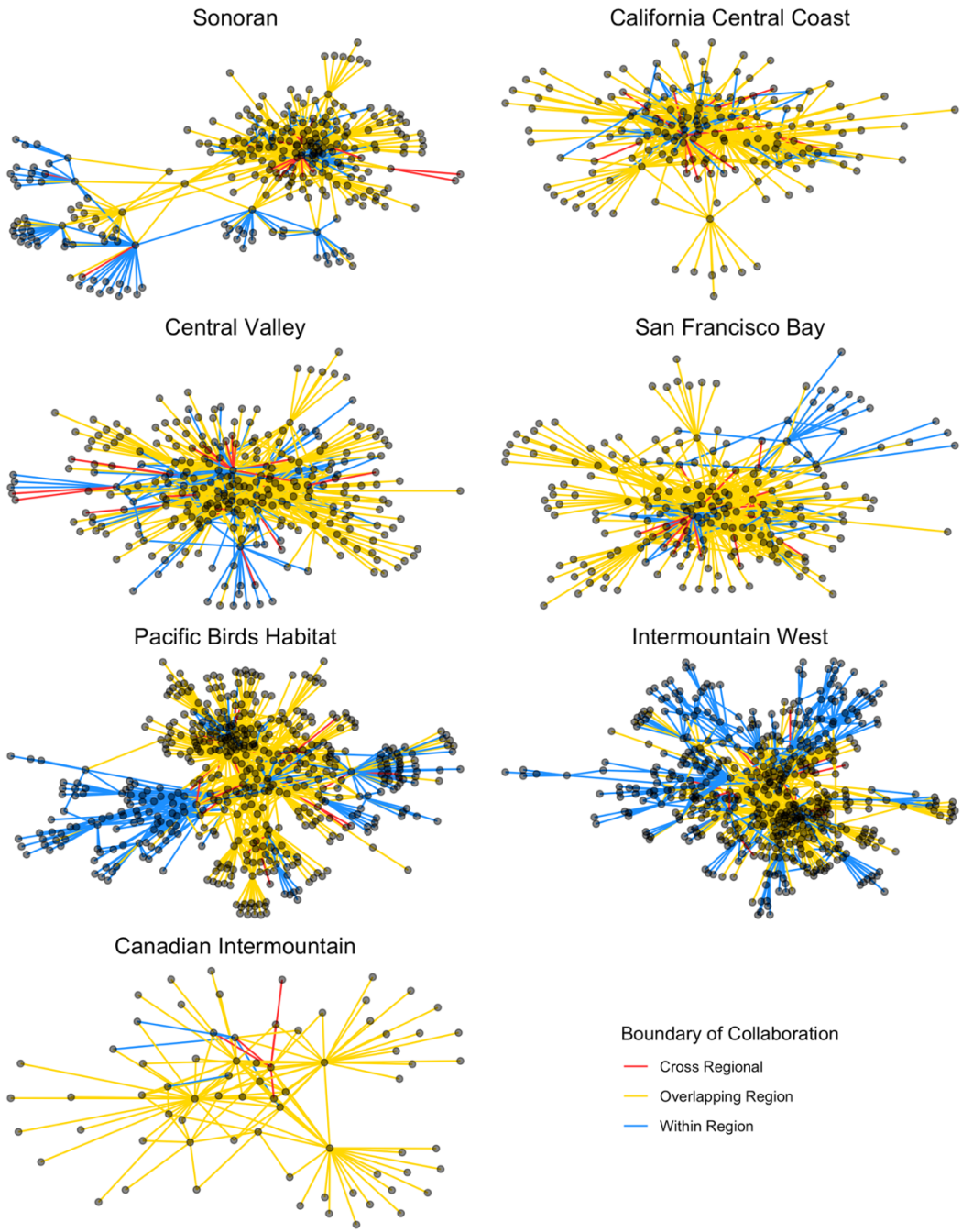

Figure 3.7 Regional waterfowl management network representing scope of collaborative tie. Regions defined by geographic boundaries of Migratory Bird Joint Ventures. Collaborative relationships occur between entities working exclusively within the same Joint Venture region (within region), within multiple regions where at least one region is shared (overlapping region), or in different regions (cross regional).

