Rethinking Condition: Measuring and Evaluating Wetland Vegetation Responses to Water Management

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Environmental water management is increasingly used to restore riverine, wetland and floodplain ecosystems and requires an understanding of what the flow regime or restoration objectives are, why these objectives are being targeted and how outcomes will be evaluated. This perspective paper focuses on non-woody vegetation, an important component of river-floodplain ecosystems and a targeted outcome for many environmental flow management programs, such as the Basin wide environmental watering strategy for the Murray-Darling Basin in Australia. Effective management of non-woody vegetation using environmental water requires identifying a suite of measurable condition outcomes (the "what"), understanding how these relate to broader functions and values (the "why") and developing clear cause-and-effect relationships between management and outcomes (the "how"). A critical component of this process is to characterise what constitutes management success, which requires reimagining current definitions of condition to better incorporate dynamic functions and diverse values. We identify the need to characterise condition in a structured framework using both ecological data and societal values. This approach will not only help inform the development of benchmarks, watering objectives and monitoring metrics, but will also facilitate engagement by a broader spectrum of the community with the management and outcomes of environmental watering.

Keywords: vegetation condition assessment, environmental flow, environmental water management, flooding, floodplain, restoration, wetland plants

INTRODUCTION

Evaluating success is a key challenge in restoration ecology (Palmer et al., 2005; Wortley et al., 2013; Prach et al., 2019). The answer is seemingly simple—"success occurs when the ecological restoration reaches its goal" (Prach et al., 2019). However, the reality is a melting pot of divergent expectations, definitions and measures of success (Wortley et al., 2013; Prach et al., 2019) with ongoing debates over how to define or categorize success or failure (Wortley et al., 2013; Prach et al., 2019; Galbraith et al., 2021; Marchand et al., 2021). Evaluating outcomes from environmental management actions, such as environmental flows, is important as it enables learning by doing to inform future management activities (Pollard et al., 2011; Vietz et al., 2018; McLoughlin et al., 2020). Evaluation also strengthens theoretical understanding (Török and Helm 2017), improving the predictability of restoration outcomes (Bullock et al., 2011; Brudvig et al., 2017).

Central to evaluating outcomes of management actions such as environmental flows is our understanding of what the restoration objectives are, why these objectives are being targeted and how
outcomes will be assessed in relation to these. This paper focuses on non-woody vegetation condition as a targeted outcome of environmental water actions. While improved vegetation condition is a common objective of environmental water management, the construct of condition is often poorly defined (Gibbons et al., 2006; Gibbons and Freudenberger 2006). In particular, naturally dynamic responses of vegetation to variable water regimes are not well represented by static descriptions of condition (Campbell et al., 2021). Following the principles of Campbell, James et al. (2021), wetland ecological condition needs to consider i) various scales and levels of ecological organisation, ii) temporal context and complexity, iii) non-hydrological modifying factors, and iv) align with management objectives and ecological, sociocultural and economic functions and values. In this perspective article we consider what we want to achieve by targeting watering for wetland vegetation condition. We explore the idea of success, specifically in terms of reimagining current definitions of condition to better incorporate dynamic functions and diverse values. We conclude by highlighting the potential for a framework of condition, structured around the principles of Campbell, James et al. (2021), to provide the building blocks for a data-driven narrative that synthesises disparate pieces of information.

WHAT DO WE WANT TO ACHIEVE BY WATERING NON-WOODY WETLAND-FLOODPLAIN VEGETATION AND WHY DO WE TARGET THESE OUTCOMES?

