Environmental Management (2017) 60:41–56
DOI 10.1007/s00267-017-0864-x

Integrative Governance of Environmental Water in Australia's Murray–Darling Basin: Evolving Challenges and Emerging Pathways

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Received: 11 August 2016 / Accepted: 5 April 2017 / Published online: 15 April 2017

Abstract Integration, a widely promoted response to the multi-scale complexities of social-environmental sustainability, is diversely and sometimes poorly conceptualized. In this paper we explore integrative governance, which we define as an iterative and contextual process for negotiating and advancing the common interest. We ground this definition in a discussion of institutional factors conditioning integrative governance of environmental water in Australia's Murray–Darling Basin. The Murray–Darling Basin is an iconic system of social-ecological complexity, evocative of large-scale conservation challenges in other developed arid river basins. Our critical assessment of integrative governance practices in that context emerges through analysis of interviews with policy participants and documents pertaining to environmental water management in the tri-state area of southwestern New South Wales, northwestern Victoria, and the South Australian Riverland. We identify four linked challenges: (i) decision support for developing socially robust environmental water management goals, (ii) resource constraints on adaptive practice, (iii) inter-state differences in participatory decision-making and devolution of authority, and (iv) representative inclusion in decision-making. Our appraisal demonstrates these as pivotal challenges for integrative governance in the common interest. We conclude by offering a perspective on the potential for supporting integrative governance through the bridging capacity of Australia's Commonwealth Environmental Water Holder.

Keywords Integration · Integrative governance · Bridging organization · Environmental water · Murray–Darling Basin

Introduction

Integration is widely promoted as a response to the multi-scale complexities of social-environmental sustainability (e.g., Collins et al. 2011; Liu et al. 2015), with diverse functional understandings of what integration means (i.e., what is to be integrated, and why) and how to achieve it (Dovers 2005). Here we focus on integrative governance, which we define as an iterative and contextual process for negotiating and advancing the common interest. We understand interests as patterns of value demands and supporting expectations regarding the conditions of their satisfaction (Lasswell and Macdougal 1992). The common interest is comprised of interests widely shared by members of a community; it would benefit the community as a whole and be supported by most members, if they can find it (Brunner 2002, p. 8). Any expression of the common interest is contextually situated, emergent from the perspectives of participants, and open to revision (Brunner and Lynch 2010). Negotiation of the common interest is a communicative process for the contextually-situated interests of participants to be reconciled if possible, and balanced when necessary; an adaptive means of satisficing[1] the pluralistic value demands of a community. As a frame

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[1] Simon (1972, p. 161) postulated that expectations of the attainable, conditioned by bounded understandings of context, define aspiration level. He created the neologism "satisficing" to describe the process of identifying and pursuing alternatives that meet this aspiration level.

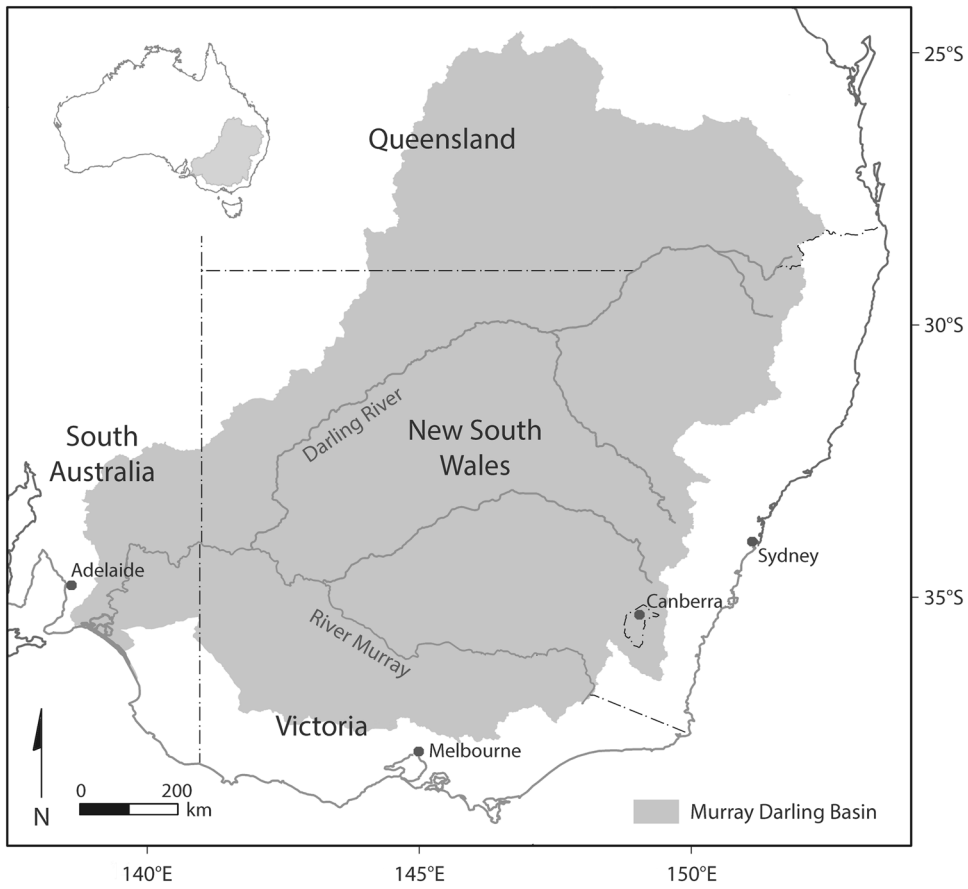


Fig. 1 Map of the Murray–Darling Basin

for negotiating and advancing the common interest, integrative governance necessarily involves co-production of knowledge relevant to the interests of community members. As such, integrative governance is a reflexive process for bringing together contextually-situated interests and forms of knowledge in order to clarify and advance the common interest, which we believe to be an appropriate goal and criterion in a democracy (Brunner and Steelman 2005, p. 9). Our purpose here is to examine factors conditioning integrative governance of environmental water in Australia's Murray–Darling Basin (MDB; alternatively 'the Basin').

The MDB (Fig. 1) is an iconic system of social-ecological and institutional complexity (Wallis and Ison 2011). Current and historic patterns of water resource use have had substantial impact on riverine and groundwater systems in the Basin (Kingsford 2000; Pittock and Connell 2010; Grafton et al. 2013). Water quality and availability are issues of enduring significance (Pittock and Finlayson 2011), as are the large-scale conservation and governance challenges associated with this multi-jurisdictional system (see Armitage et al. 2015). The MDB is evocative of challenges encountered in other large basin systems (e.g., the Colorado River Basin), and has been of interest to management practitioners and researchers in those settings (Garrick 2015).