3.7 Tables

Table 3.1 Operationalization of hypotheses in valued exponential random graph models

Variable	Value	Detail
H1: Organization Type		
Type	Baseline: Federal Additional parameters for Tribe, State, Local, NGO, and Other	
Homophily	Homophily parameter for each type: Federal, Tribe, State, Local, NGO, and Other	Both nodes are the same type
H2: Organization Scope		
Management Scope	Baseline: Local Additional parameters for Regional and National	
Protected Area	Dummy variable 0 – not protected area 1 – protected area	Protected areas include National Wildlife Refuges, state Wildlife Management Areas, etc.
H3: Forum Engagement		
Joint Venture Involvement	Baseline: No involvement Additional parameters for Limited, Moderate, and Heavy involvement	Based on composite self-reported involvement from waterfowl management survey
H4: Social-ecological Alignment		
Region	Dummy variable for each region 0 – not working within the region 1 – working within the region	See Table 3.2 for proxies of regional ecological patterns
Collaboration Scope	Baseline: Exclusive Region Additional parameter for Multiple Regions and External Region (outside of Pacific Flyway)	Used to represent degree of cross-boundary collaboration (working exclusively within a single region, multiple regions, or cross-regional)

Table 3.2 Proxies for ecological patterns of waterfowl within each Joint Venture region. Where counts are specific to sub-regions, region noted parenthetically.

Region	Primary Focus[1]	Wintering Populations[2]	Breeding Populations[2]	Migrating Populations[2]
Sonoran	Wintering	2.2M	Not prioritized	Not prioritized
Central Valley	Wintering	5.4M	145,000-300,000	Included in wintering count
California Central Coast	Migrating[3]	Unknown	Unknown	Unknown
San Francisco Bay	Wintering	0.5M	196,000	Included in wintering count
Pacific Birds Habitat	Breeding Migrating Wintering	1M (British Columbia)	10M+ (Alaska)	Unknown; BC also identified as migrating and staging region
Intermountain West	Wintering Migrating	2.8M (Great Salt Lake)	1.6 – 2.1M	4.9M (SONEC Region)
Canadian Intermountain	Breeding	Not prioritized	1.45M	Minimally prioritized

[1] Primary focus refers to particular stages in life cycle and migratory journey. Focus determined by population sizes and predominant management focus of each Joint Venture. This determination does not preclude management action for other stages in migration nor does it place a value statement on management focus.

[2] Focus and estimates derived from Joint Venture Implementation Plans and other management documents. Population totals are often based on focal species (CVJV 2020, Beardmore 2007, IWJV 2013, ADFG 2015, CIJV 2020, PBHJV 2020, C3JV 2022, SFBJV 2022)

[3] Migratory refers to stopover, staging, molting, and other habitat aside from wintering and breeding.

Table 3.3 Waterfowl management network descriptive statistics

Network Measure	Statistic
Density	0.0023
Mean degree	3.71
Transitivity	0.1951
Centrality (Eigenvector)	0.3385

Table 3.4 Descriptive statistics by node attributes

Node Attribute	Percent of Nodes	Mean degree	Mean betweenness
Type			
Federal	30.0%	5.63	341
Tribe	5.1%	1.84	24.8
State	17.1%	7.61	706
Local	14.7%	2.05	39.7
NGO	18.0%	5.02	258
Other	15.0%	2.75	139
Management Area			
Yes	23.2%	6.85	211
No	76.8%	4.17	283
Scope			
Local	52.0%	3.37	85.4
Regional	38.1%	5.30	439
National	9.9%	5.65	372
Joint Venture involvement[1]			
None	36.1%	11.3	664
Little	17.0%	13.7	419
Somewhat	19.7%	18.3	1951
Heavily	27.2%	33.7	3941

[1] Survey respondents were asked to report their level of involvement in Joint Ventures. Therefore, percentages are based only on survey responses.

Table 3.5 Model estimates for valued ERGM of organization level drivers of collaboration in the waterfowl management network.

Coefficient	Estimate	SE	Expected Value
Sum Intercept	0.492**	0.087	1.636
Nonzero	-10.499**	0.086	0.00002
Tribe	-0.364**	0.059	0.695
State	0.151**	0.034	1.164
Local	-0.0454	0.051	0.956
NGO	-0.025	0.034	0.975
Other	-0.233**	0.039	0.792
Protected Area	0.020	0.039	1.021
Federal Homophily	0.126*	0.053	1.134
Tribe Homophily	-0.028	0.494	0.973
State Homophily	0.031	0.059	1.031
Local Homophily	-0.022	0.160	0.978
NGO Homophily	0.179*	0.061	1.196
Other Homophily	0.066	0.126	1.068
Regional Scope	0.354**	0.035	1.425
National Scope	0.321**	0.040	1.378

** $p < 0.001$, * $p < 0.05$; AIC -5563148

Table 3.6 Model estimates for valued ERGM of systems level drivers of collaboration in the waterfowl management network.