Determining objectives for environmental management or restoration projects remains a critical first step (Prach et al., 2019) and processes and principles for setting objectives have been dealt with extensively in the literature (Tear et al., 2005; Lindenmayer et al., 2008; Horne A et al., 2017; Campbell et al., 2021). Ultimately why we water rivers, wetlands and floodplains reflects what we value about them (Gonzalez Lopez and Amerigo Cuervo-Arango, 2008; Arsenio et al., 2020). An outcome may be valued because of its intrinsic worth, such as biodiversity or the inherent right of a species to exist (Dudgeon 2014; Jax and Heinke 2015). In some situations management is focussed on maintaining or restoring ecological functions (de Groot et al., 2002; Capon et al., 2013), such as the provision of habitat or food (Valinoti et al., 2011; Bice et al., 2014; McGinness et al., 2014). Increasingly management is focused on achieving multiple ecosystem services including: aesthetics (Cottet et al., 2013), cultural connection (Douglas et al., 2019; Moggridge and Thompson 2021), recreation (Gitau et al., 2019), education (Flitcroft et al., 2016), or tourism (Balmford et al., 2009; Harrison et al., 2010). There are also calls for environmental water management to increase the focus on managing for resilience to better link environmental water management to ecological sustainability and social well-being (Arthington et al., 2018; Poff 2018). Research has shown that the level of support for the implementation of environmental management activities is linked to stakeholder engagement, including the ability to relate to environmental outcomes by a shared belief in the value of the outcome (Conallin et al., 2018; Okumah et al., 2020; Liguori et al., 2021).

Non-woody vegetation (NWV) can comprise a significant proportion of biodiversity in many catchments and is fundamental to many ecosystem functions. The Murray-Darling Basin (MDB) in Australia, for example, supports a tremendous diversity of both plants and vegetation communities (Brooks 2020; Capon and James 2020), including more than 700 native plant species (Dyer et al., 2021) and a wide diversity of vegetation communities (Brooks 2021). Many of these plant species can be described as non-woody—which in the context of this paper refers to all vascular plant species except trees and large shrubs as well as macro-algae such as charophytes. NWV comprises floating plants, submerged macrophytes, herbs, grasses, sedges, sub-shrubs, and tall reeds. NWV communities tend to be highly dynamic in space and time (Keddy 2010; Capon and Reid 2016; Hunter 2021), reflecting variation in inundation patterns over multiple scales (Thoms et al., 2006; Leblanc et al., 2012; Tulbure and Broich 2019).

Functionally, non-woody plant species and vegetation communities are critical components of river-floodplain ecosystems, providing food and habitat for a large array of biota including fish (Bice et al., 2014), woodland and waterbirds (Kingsford and Thomas 2004; Ma et al., 2010; McGinness et al., 2018), frogs (Wassens et al., 2010; McGinness et al., 2014), and macroinvertebrates (Warfe and Barmuta 2006). NWV also supports a wide range of ecological functions such as carbon and nutrient cycling (Carpenter and Lodge 1986; Baldwin et al., 2013), bank stabilisation (Marden et al., 2005; Docker and Hubble 2008), sediment and flow dynamics (Neary et al., 2012), water quality (Withers and Jarvie 2008) and regulation of microclimates (Reeder 2011; Choi et al., 2014; James et al., 2015). Furthermore, NWV supports many social, cultural and economic values, often playing a key role in shaping aesthetically beautiful places (Cottet et al., 2013; Saha et al., 2020), having cultural importance for food, medicine, or fibre (Conroy et al., 2019; Higgisson et al., 2021), contributing to the enjoyment of recreational pursuits (Harrison et al., 2010; Zhu et al., 2011), or supporting tourism (Siikamaki et al., 2015; Hausmann et al., 2020). Thus, by watering wetlands and floodplains and supporting the vegetation communities within them, we can support a range of ecological, socio-cultural, and economic functions.