The Basin extends across 4 states and 1 territory in Southeastern Australia. Irrigated agriculture in the Murray–Darling is valued in excess of $6.7 billion per year (ABS 2014), and agricultural use accounts for over 80% of water consumed within the Basin (ABS 2008). The arid river systems of the Basin are typified by hydrological variability (Leblanc et al. 2012). Dynamic flow regimes in the Murray and Darling Rivers are integral to ecosystem processes in the Basin's floodplain and wetland ecosystems (Overton et al. 2009; Rogers and Ralph 2011), which exhibit high temporal and spatial heterogeneity. Patterns of water availability drive complex shifts in composition and structure of ecological communities (MacNally et al. 2011), linked to ecosystem processes at multiple scales (Davies et al. 2010). Irrigators in the Basin typically extract water directly from river channels, and flows in the Murray and Darling are highly regulated by dams and weirs. Patterns of extractive use have altered flow regimes in the Basin (Grafton et al. 2014), with substantial and largely negative impact on ecosystems (Kingsford et al. 2011; Pittock and Finlayson 2011).

The evolution of water governance in the MDB can be understood as an ongoing effort to address the scale-engendered complexity of the Basin, and the diverse interests of its human communities across a heterogeneous

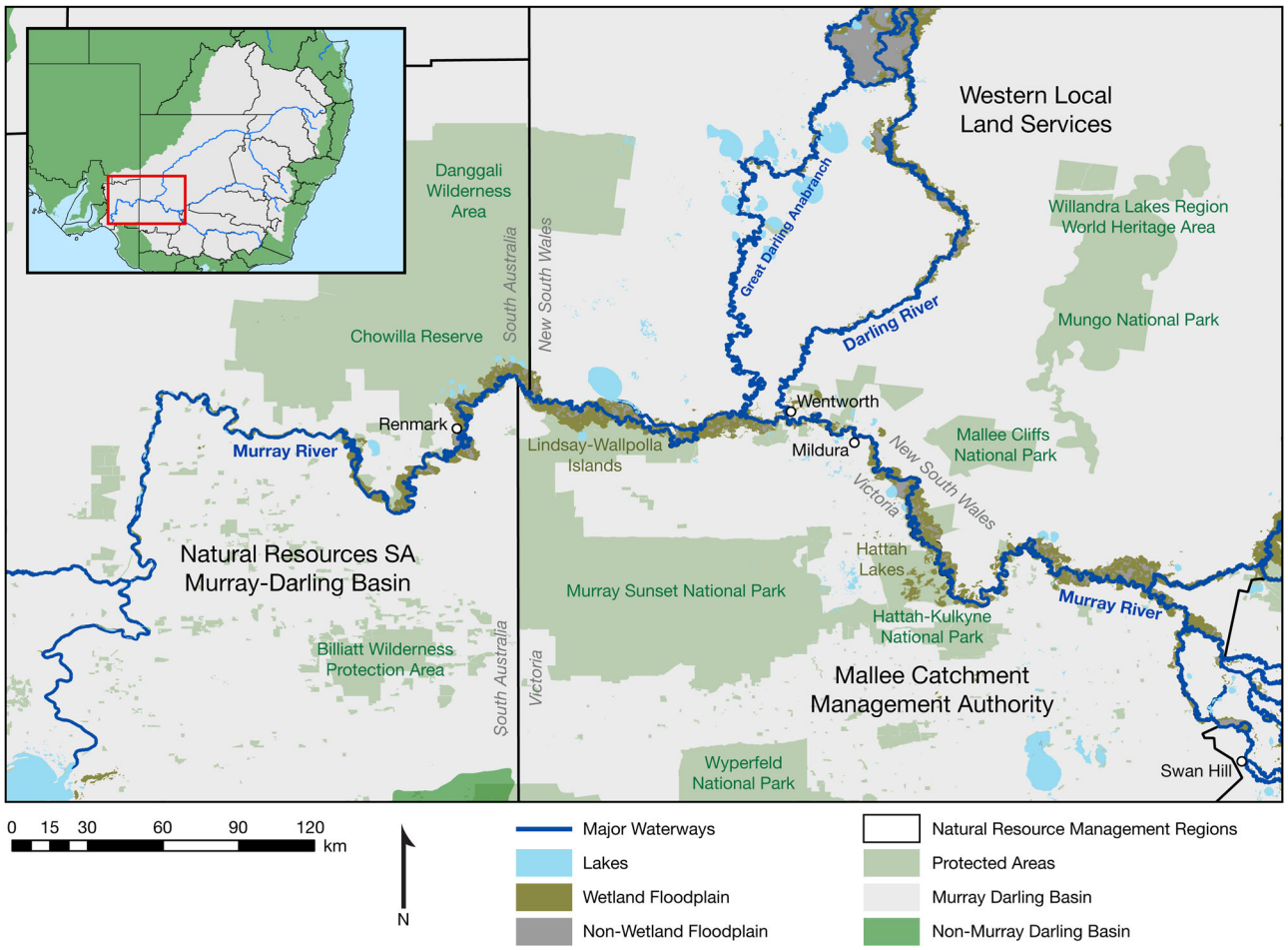


Fig. 2 Map of the tri-state area of southwestern New South Wales, northwestern Victoria, and the South Australian Riverland

institutional and jurisdictional landscape (Connell 2007). These efforts are currently focused on implementation of the 2007 Water Act and 2012 Murray–Darling Basin Plan (MDBP). The Water Act and MDBP express goals of sustainably optimizing social and environmental outcomes in relation to water use in the Basin (Cwlth 2007; MDBA 2012). Collectively, they comprise a response to past patterns of fragmentation, and a basin-scale framework for adaptive water resource governance (Garrick et al. 2012). The Water Act relies on state capacity for implementation while providing structure for vertical coordination. In this way, it is intended as a mechanism for transboundary coordination of management practices, and as an instrument for balancing regional perspectives with national interests in a socially and environmentally sustainable Basin (Burke 2012); a function conditioned by diverse understandings of what sustainability might mean (Bischoff-Mattson and Lynch 2016). Recovery and management of environmental water—defined as water held or available under access, delivery, or irrigation right "for the purposes of achieving environmental outcomes" (Cwlth 2007, p. 10)—is in turn a principal policy mechanism for advancing sustainability goals of the Water Act.

Within this context, it remains unclear whether Australia's environmental water managing institutions will function to support integrative governance in the common interest. Our goal here is to explore the context-specific contingencies of integrative governance *in practice*, and the prospective role of existing institutions and organizations in addressing barriers. Case studies such as this, sufficiently comprehensive and detailed to allow relevant factors and their significance to be understood in context (Brunner and Steelman 2005), are a basis for translating insights into other contexts without abstracting them into generalized lessons or formulas for 'success' (Brunner and Lynch 2010).