Coefficient	Estimate	SE	Expected Value
Sum Intercept	1.415**	0.059	4.118
Nonzero	-9.658**	0.088	0.0001
Involvement Unknown	-0.871**	0.026	0.418
Limited JV Involvement	0.107*	0.035	1.113
Moderate JV Involvement	0.129**	0.033	1.138
Heavy JV Involvement	0.332**	0.028	1.394
CVJV Region	0.095**	0.024	1.100
SJV Region	-0.124**	0.035	0.883
IWJV Region	-0.047*	0.020	0.954
PBHJV Region	0.038	0.021	1.039
SFBJV Region	-0.047	0.037	0.954
CIJV Region	-0.200**	0.047	0.818
CCCJV Region	0.121*	0.059	1.128
External Region	-0.132*	0.048	0.876
Multiple Regions	0.216**	0.023	1.241

** $p < 0.001$, * $p < 0.05$; AIC -5494088

Table 3.7 Descriptive statistics of regional networks.

Joint Venture	Number of nodes	Density	Mean degree	Centrality (Eigenvector)	Transitivity	Boundary of collaboration (Percent of edges)		
						Within	Overlapping	Cross
Full network	1153	0.0023	3.71	0.3385	0.1951	38.4%	58.2%	3.4%
Sonoran	264	0.0118	6.21	0.3560	0.2552	21.1%	75.9%	3.0%
Central Valley	277	0.0118	6.53	0.3452	0.2434	18.2%	78.7%	3.1%
California Central Coast	160	0.0267	8.48	0.3432	0.2663	14.6%	82.4%	2.9%
San Francisco Bay	211	0.0169	7.08	0.3514	0.2578	16.5%	80.7%	2.8%
Pacific Birds Habitat	490	0.0058	5.66	0.3383	0.2245	26.5%	69.9%	3.6%
Intermountain West	503	0.0055	5.55	0.3401	0.2246	31.9%	65.1%	3.0%
Canadian Intermountain	72	0.0282	4.00	0.6260	0.2345	4.2%	92.4%	3.5%

APPENDIX 1. DATA COLLECTION PROCEDURES

Table A1.1. Semi-structured interview questions

1. What is your role within [agency/organization]?
2. How do you define waterfowl management?
3. Describe the waterfowl management projects with which you are involved.
4. How effective do you think the Joint Ventures are at building ecosystem or landscape level science, policy, and management?
5. Are you associated with other formal partnerships or collaborations, and if so, what are they?
6. How would you describe the overall level of stakeholder collaboration in your region and/or across the flyway?
7. What are the barriers to collaboration
8. Who do you collaborate with and why?
9. What are the core governance or management problems you are facing?
10. How does the overall system of waterfowl management work with respect to ecological patterns and bird movement across the flyway?
11. Do you think science is used effectively in decision-making?
12. How do you determine the success of any management actions or decisions?

Table A1.2. Survey instrument

Section A. Professional attributes
1. Please provide your name and employer/affiliation
2. In total, how long have you been involved in waterfowl and/or wetland management?
a) 0-5 years
b) 6-10 years
c) 11-15 years
d) 16-20 years
e) 21 or more years

3. Which of the following describes the predominant geographic scope of where you work?
    a) Local
    b) Substate region
    c) State-wide
    d) Multi-state region
    e) International
4. In accordance with your response to the previous question, what is the name of the region in which you work?
5. Are you involved in the management of any national wildlife refuge, wildlife management area, or other protected area? If yes, please provide the name(s) of the protected area(s).
    a) Yes
    b) No
6. Which of the following topics is the primary focus of your work?
    a) Waterfowl topics: may include population statuses, surveys, movement patterns, waterfowl biology research, associated funding (e.g., research funding), among others.
    b) Habitat topics: may include wetland management, planning, water management, planting food, water conveyance and allocation, associated funding (e.g., habitat restoration funding, cost for conveyance infrastructure repair), among others.
    c) Human dimension topics: may include public engagement, cultural & economic importance of waterfowl, subsistence and/or recreational hunting management, balancing consumptive and non-consumptive values, among others
7. With respect to your role in waterfowl and/or wetland management, with which of the following guilds do you work? (Select all that apply)
    a) Waterfowl
    b) Shorebirds
    c) Other waterbirds (e.g., wading birds, secretive marsh birds)

d) Wetland & riparian songbirds

e) Other

Section B. Name generators

8. Do you communicate about waterfowl and/or wetland management with any individuals in **federal or tribal government agencies**?