Environmental water management can also be targeted to promote ecological resilience, i.e., the ability for ecosystems to resist or respond to change and implies long-term sustainability (Capon and Reid 2016; Chambers et al., 2019). To persist into the future, plant species and vegetation communities, as well as the functions these underpin, need to be resilient to factors such as a changing climate (Capon et al., 2013) that includes changes to rainfall, temperature, fire regimes and the intensity of extreme events (CSIRO and Bureau of Meteorology 2015). Plant species and vegetation communities also need to be resilient to pressures...
from development, land use, pollution, pest plants and animals, and ongoing competition for water resources (Reis et al., 2017; Dudgeon 2019; Reid et al., 2019). Managing for resilience is a function of understanding the different traits of taxa and communities that contribute to resilience (Combroux et al., 2001; Santamaria 2002; Clarke et al., 2015) to particular environmental disturbances (Chambers et al., 2019), key factors which underpin recovery mechanisms such as dormant seed banks (Brock 2011; Haines-Young et al., 2012; Capon and Reid 2016; Liu et al., 2020) as well as spatial resilience (Chambers et al., 2019). In many modified catchments, environmental water actions are likely to play a critical role in building resilience, helping to restore the health of vegetation from a degraded state (Overton et al., 2014; Bond et al., 2018), which can require a recovery flow regime that is, more frequent than the long-term average (Campbell et al., 2021). Environmental water can also help fill the role of small to medium floods (Bond et al., 2014) which, because of regulation, have been lost from the hydrograph in locations such as the mid to lower River Murray (Maheshwari et al., 1995).

HOW DO WE KNOW IF WE’VE SUCCEEDED IN MEETING THE OBJECTIVES?

Evaluating outcomes against goals or objectives remains pivotal to determining the success of environmental water management and ecological restoration projects (Prach et al., 2019), though what constitutes success or failure is still a topic of debate (Wortley et al., 2013; Prach et al., 2019; Galbraith et al., 2021; Marchand et al., 2021). Evaluation is “the process of judging or calculating the quality, importance, amount or value of something” (Cambridge-English-Dictionary 2020), and inevitably involves some degree of subjectivity albeit informed by expert opinion and experience (Prach et al., 2019). Considerable benefit in evaluating outcomes to environmental water management comes from the knowledge gained in relation to managing future environmental water management actions. For example, determining the factors that led to objectives not being met, such as water availability, climate or other factors, can help inform future water management. Results may indicate the need for complementary actions, such as the control of pest animals, or the need to adjust future objectives or expectations. Because environmental water management is often carried out at scales that prevent the establishment of unmanaged “controls” for comparison, evaluation often requires a sophisticated “teasing apart” of the roles of different drivers and potential confounding variables (Konrad et al., 2011; Gawne et al., 2019). For long-term goals and objectives, this may require multiple scenarios of expectations based on a range of potentially interacting variables and management options that may influence water availability, or broader scale factors such as climate.

The definition of evaluation given in this paper highlights the need to know the state of what is being evaluated, i.e., its quality, importance, amount or value—which in the context of assessing vegetation outcomes to management activities such as environmental flows can be broadly defined as vegetation condition. There is no standard definition for “vegetation condition” (Gibbons et al., 2006), rather it is seen as a continuum of “good” to “bad” depending on the context or goal (Gibbons and Freudenberger 2006). Condition is also inherently a comparative concept (Parkes and Lyon 2006) and involves value judgements—good condition for whom or good condition for what (Gibbons and Freudenberger 2006). Viewing condition as representing “the quality, importance, amount, or value of something” links to key elements of what we’re trying to achieve by watering NWV namely the contribution NWV makes to ecological, socio-cultural and economic functions and values, biodiversity, and the need to support resilience to maintain these values into the future. It also aligns with Driver-Pressure-State-Impact-Response (DPSIR) models used internationally (Tscherning et al., 2012; Obere Gari et al., 2015) in environmental assessments, such as Australian State of the Environment (SoE) reporting (Jackson 2017). The SoE approach describes the “State” as incorporating both current condition as well as recent trends in condition (Jackson 2017), highlighting the importance of temporal trajectories.