In this paper we describe insights on factors conditioning integrative governance practices applied to environmental water that emerged through interviews with policy participants and a review of policy documents pertaining to environmental water management in southwestern New South Wales (NSW), northwestern Victoria (VIC), and the South Australian (SA) Riverland (Fig. 2), conducted in

2015. For purposes of this discussion we define institutions broadly as patterns of rules, norms, perspectives, and organized interaction (Ostrom 2005). We begin by discussing our standpoint on integrative governance, as well as the role of knowledge co-production, boundary objects, and bridging organizations in integrative practice. We then describe the policy context for environmental water management in Australia, and present a critical discussion of integration challenges manifest in our interview and document data. We conclude by exploring the role of the Commonwealth Environmental Water Holder (CEWH) as a prospective bridging organization to support integrative governance.

Integrative Governance

We have defined integrative governance as a process for iteratively and contextually negotiating and advancing the common interest. This is an adaptive, communicative process for participant interests to be reconciled if possible, and balanced when necessary. As a frame for negotiating and advancing the common interest, integrative governance necessarily involves co-production of knowledge relevant to that common interest, and represents an approach for bringing together contextually-situated interests and forms of knowledge in order to understand and address problems (see Van Kerkhoff and Lebel 2006). Problems can be understood functionally as discrepancies between goals, as expressions of interests, and conditions (current or anticipated) (Lasswell and Macdougal 1992). Since goals are subject to revision in the face of changing expectations, and perfect knowledge of conditions is never possible, problem definitions are not only a matter of perspective; they are subject to often rapid evolution.

This approach recognizes the ordinary, as well as epistemic uncertainties associated with complex systems, the bounded nature of knowledge about them (see Rittel and Webber 1973; Funtowicz and Ravetz 1993; Ludwig 2001; Holling 2001), and the limitations of fragmented approaches to knowledge creation, organization, and use (see Ascher et al. 2010; Clark and Wallace 2015). It recognizes that environmental issues cannot be dissociated from human values, and the related importance of deliberative interaction around knowledge claims and problem definitions (see Dewulf et al. 2005; Stern 2005; Roux et al. 2006). Within this context, we view interests and knowledge as interlinked elements of perspective or worldview (see Koltko-Rivera 2004); knowledge cannot be decomposed from the meaning-making activities (socially-situated and bounded, reflecting cognitive standpoint), interests, and power relations that frame it (Nadasdy 2003; Howitt et al. 2013).

Knowledge co-production can be understood as a collaborative process of bringing a plurality of knowledge sources and types together to address a problem (Armitage et al. 2011, p. 996). It is a process for interrelating different perspectives and systems of understanding, and a critical component of developing an expression of the common interest in any context. As an interactive process of collective action and reflection, knowledge co-production can function as a mechanism for social learning, which we understand as a process for transformative change in perspectives, norms, and values (Keen et al. 2005; Cundill and Rodela 2012; akin to 'transformative learning' per Mezirow 1997). In this respect, knowledge co-production is a mechanism for reconciling plural interests through construction of shared perspectives on a system, incorporating multiple ways of knowing, subject to revision given evolving understandings of that system. As such, knowledge co-production is a contextual process both discursive and practical; simultaneous production of knowledge and social order (see Jasanoff 1996), with participants interacting to define objectives of inquiry, relevant evidence, and convincing forms of argument (Berkes 2004, p. 624, Berkes 2009a). The fundamental role of science in this context is to support freedom of choice in addressing real-world problems (Lasswell 1951), an approach grounded in philosophical pragmatism (see Bacon 2012). From this and a knowledge co-production perspective, standards of objectivity are historically and socially situated, sufficient until demonstrated otherwise; a matter of securing solidarity among a community of inquirers (see Rorty 1982; Misak 2007).

Politics are in turn a necessary and fundamental part of any collective decision-making process. Where interests cannot be reconciled[2], differences must be resolved politically if the community is to act democratically. In a system such as the Murray–Darling, multiple alternative goals answer to evidentiary bases, and interests are implicated in any alternative (Lynch et al. 2013, p. 111). As such, arenas for political interaction are an essential mechanism for participants to negotiate policy in the common interest, conditioned by the knowledge, authorities, funds, and other resources brought to the table by participants, as well as their capacity to develop mutual respect and trust (Brunner and Steelman 2005, p. 24).

Framed in these terms, integrative governance reflects elements of adaptive governance and integrated water resources management (IWRM). Adaptive governance is an analytic construct for framing the decision-making and knowledge production challenges engendered by complex human–environment systems (Dietz et al. 2003; Steelman 2015). IWRM can be understood as a response to collective

[2] Any setting with high decision stakes, a plurality of legitimate interests, and irreducible uncertainties will ultimately confront decision-makers with "super-wicked", "diabolical" or even "tragic" alternatives (Brown 2007; Garnaut 2008; Levin et al. 2012).

action challenges engendered by the multi-valued nature of water in transboundary hydrological systems (Schoeman et al. 2014). While applications of IWRM reflect diverse understandings and definitions (Lubell and Edelenbos 2013), discussions of adaptive governance and IWRM both stress the significance of place-based processes for participants to consensually and communicatively make decisions (Brunner 2002; Saravanan et al. 2009). Consistent with this element of both frames, we emphasize open decision-making structures as a basis for reflective and participatory approaches to defining common-interest goals and problem definitions (see Grigg 2008; Brunner and Lynch 2010).

How to operationalize integrative governance remains an open question. Trans-boundary river systems engender considerable challenges, and 'integrated management' is frequently invoked in these settings, often with diverse connotation in terms of how 'integrating' might be understood[3]. Within this context, critiques of integrative water management often identify deeply entrenched institutional barriers to governance that is participatory or learning-centered (Allan 2012). These institutional barriers can manifest in emphasis on prescriptive coordination and the integration of technical procedures and expert practices (Conca 2006; Byron 2011; Biswas 2008). This is a pattern of 'partial encorporation' exacerbated by tendencies to frame participation and knowledge co-production as ends rather than means (a form of goal displacement) (Lasswell and Macdougal 1992). As such, the role that institutions play in any 'integrating' process is critical, particularly in contexts with established power asymmetries or patterns of limited voice and standing for certain community members (e.g., Brunner 2004). Here, we emphasize integrative governance as a goal-directed process for constructing policy alternatives that advance the common-interest.

Integrative governance of this sort requires deliberative arenas for affected participants to negotiate common-interest goals that reconcile the interests of community members when possible, balance them when necessary, and bring relevant knowledge to bear as a basis for developing and implementing alternatives for action. This function is predicated on decision processes open to participation and representative of the diversity of interests at stake, encorporating information that comprehensively represents relevant factors but is appropriately targeted to problem and context (Clark 2002).