    a) Yes

    b) No

9. Please provide the names of up to 5 or 6 **federal agencies or tribal governments** with whom you communicate about waterfowl and/or wetland management. Where known, please also provide the associated protected area, regional office, program, or division for each connection.

10 – 17. Repeat of questions 8 and 9 for state agencies, local agencies, non-governmental organizations, and other entities

Section C. Name interpreters

18. For each of the names you listed please indicate which areas of waterfowl management you discuss.

    - Waterfowl: Discussions of waterfowl may include topics such as population statuses, surveys, movement patterns, waterfowl biology research among others
    - Habitat: Discussions of habitat may include topics such as wetland management, planning, water management, planting food, water conveyance and allocation, associated funding (e.g., habitat restoration funding, cost for conveyance infrastructure repair), among others
    - Human dimensions: Discussions of human dimensions may include topics such as public engagement, cultural & economic importance of waterfowl, subsistence and/or recreational hunting management, balancing consumptive and non-consumptive values, among others.

    Question formatted as check box matrix with columns for waterfowl, habitat, and human dimensions topics and rows for each entity identified in name generator questions in section C.

19. Please indicate which of the following activities you engage with each of the agencies and organizations you mentioned earlier.

- Share resources (including giving or receiving funding, equipment)
- Collaborate on decision making
- Jointly implement projects

Question formatted as check box matrix with columns for each above activity and rows for each entity identified in name generator questions in section C.

Section D. Partner engagement

20. With respect to waterfowl and/or wetland management, in which of the following collaborative activities have you been involved in the last two years? (Select all that apply)
    a) Sharing data and information with another organization
    b) Sharing personnel with another organization
    c) Joint research projects with another organization
    d) Joint grant/funding proposals
    e) Co-management of a protected area (does not include sharing information that informs management)
    f) Joint development of conservation easement or similar agreement
    g) Sharing permitting or regulatory activities
    h) Sharing surveying or reporting responsibilities
    i) Other
21. Thinking about the partnerships you have with other agencies/organizations, which of the following statements most reflects how you think about your position?
    a) Spending more time on collaborative activities would enhance my job.
    b) My collaboration with other agencies is about where I think is optimal.
    c) I spend more time than is necessary on collaborative activities.
    d) Unsure
22. How frequently do you communicate with individual private landowners?
    a) Never
    b) Rarely
    c) Sometimes
    d) Frequently

Section E. Joint Ventures

23. Are you involved with a Joint Venture? (Check any/all that apply)
    a) Sonoran Joint Venture
    b) Central Valley Joint Venture
    c) Central California Coast Joint Venture
    d) San Francisco Bay Joint Venture
    e) Pacific Birds Habitat Joint Venture
    f) Intermountain West Joint Venture
    g) Canadian Intermountain Joint Venture
    h) Other? _____
    i) I am not involved in any Joint Ventures
24. You previously indicated that you are involved with the Sonoran Joint Venture. How involved are you with Sonoran Joint Venture?
    a) Very little
    b) Somewhat
    c) Heavily

25 – 31. Repeat question 24 for each Joint Venture in question 23 a – h as needed based on each participant's response

32. Based on your involvement with and/or knowledge of Joint Ventures, to what extent do you agree with the following statements:

    The Joint Ventures are successful at advancing **regional** waterfowl management within the boundaries of the Joint Ventures.
    a) Strongly agree
    b) Somewhat agree
    c) Unsure
    d) Somewhat disagree
    e) Strongly disagree

33. The Joint Ventures are successful at advancing **flyway level** waterfowl management across Joint Ventures boundaries.
    a) Strongly agree
    b) Somewhat agree

c) Unsure
d) Somewhat disagree
e) Strongly disagree

34. If there is anyone in particular who you think should also take this survey, please provide me with their name, affiliation, and email if known.