In a system such as the Murray–Darling, this involves processes spanning levels of authority and control, across a range of participant groups and jurisdictions. As such, boundary objects and bridging organizations are important mechanisms for integrative governance as we have defined it. Boundary objects provide a shared focus of attention through which groups collaborate (Star and Griesemer 1989); infrastructures of cooperative action emerging from the contextual "information and work requirements" of participants (Star 2010, p. 602). The 'object' is any article, process, or idea that people act toward and with, and whose significance is open to interpretive flexibility. That is, the boundary object is terrain for co-production of knowledge and contextual negotiation of common interests through the construction of action alternatives. This function can be of particular significance in contexts (e.g., involving indigenous communities) where epistemic standards and ontological bases for information-gathering and decision-making must be negotiated up-front (e.g, Veland et al. 2014). Bridging organizations[4] in turn reduce transaction costs and provide social incentives for participation (Hahn et al. 2006; Kowalski and Jenkins 2015). In this respect they support relational networks essential to social learning (Bodin and Crona 2009; Pahl-Wostl and Hare 2004; Pahl-Wostl et al. 2007), and facilitate knowledge co-production, meaning making, conflict resolution, and trust building (Berkes 2009b); factors essential to integrative governance as we have defined it. Where bridging organizations exist, they can also facilitate the horizontal diffusion and adaptation of innovations (Lynch et al. 2014). As such, we emphasize the prospective role of bridging organizations in addressing barriers to integrative governance.

Data and Methods

We reviewed 120 national, state, and regional policy documents relevant to environmental water management in the tri-state area encompassing southwestern New South Wales, northwestern Victoria, and the South Australian Riverland (Fig. 2). Policy documents in our review included Commonwealth and state legislation, as well as research, management planning, and reporting documents from national, state, and local policy-delivery agencies. In addition, between August and September 2015 we conducted 54 semi-structured interviews with policy participants associated with environmental water management in the tri-state study area. Interviewees comprised individuals active across policy levels: members of national, state, and local government; members of research and policy-delivery agencies; representatives of non-government organizations;

[3] For example, integrating around water resources has been conceptualized in terms of modelling tools (Holzkämper et al. 2012), knowledge types and sources (e.g., science and local knowledge) (Failing et al. 2007), management processes and sectors (Jønch-Clausen and Fugl 2001), mental models (Kolkman et al. 2005) and participant frames (Mostert et al. 2008), among other approaches.

[4] Bridging organizations relate closely to the concept of boundary organizations (see Guston 2001), but differ in scope; 'boundary organization' typically refers to a narrower focus on science-policy interface (Crona and Parker 2012).

Table 1 Rank ordered distribution of anonymous interviewees across categories of organizational and professional affiliation

Affiliation Categories	Number of interviewees ($n = 54$)[a]
State policy-delivery or research organization (e.g., Mallee CMA)	14
Commonwealth policy-delivery or research organization (e.g., CEWH)	12
Agricultural industry and/or agricultural industry organization (e.g., Dried Fruits Australia)	8
Local community organization (e.g., Loxton-to-Bookpurnong Local Action Planning)	6
Water distribution and/or river infrastructure authority (e.g., Goulburn–Murray Water)	5
Academic institution (e.g., University of Adelaide)	5
Environmental organization (e.g., Nature Foundation SA)	5
State participatory decision-making body (e.g., SAMDB Natural Resource Management Board)	4
Parliamentary body (State or Australian Government)(e.g., Parliament of Victoria)	3
Commonwealth participatory decision-making body (e.g., MDBA Basin Community Committee)	2

[a] Some interviewees had affiliations across multiple categories (e.g., as members of participatory decision-making bodies). This allowed interviewees to offer their perspectives as participants in multiple capacities

academics; land owners and other private citizens active in water resource issues (Table 1).

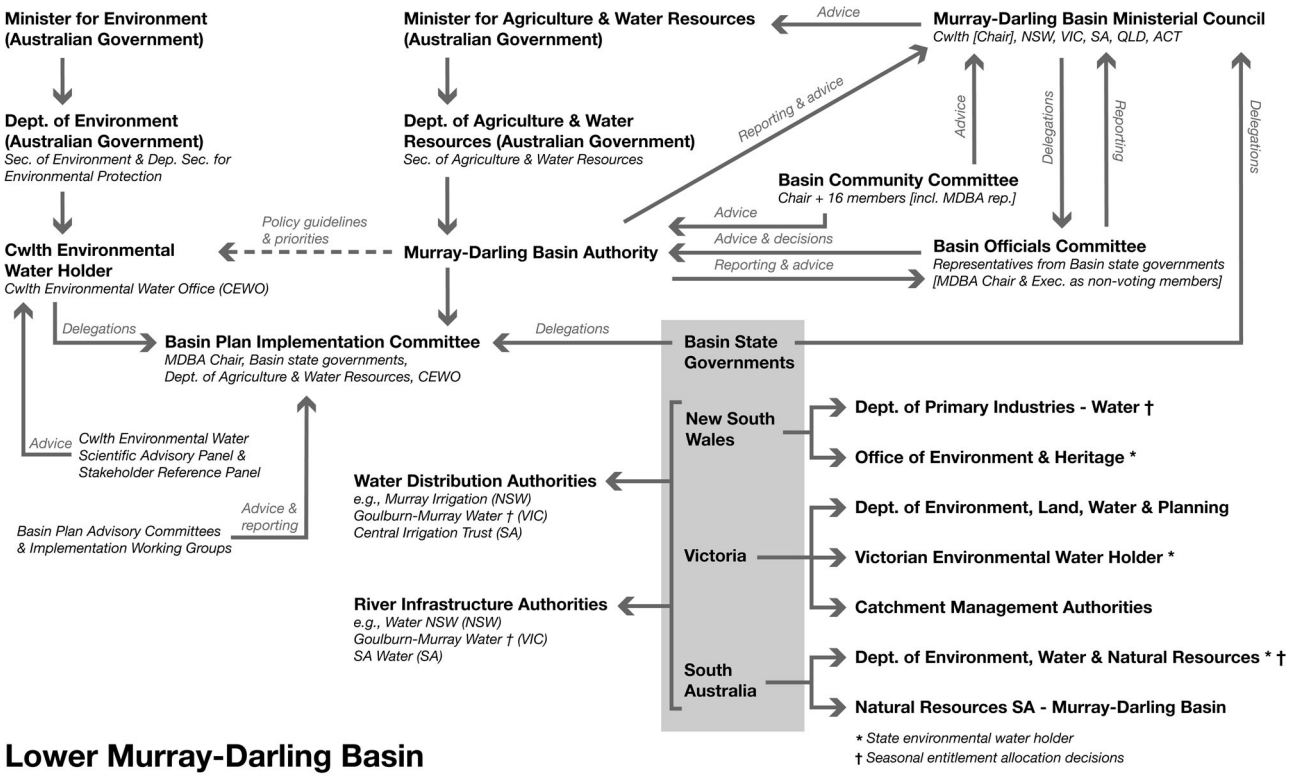
We used a semi-targeted chain-referral sampling method to identify interview subjects, beginning with easily identifiable key stakeholders (Penrod et al. 2003; Babbie 2004). Each interviewee recommended additional interview subjects and, in many cases, provided direct introduction. Interviews were anonymous, in-person, recorded using a hand-held digital voice recorder, conducted with IRB approval, and lasted between 45 and 180 min. Informed consent was obtained from all individual participants included in the study. Our approach was to structure interviews minimally with a set of prompts for open-ended conversation. These prompts were tailored to each interviewee, but addressed the interviewee's perspective on significant challenges, trends, and conditioning factors shaping water resource governance in the MDB.

We coded interviews and documents using Atlas.ti qualitative data analysis software, in order to elucidate themes related to integrative governance in practice. Thematic coding was structured up-front by this frame, while allowing the substance of each theme to emerge from logical groupings of content. This approach reflects principles of grounded theory and qualitative content analysis, and allowed us to develop contextual analytic categories (i.e., themes) directly through our interview process and data (Boyatzis 1998; Charmaz 2000; Hsieh and Shannon 2005). Our purpose was to clarify salient themes, as manifest in the discourses (per Hajer 1995) of policy participants in this context, relevant to our understanding of integrative governance as a higher-order concept for framing environmental water management activities.

Policy Context

Water governance in the Murray–Darling has historically been the purview of individual states, with management functions devolved to state and local practitioners. This is consistent with the constitutional structure of the Australian federal system, and mirrored in many Australian policy domains. Management institutions organized around technical and scientific expertise developed concurrently and independently in each state, principally in support of irrigated agriculture, but with different decision-making processes, structures of management practice, and systems of water allocation and entitlement. As in other policy spheres, different geophysical contexts and European settlement histories have fostered divergent expectations about the appropriate relationship between state and national governments and local communities (Connell 2007). These factors condition the interjurisdictional scope of integrative governance challenges in the Murray–Darling, and make it a useful case study for exploring challenges and pathways.

Concern over water quality, soil salinity, ecosystem degradation, and allocation of limited and variable supply have catalyzed successive efforts for inter-jurisdictional coordination in the Basin. The 2002 Living Murray Program (TLM) and 2004 National Water Initiative (NWI) (COAG 2004a, b) expanded on previous Council of Australian Governments agreements, and were explicit in articulating fundamental tensions in the diversity of demands placed on water resources (see Dovers et al. 2005; Hussey and Dovers 2006; Connell and Grafton 2008). The NWI expressed national goals of balancing consumptive and non-consumptive interests to achieve socially and environmentally sustainable levels of extraction (COAG 2004a, p. 3), and created mechanisms for the recovery or purchase of environmental water in the form of allocation entitlements (NWC 2010); a substantial shift from established approaches of defining and managing environmental water in terms of minimum end-of-system or passing flow requirements (Docker and Robinson 2014). Most classes of volumetric water allocation entitlement in Australia are separated from land titles and traded on a National Water



Adapted from Murray Darling Basin Authority (2015). *Annual Report 2014-2015*. Canberra: MDBA.

Fig. 3 Diagram of national-state-regional governance structure in the lower Murray–Darling Basin

Market. Commonwealth environmental water holdings are largely comprised of these tradable water rights (see Crase et al. 2004; Wheeler et al. 2014).

Basin-scale initiatives prior to 2007 were largely cooperative, with corresponding water legislation passed in parallel in each state, and coordinated implementation contingent on agreement among those governments. Compliance with national initiatives was typically sustained through delivery of Commonwealth funds (Marshall et al. 2013); an arrangement reflecting the constitutional sovereignty of the states, as well as the fiscal dominance of the Commonwealth (Connell 2011). Perceived limitations of this structure in the face of the 2002–2010 'Millennium Drought' catalyzed the 2007 National Plan for Water Security (an initial AUD 10 billion funding initiative to address consumptive over-allocation, repackaged and expanded in 2008 as Water for the Future; Howard 2007a, b) and the 2007 Water Act. The Water Act, still in force, is implemented through the MDBP, enacted in 2012, which establishes sustainable diversion limits on consumptive use, water trading rules, and a framework for state and Commonwealth environmental water, water quality, and salinity management (MDBA 2012).

The Water Act created two "cooperative but independent" statutory bodies (Garrick et al. 2012; see also ANAO 2011): the Murray–Darling Basin Authority (MDBA) and CEWH (see Fig. 3). The MDBA is tasked with developing and implementing the Basin Plan to advance a comprehensive suite of social-ecological objectives for "equitable, efficient and sustainable use of the Basin water resources" (Cwlth 2007, p. 273). The CEWH operates with a narrower mandate of protecting and restoring the ecosystems and ecosystem functions of the MDB through management of the Commonwealth environmental water portfolio (see Cwlth 2007, p. 173; CEWH 2013a, p. 11). The MDBA establishes a broad framework for environmental water management, expressed through an Environmental Watering Strategy and annual management priorities. This framework is developed through interaction with environmental water managers (including CEWH) and river operators, and through community consultation on environmental and other needs (MDBA 2014a).

Information-gathering and policy-delivery capacity within the Basin is predominately situated at the state level, in state resource management agencies, catchment (watershed) authorities, and water distribution agencies. While a goal of the Water Act was to reform the structure for constitutive and ordinary decision making (per Ostrom 2007) to provide increased vertical coordination, management functions at all scales are conditioned by the Basin's

considerable institutional diversity and decentralized political landscape (Connell 2011; Marshall et al. 2013).

Environmental Water Management in the 'tri-state area'

Southwestern New South Wales, northwestern Victoria, and the South Australian Riverland are dominated by the Murray and Darling Rivers, their anabranches, and associated wetland and floodplain complexes (Fig. 2). This tri-state area encapsulates a shared history of agricultural development set against the backdrop of three distinctly evolving socio-political contexts. This is an area of historically high cross-border exchange and collaboration in irrigated agriculture and water management (Daniel Connell, pers. comm. 2015), and a useful arena to explore integrative governance in operation.

Restoration of river-wetland-floodplain connectivity is a focus of environmental water management activity in all three states. Primary management tools relate to the timing and volume of releases from storages, as well as environmental watering—"delivery or use of environmental water to achieve environmental outcomes" (Cwlth 2007, p. 9)—supported by pumping, diversion, and river regulator infrastructure to improve targeted effectiveness of delivered flows. Environmental water is held in the form of entitlements by the CEWH, as well as state environmental water holders and the MDBA (see Fig. 3). The CEWH holds 2409 gigaliters of registered entitlements with an average annual allocation yield of 1673 gigaliters (DoE 2016a). MDBA and State holdings are considerably lower; the Victorian Environmental Water Holder, for example, manages around 650 gigaliters (VEWH 2016). The MDBA and CEWH have limited direct presence in the tri-state region, though CEWH Local Engagement Officers (LEOs) play an active role in developing project partnerships at the catchment scale.