APPENDIX 2. SURVEY RESPONSE RATES

Table A2.1 Response rates by Joint Venture region and actor type for the Waterfowl Management Collaboration Survey. In some instances, multiple individuals within a single program were surveyed. Individual responses are grouped at the highest entity level (agency or organization) for most cases. Exceptions include federal agencies and national non-governmental organizations, where responses are separated by region.[a]

Group	Surveyed	Response Rate[a]
All	485	34.02%
Region[b]		
Sonoran Joint Venture	65	43.08%
Central California Coast Joint Venture	26	57.69%
Central Valley Joint Venture	101	40.59%
San Francisco Bay Joint Venture	47	57.45%
Intermountain West Joint Venture	176	43.18%
Pacific Birds Habitat Joint Venture	202	32.18%
Canadian Intermountain Joint Venture	15	46.67%
Multiple[c]	17	23.53%
Type		
Federal		
Regional Agency or Program[d]	67	37.31%
Individual Protected Area	80	40.00%
Tribe	37	10.81%

State		
Agency or Program	26	53.85%
Individual Protected Area	60	38.33%
Local	76	26.67%
NGO	98	39.80%
Private	14	7.14%
Other	18	38.98%
Joint Venture	9	44.44%

[a] For example, The Nature Conservancy in California is considered distinct from The Nature Conservancy in Alaska Response rates include complete and partial survey responses from entities.

[b] The region totals do not equal the overall total as some entities work within multiple Joint Venture regions. Therefore, while the number of surveys not empirically meaningful as some responses are counted twice, the response rate is still representative of the overall survey coverage of each region.

[c] Some programs are national in scope and their work cannot be attributed to one or more specific Joint Ventures.

[d] Individual protected areas include national wildlife refuges and wildlife management areas which are not grouped with the responses from the managing agency (e.g., U.S. Fish and Wildlife Service, state wildlife agencies)

APPENDIX 3. REGIONAL NETWORKS

A3 Figures

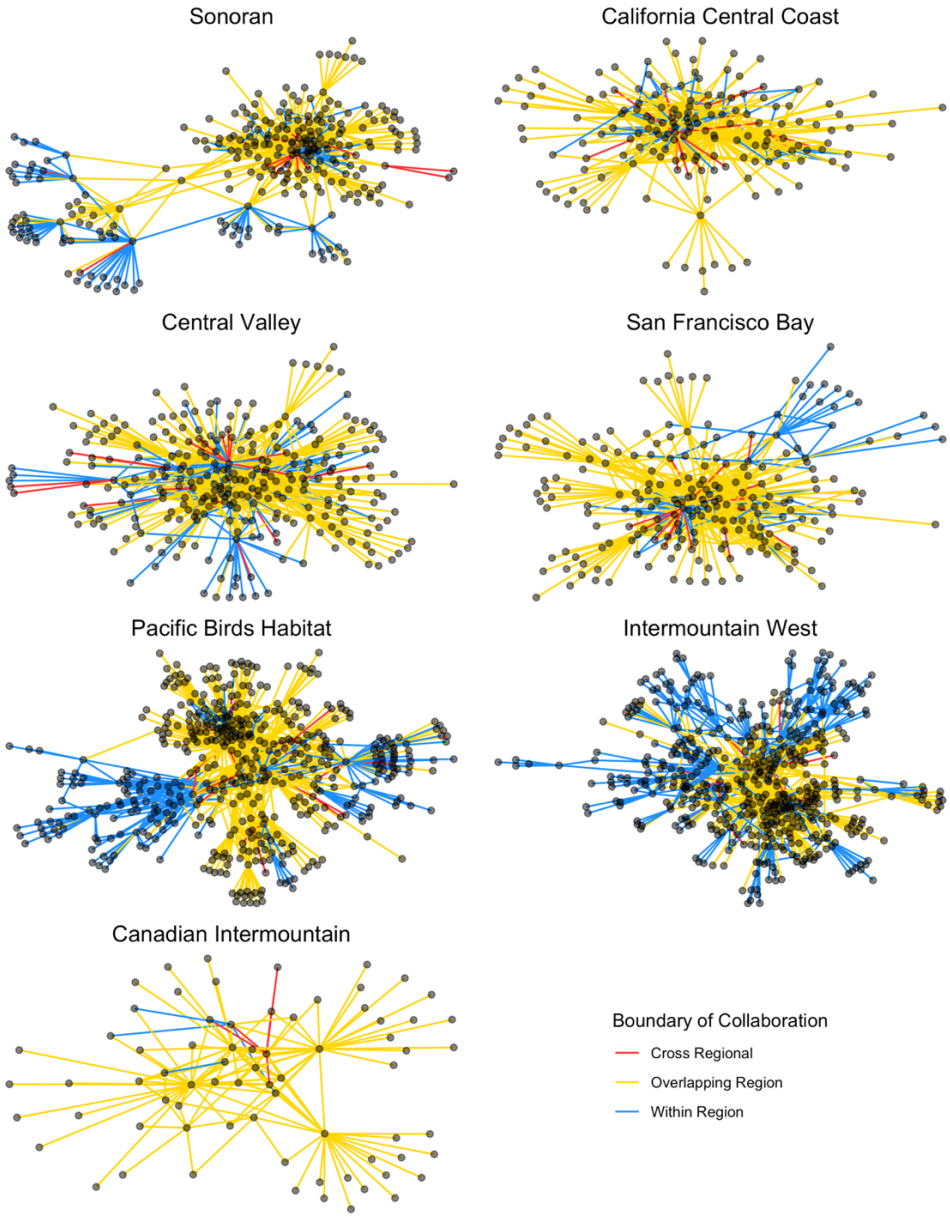

Figure A3.1. Regional waterfowl management networks within the Pacific Flyway. Regions defined by geographic boundaries of Migratory Bird Joint Ventures. “Within region” ties exist between two entities working exclusively within the same region. ‘Overlapping region’ ties are between entities that work within the same region and at least one entity works in multiple regions. ‘Cross regional’ ties are between entities that work in separate regions.