In the tri-state area, environmental water is delivered in partnership with state and regional managers and infrastructure operators, as well as non-government organizations (e.g., Nature Foundation SA) and private partners (e.g., Banrock Station, owned by the privately held Accolade Wines, the largest wine company by volume in Australia). A large portion of the tri-state region is private land, and collaborative projects involving land owners or lessees exist in each state (e.g., through the NSW Private Property Wetlands Watering Project or under auspices of SA Local Action Planning groups).

Operational monitoring and assessment functions, as well as long-term monitoring of environmental assets, are largely delegated to state and local water resource agencies (DoE 2016b). The CEWH holds primary responsibility for direct monitoring of environmental water management interventions, often administered through partner delivery organizations or agencies, and the CEWH is in practice reliant on regional partners and capacity through most phases of environmental water delivery and assessment. Within this context, the Commonwealth has provided substantial initial resourcing to state and local policy-delivery agencies, with major funding commitments through 2020 (COAG 2013, 2014). State-Commonwealth joint funding arrangements for Basin Plan implementation (including environmental water management) remain an object of contention, and ongoing uncertainty over state contributions to MDBA funding remain a concern in terms of sustainable delivery of programs (see MDBA 2015: 18, 119). Limited state commitments to implementation may accentuate existing Commonwealth-state capacity, information, and resource asymmetries, and successful implementation of the Plan will remain contingent on cooperation between the Commonwealth and states (Connell 2011).

Within this context, four linked integrative governance challenges emerged through our contextual analysis of environmental water management documents and interviews: (i) decision support for developing socially robust environmental water management goals, (ii) resource constraints on adaptive practice, (iii) inter-state differences in participatory decision-making and devolution of authority, and (iv) representative inclusion in decision-making.

Evolving Integrative Governance Challenges

Decision support for robust management goals

Environmental water management in the Murray–Darling is framed in terms of protecting and restoring ecosystems and ecosystem functions, as well as ensuring that water-dependent ecosystems are resilient to climate change (CEWH 2013b). Large-scale objectives are described with regard to four ecological components—"river flows and connectivity, native vegetation, waterbirds and native fish" (MDBA 2014a, p. 9), colloquially known as 'birds, fish and trees management'. Restoration of "a more natural [flow] regime" is described as both a mechanism to secure objectives associated with these components and as an outcome to be valued (MDBA 2014a, p. 8).

This framework for environmental water management is predicated on the capacity to measure environmental response to different flow regimes and develop a more complete understanding of ecosystem relationships, as a basis for improved management prescriptions (see CEWH 2013c; DoE 2016c). The complexity of this challenge is conditioned by the Basin's considerable biophysical variability on a range of spatial and temporal scales. For purposes of many environmental watering interventions "the science is just not there yet" (anonymous interviewee). Across a spectrum of backgrounds and affiliations,

interviewees pointed to limited existing knowledge of system responses to environmental water management, described by one state agency practitioner as "trial and error […] still a learning process" (anonymous interviewee). This is an apt expression of adaptive practice. But effective use of environmental water further implies a strategic prioritization of actions to support ecosystems and ecosystem processes valued in different ways, at different scales, by the Basin's human communities (see CEWH 2013a, pp. 13–14). This prioritization has not occurred explicitly, and indeed, governance mechanisms for setting these priorities have not been clarified substantially by the Basin Plan. Addressing the multi-valued character of the Basin's ecosystems demands that community interests—as manifest in perspectives on valued ecological outcomes—be contextually reconciled and balanced, as a basis for scientific assessments and the application of technical prescriptions (see Finn and Jackson 2011). Addressing these issues is a matter of social, as well as scientific capacity. Lacking decision-support resources to negotiate the common interest and set socially robust environmental water management priorities in the face of irreducible complexity and uncertainty, practitioners rely heavily on existing patterns of practice to define what is required.

Resource constraints

Patterns of resourcing, including funding and capacity, are persistent underlying sources of constraint and conflict in efforts to manage environmental water. Agency resourcing varies widely between Basin states (see Robins and Dovers 2007a, b). Further, agency practitioners in all three states described project-based grants through state and Commonwealth programs as a significant and growing source of operational funding. Funding cycles associated with these grant programs can limit robust and sustained follow-through on management initiatives. Lacking sufficient follow-through, "adaptive management has largely failed" (anonymous interviewee); a perspective voiced by several members of non-government environmental and community organizations. Continuity and security of funding for adaptive management (especially in terms of monitoring and evaluation of management interventions) is a well-established concern in this context (Bellamy et al. 2002; Paton et al. 2004; Lockwood et al. 2009). For example, TLM program funding for ecological monitoring was reduced 25% in SA from 2014–2015 (DEWNR 2015, p. 57). Funding constraints to support monitoring and adaptive delivery also impact non-government project partners (e.g., environmental and community organizations) that may have limited funding to cover equipment and personnel costs. In-kind contributions by private landholders can be crucial in these contexts but demand committed relationship-building, an imposition on time and attention for a stretched workforce. Further, environmental water delivery and assessment costs vary widely depending on site characteristics and scale, specific uses of pumping or regulator infrastructure, monitoring and administrative requirements, among other factors. According to government and non-government interviewees, limited resources often concatenate with these factors to shape project placement and goals.

Interviewees across a range of government, non-government, and academic affiliations pointed to recurrent interstate conflict over joint-funding for Basin Plan implementation and state cost-shifting around Commonwealth-funded programs as familiar patterns of intergovernmental parochialism. Local management practitioners, particularly in SA and NSW, stressed the potential for these dynamics to exacerbate already limited forward funding commitments, thus limiting practitioner capacity to build and maintain credibility with stakeholder communities and affecting the contours of regional participatory decision-making processes. Within this context, management practitioners in all three states observed that persistent intergovernmental tensions over funding were likely to affect the scope and focus of management interventions, and capacity to assess complex environmental responses. From an integrative governance perspective, these dynamics are a strong constraint to processes by which participants interact to negotiate management goals, and by which appropriately scaled and targeted knowledge can be co-produced to support the development of contextual management interventions.