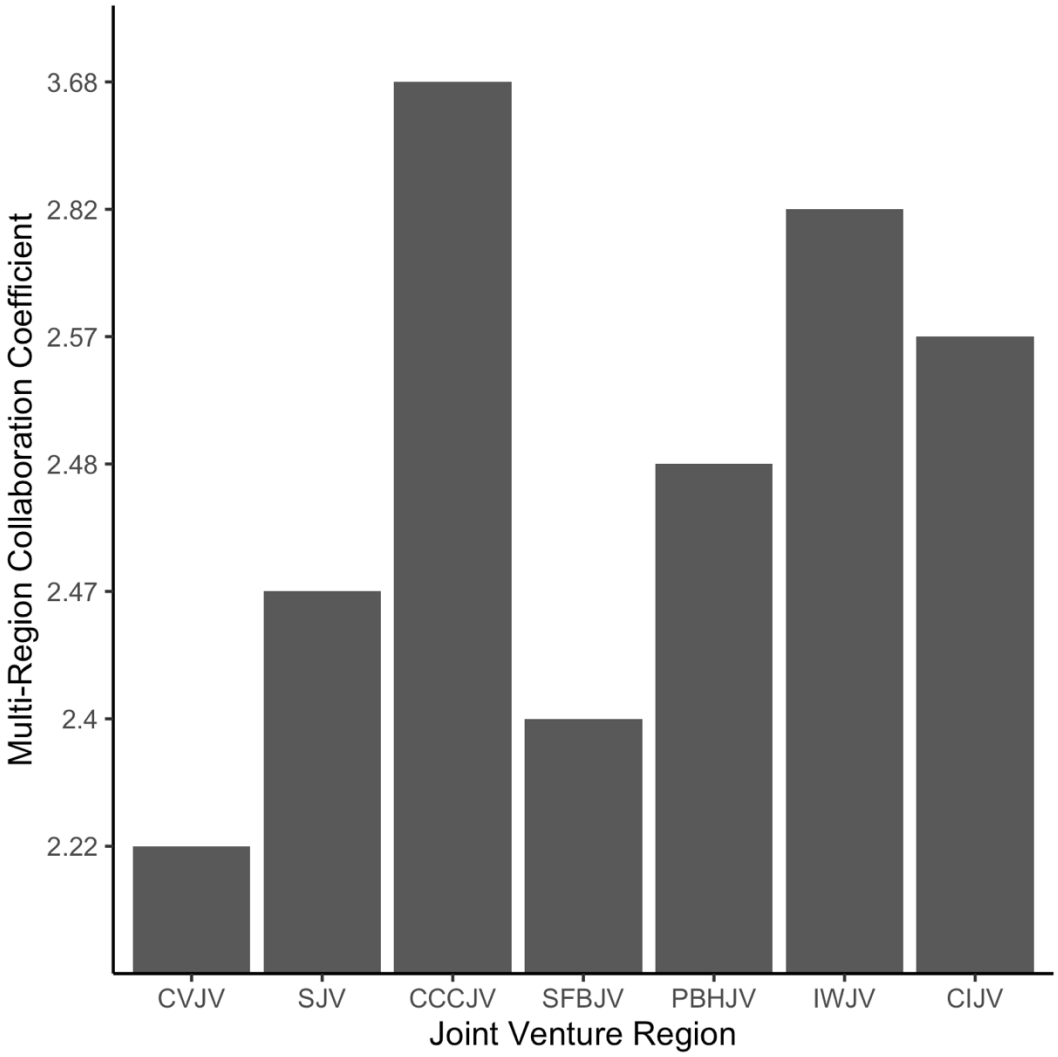

Figure A4.2 Differences in the effect of working within multiple regions on likelihood of collaboration between each region. Effect calculated as increased odds of multiple region collaboration from baseline effect of working exclusively within a single region (expected value for sum intercept * expected value for multiple region in Table A4.2).

A3 Tables

Table A3.1 Descriptive statistics of regional networks.

Joint Venture	Number of nodes	Density	Mean degree	Centrality (Eigenvector)	Transitivity	Boundary of collaboration (Percent of edges)		
						Within	Overlapping	Cross
Whole network	1153	0.0023	3.71	0.3385	0.1951	38.4%	58.2%	3.4%
Sonoran	264	0.0118	6.21	0.3560	0.2552	21.1%	75.9%	3.0%
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Intermountain West	503	0.0055	5.55	0.3401	0.2246	31.9%	65.1%	3.0%
Canadian Intermountain	72	0.0282	4.00	0.6260	0.2345	4.2%	92.4%	3.5%

Table A3.2 Cross-boundary collab regional ERGMs

Coefficient	Sonoran	Central Valley	California Central Coast	San Francisco Bay	Pacific Birds Habitat	Intermountain West	Canadian Intermountain
Sum							
Intercept	0.555**	0.533**	1.094**	0.535**	0.653**	0.707**	0.635**
Nonzero	-9.247	-9.48**	-8.140**	-8.893**	-10.025**	-9.491**	-8.374**
Regional							
Homophily	0.040	0.282**	-0.309**	0.031	0.071**	0.139*	-0.056
External							
Region	0.034	-0.084	-0.263	0.012	-0.154**	-0.175*	-0.193*
Multiple							
Regions	0.348**	0.264**	0.208**	0.339**	0.256**	0.330**	0.311**

** $p < 0.001$, * $p < 0.05$

Table A3.3 Highest degree nodes in regional waterfowl management networks. Acronyms defined in Table A4.4.

Rank	Whole Network	Sonoran	Central Valley	California Central Coast	San Francisco Bay	Pacific Birds Habitat	Intermountain West	Canadian Intermountain
1	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	CDFW	DU – Canada
2	USFWS – Migratory Birds	CWA	CWA	CWA	CWA	CWA	CWA	CWS – Wildlife and Habitat Assessment
3	CWA	USGS – WERC	CVJV	USGS – WERC	USGS – WERC	DU – Washington	USGS – WERC	CWS – Pacific Region
4	DU – Washington	UCD	USGS – WERC	UCD	UCD	USGS – WERC	USFWS – Migratory Birds	Birds Canada
5	USGS – WERC	River Partners	DU – Western Region	TNC - California	River Partners	ADFG	IDFG	CIJV

Table A3.4 Acronym identification for high degree nodes in regional networks

Acronym	Organization Name	Type
ADFG	Alaska Department of Fish and Game	State
CDFW	California Department of Fish and Wildlife	State
CIJV	Canadian Intermountain Joint Venture	Other
CVJV	Central Valley Joint Venture	Other
CWA	California Waterfowl Association	NGO
CWS	Canadian Wildlife Service	Federal
DU	Ducks Unlimited	NGO
IDFG	Idaho Department of Fish and Game	State
TNC	The Nature Conservancy	NGO
UCD	University of California Davis	Other
USFWS	U.S. Fish and Wildlife Service	Federal
USGS-WERC	U.S. Geological Survey - Western Ecological Research Center	Federal