Participatory decision-making and devolution of authority

Capacity for reconciling and balancing the contextually-situated interests of participants, and for co-production of knowledge, is shaped by the devolution of authority and the composition of participatory bodies, both of which vary considerably across state boundaries. State natural resource agencies (Fig. 3) play a central role in regional water policy development and delivery in all three states, but many of these functions are subsumed within the Catchment Management Authority (CMA) framework in VIC. Victorian CMAs are formally subordinate to the state government, but hold authority for a range of planning and implementation functions, and may receive support directly from Commonwealth programs and agencies. Indeed, "there's a 20 year history of the Commonwealth looking for mechanisms to go around the states" (anonymous interviewee); a perspective articulated by several academics and members of non-government organizations. Decision-making at the CMA level is conducted with participation of technical and community advisory committees that include representatives of local government, indigenous communities, industry, and non-government organizations (Mallee CMA 2013,

p. 59; Mallee CMA 2015). CMA offices frequently house interagency research and management teams.

Regional water policy development and delivery in NSW is undertaken by state agency officers. Catchment-scale bodies for water resource management have tended to play a more limited and informal role in NSW, and regional management organizations (currently in the form of Local Land Services districts) are relatively detached from water resource issues. Appointees to participatory decision-making bodies in NSW have typically been selected to represent primary stakeholder groups (with a de-facto emphasis on agriculture; Bellamy et al. 2002). Participatory decision-making around environmental water projects in NSW occurs through the state Office of Environment and Heritage Murray Lower Darling Environmental Water Advisory Group.

In SA, state water allocation planning, water-use licensing, and permitting are conducted in partnership with regional Natural Resources Management Boards. Key regional policy development and implementation functions in the Riverland are devolved to the Natural Resources SA Murray–Darling Basin Natural Resources Management Board and Riverland Natural Resources Management Group. Community participation is an expressed policy emphasis in regional planning and delivery processes (e.g., through community and local government advisory groups and Aboriginal Partnerships Programs) (SAMDB NRM Board 2015; DEWNR 2015). As the furthest downstream state, most dependent on basin-scale initiatives to secure inflows, SA management institutions orient strongly toward advocacy in national decision-making and leveraging commonwealth environmental water programs.

Self-organized and often transient collaborations are important mechanisms for knowledge co-production and social learning around environmental water management (see also Marshall et al. 2013). This dynamic is particularly evident along the NSW-VIC border, where place-based project collaboration has allowed significant resource and capacity leveraging. Interviewees on both sides of that border, across a range of government and non-government affiliations, emphasized the importance of these relationships in supporting operational capacity, as well as the diffusion of environmental water management innovations.

Nonetheless, structural differences result in a lack of fit between institutions across jurisdictional boundaries, as well as conditioning their downward accountability (Moore and Rockloff 2006) and the openness of participatory processes. All interviewees made reference to participatory decision-making, but with significant diversity in the assumed form and effect of participatory processes. Within this context, agency interviewees in each state articulated different perspectives on tradeoffs between community involvement and accountability on the one hand, and risk of cooptation or capture by dominant coalitions on the other. These are well-established concerns associated with 'community-based' and other forms of participatory decision making (see Cooke & Kothari 2001; Reed 2008; Bixler et al. 2016). Where self-organized practitioner collaborations have emerged to span these gaps and leverage institutional complementarities, they have required regional practitioners to draw on crucial yet fragile relational capital built through long-term interaction (see also Wallis and Ison 2011).

Representative inclusion

Public engagement by the MDBA was criticized during development of the Basin Plan (SCRA 2011), and appropriate representation of Basin communities at national levels remains a fraught issue (Crase et al. 2013; Evans and Pratchett 2013). The MDBA framework for evaluation articulates the significance of "community views and expertise" in Basin Plan implementation (MDBA 2014b, p. 27). Agricultural and indigenous communities are critical contributors to this process, though perception among several members of participatory decision-making bodies and agricultural industry organizations that Basin communities have been "consulted to death" (anonymous interviewee) underscores the significance of substantive rather than strictly symbolic engagements.

Irrigated horticulture is the dominant agricultural water use in the tri-state area, primarily in the form of grapes, almonds, and citrus (ABS 2008; MDBA 2010). Falling wine grape prices over the past decade (MDC 2014a; Anderson 2015) have contributed to a marginal ongoing decline in the area under wine grape cultivation, accompanied by two waves of investment in almond production over the past 15 years (Aither/RIRDC 2016; ABA 2015). Alongside large Commonwealth-funded irrigation infrastructure programs, major greenfield almond developments and processing facilities are underway in the area, financed with significant foreign investment and on expectations of ongoing production uncertainty in California (MDC 2014b). These developments fit within longer-term regional trends toward consolidation of agricultural land and water holdings, as well as shifts away from historical irrigation districts (Mallee CMA 2010; Aither/RIRDC 2016). The emerging picture is of dynamic agricultural communities facing multi-scale pressures. These trends, alongside increasingly diverse regional centers at Mildura and Renmark, reflect an evolving socioeconomic context in which community interests cannot be assumed to be stable in time.

Limited representation of indigenous communities in authoritative decision making is a well-established concern in this context (Bark et al. 2012; Lynch et al. 2013; Jackson 2015). The Basin Plan requires that state water resource

plans have regard to "the social, spiritual, and cultural values of indigenous people" [MDBA 2012, sec. 10.52(2)], and recent amendments to the Water Act have reiterated commitments to incorporating indigenous values and uses (see Cwlth 2015). State and commonwealth agency personnel, as well as indigenous community members, expressed interest in clarifying the concept of 'cultural water'[5] management and how it might be operationalized. Several initiatives, including a National Cultural Flows Research Project and MDBA Aboriginal Partnerships Action Plan, have been funded to address aspects of this issue. While there was general agreement among environmental water managers that they should ultimately play a role in addressing indigenous cultural concerns, there were divergent perspectives on the appropriate form and extent of that function. There was general consensus among state and commonwealth management practitioners that environmental watering should be leveraged where possible to support culturally and spiritually significant outcomes. State agency practitioners nonetheless tended to express concern over the gap between mandates for indigenous participation and the existence of local institutions with which to build collaborative relationships. These perspectives were most evident in VIC and NSW. With a few regional exceptions, "[most] organizations simply haven't got the structure to engage" (anonymous interviewee). These patterns illustrate persistant scale and structure mismatches between local indigenous and management institutions, and are a persistent barrier to two-way communication, knowledge co-production, and representation of indigenous interests in environmental water management.

That said, mechanisms for indigenous engagement exist in all three states, including peak advocacy organizations such as the Murray Lower Darling Rivers indigenous Nations, and agency-based indigenous engagement officers. Recognizing the positive potential of these relationships, several indigenous interviewees, situated in state agencies and non-government organizations, noted that the prevailing cultural heritage management and 'impact assessment' frame was ultimately an insufficient mechanism for representing the scope of indigenous values implicated in environmental water management (see Jackson 2006, Finn and Jackson 2011, Lynch et al. 2014). "The environmental watering approvals process limits discussion of outcome tradeoffs" (anonymous interviewee) and ultimately "restricts indigenous peoples […] it's sticks and bones and trees […] and the landscape's more than that" (anonymous interviewee). Interviewees across a spectrum of roles and affiliations emphasized indigenous community self-organization and institutional capacity-building as broad and persistent issues, along with entrenched patterns of conflict and mistrust. Almost all interviewees recognized the significance of building relationships and legitimacy, but also the challenge of recruiting and sustaining resources dedicated to address those concerns. These are substantial barriers to integrative governance as we understand it.

[5] Cultural water has been defined broadly by Murray-Lower Darling Rivers Indigenous Nations as "water entitlements that are legally and beneficially owned by the Indigenous Nations and are of sufficient and adequate quantity to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations" (MLDRIN 2007: Article 1).

CEWH as Bridging Organization for Integrative Governance

The barriers to integrative governance we identify—limited decision-support resources for socially-robust goal-setting, resourcing patterns that restrict adaptive practice, inter-jurisdictional capacity gaps and lack of fit, entrenched patterns of indigenous under-representation—are not unique to the Murray–Darling (see e.g., Allen and Gunderson 2011; Bark et al. 2012; Davidson and de Loë 2014), but salient precisely because they constrain arenas for participants in this policy system to negotiate their common interest in environmental water, and co-produce knowledge relevant to advancing that common interest. The role of bridging organizations in support of these functions has been emphasized in a variety of resource settings (e.g., Dewulf et al. 2013; Armitage et al. 2015; Kowalski and Jenkins 2015; Wyborn 2015; Horning et al. 2016). Within *this* context, it appears the CEWH may be uniquely positioned and resourced to serve as a bridging organization to address barriers and support integrative governance.

The CEWH has substantial latitude within the scope of its mandate to protect and restore water dependent ecosystems and ecosystem functions. Coupled with CEWH reliance on regional delivery partners, this presents an opportunity for experimentation and innovation. Specifically, the CEWH may be well-placed to support (i) inclusive negotiation of goals for environmental water management, (ii) robust downward accountability, and (iii) open decision processes. In these respects, we suggest that the CEWH—particularly through local/regional project development and implementation—can function to address integrative governance barriers we identified. Agency leadership may be a crucial factor in realizing these aspirations.

The CEWH framework for environmental water management emphasizes the role of local values, knowledge, and capacity in setting operational goals that maximize environmental benefits to protect and restore ecological 'assets', understood as sites or processes of significance (CEWH 2013a, c). There is a strong place-based corollary to these elements of the CEWH framework, and experience in the tri-state area demonstrates a tradition of place-based collaboration as a means of addressing institutional

constraints. As targets of management attention and activity, place-based environmental assets and watering projects can function as boundary objects for collaboration. As boundary objects, environmental assets are a prospective basis for participants to co-create compatible frames for pursuing management actions, and a mechanism for negotiating the common interest at a tractable scale. The CEWH is positioned to function as an effective bridging organization in this context, through asset-focused environmental water planning and implementation with regional delivery partners. In the tri-state area, the CEWH can likewise facilitate diffusion of innovations through existing collaborative networks and the access of CEWH LEOs to multi-jurisdictional 'communities of practice' (per Wenger and Snyder 2000).

Bridging functions are contingent on building and maintaining trust across participant networks. Critically, effective bridging will demand stable resource commitments to support the physical presence of CEWH staff, maintenance of multiple environmental watering projects involving overlapping groups, regular contact with project participants, and flexibility in resource allocation and project implementation. One mechanism is the AUD 10 million allocated for CEWH administration under the MDB Environmental Water Knowledge and Research Project (DoE 2016d). Success may also be supported by collaborative independent monitoring of environmental watering outcomes. Collaborative monitoring supports diverse approaches to assessing dynamic ecosystem responses, information sharing across participants, and reflective clarification of local values (Brunner and Lynch 2010); dynamics essential to knowledge co-production. These factors are also salient in supporting representative inclusion in decision-making through engagement with indigenous and other communities in the tri-state area.

As noted, CEWH is reliant on state and MDBA resources for environmental water delivery and assessment, and overarching inter-state and federal-state tensions may ultimately limit its capacity as a bridging organization. Evolving multi-jurisdictional tensions related to constraints on environmental water delivery (property rights, third-party impacts, infrastructure), and interstate agency competition over CEWH and MDBA portfolio resources may be significant factors in this context (see Garrick et al. 2012). Recognizing these contingencies, there will be scope for the CEWH to leverage its role as the largest environmental water holder in the Basin for access to decision processes at multiple levels.

Agency leadership will largely define the scope of CEWH activity in relation to its mandate. Statutory requirements for community involvement, for example, are largely met through water resource planning processes undertaken by the MDBA and Basin states. There may be limited obligation in this context to engage substantively with the integrative governance challenges or pathways discussed here. While several commonwealth agency interviewees emphasized prospects for "communities to be involved and take ownership" of environmental water management objectives and outcomes (anonymous interviewee), the CEWH's role relative to partner agencies and local communities was often described as "an ongoing negotiation" requiring contextually sensitive engagement at multiple scales (anonymous interviewee). "Demonstrating positive outcomes" and building "social license" for environmental water management in the face of lingering political opposition is a substantial concern in this context (anonymous interviewee). Strategic concern for deflecting criticism by regional communities, politicians, and advocacy organizations may ultimately motivate a conservative public approach to framing the CEWH's role and responsibility.

Conclusion

This analysis contributes a provisional perspective on contextual challenges and potential pathways for advancing integrative governance of environmental water in the MDB. In this study we identified critical barriers to integrative governance in practice, and discuss means of addressing them through the bridging capacities of a multi-jurisdictional organization. Our approach has highlighted the dynamic character of environmental water management challenges in this vast watershed, and the significance of governance processes that function to reconcile the contextually-situated interests of participants in this policy process where possible, balance them when necessary, and support co-production of knowledge relevant to advancing the common interest.

Implementation of the Basin Plan extends through 2024 (MDBA 2016), and key elements of context—formal policy objectives, funding commitments and patterns, working relationships—will continue to evolve in ways that impact the dynamics we describe here. Recognizing these contingencies, this case illustrates pivotal integrative governance challenges of negotiating socially robust goals for management, resourcing to support adaptive practice, interjurisdictional lack-of-fit in participatory decision-making and devolution of authority, and pursuing representative inclusion in open decision processes. These dynamics are broadly relevant to resource managers in other river systems, as is the potential for a multi-jurisdictional organization like CEWH to function in a bridging role. Notwithstanding the evolving role of the CEWH, success in addressing these integrative governance challenges in the

common interest will shape prospects for advancing social and ecological sustainability in the Murray–Darling.

Acknowledgements This work has been supported by Brown University and the Institute at Brown for Environment and Society. We wish to acknowledge the generous contributions of Keith Spangler. We also thank two anonymous reviewers for their insightful comments and encouragement.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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