Definitions of condition, however, are not straightforward. Defining the state of something, such as NWV, is complex. NWV responses occur across different spatial and temporal scales. As highlighted by the SoE approach (Jackson 2017), state needs to consider current condition along with trends. Trend changes in NWV are influenced by a number of factors including flow regimes and climatic cycles across different temporal scales (Ryo et al., 2019). Considering the spatial scale across which responses and trends are assessed is important and influences ecological and spatial resilience (Chambers et al., 2019). Condition, as described in the paragraph above, is framed by the functions and values provided by NWV—“the quality, importance, amount, or value of something.” Functions and values also inform targets which are further used in the evaluation of the quality of condition in relation to targets (Figure 1). NWV provides numerous ecological, socio-cultural and economic functions and values, that can be broadly grouped as providing i) habitat, ii) regulating, iii) production, and iv) information functions and values (de Groot et al., 2002; Capon et al., 2013). NWV also contributes to biodiversity at different levels of ecological organisation (Noss 1990), such as individual plants, populations, species, communities, and vegscapes, which are landscape-scale mosaics of plant communities, and through the expression of a variety of attributes—composition, structure and process (Noss 1990) (Figure 1).

As depicted in DPSIR models, the state of NWV, is further influenced by drivers and pressures (Figure 1). For NWV in floodplain-wetland systems key drivers and pressures include aspects of flow regimes across multiple temporal scales, such as individual pulses or inundation events, short-term flow regimes (e.g., annual to 10 years), and longer-term flow patterns over decades to centuries. NWV responses are also influenced by a range of non-flow drivers and stressors such as climate, pest plants and animals and land use development (Reid et al., 2019). The above components are depicted graphically in Figure 1 and further discussed in Campbell et al. (2021). Campbell et al. (2021) summarised characteristics of NWV responses into four
principles to guide the development of objectives and evaluation approaches: i) identify indicators that align with management objectives and ecological functions that support ecological, socio-cultural and economic values; ii) identify appropriate spatial scales and levels of ecological organisation; iii) identify relevant temporal dynamics, trajectories and uncertainties; and iv) identify non-hydrological modifying drivers. In the following section we propose a vision for NWV condition and the evaluation of outcomes, particularly across broad spatial scales such as whole-of-Basin, that encapsulates these principles, as well as the construct of condition as representing “the quality, importance, amount or value of something” as presented here. While the MDB has been the backdrop for developing these ideas, the proposed characterisation of condition is applicable to other floodplain-wetland systems where environmental water management is used to achieve non-woody vegetation outcomes.

**WHAT DOES GOOD CONDITION LOOK LIKE FOR WETLAND-FLOODPLAIN NWV?**

We propose that good condition should reflect a combination of ecological-socio-cultural and economic functions and values, biodiversity, and resilience—where resilience incorporates current and projected changes to flow regimes, climate, and other non-flow stressors and drivers, and that these components of condition should be assessed across multiple spatiotemporal scales and across multiple levels of ecological organisation (Figure 1).

This characterisation of NWV condition requires a multifaceted approach that can be informed by reference to literature, ecological theory, analysis of data, and human insights. There is a wealth of knowledge and insight held by practitioners working in the environmental water management space that is, rarely captured in published literature [with notable exceptions such as Jahnig et al. (2011); Horne A. C. et al., 2017; Wineland et al. (2021)]. Relationships between vegetation responses and flow regimes to inform definitions of condition, can be derived from quantitative analysis of data (e.g., Bowen 2019), expert elicitation (e.g., Sinclair et al., 2015; DELWP 2016; Sinclair et al., 2018), professional insights (Jahnig et al., 2011; Cook et al., 2012), traditional knowledge (Jackson et al., 2015; Douglas et al., 2019; Moggridge et al., 2019), structured literature reviews (e.g., Greet et al., 2011; Webb et al., 2012), conceptual models (Capon et al., 2009; Casanova 2015), or approaches which combine multiple aspects (e.g., Webb et al., 2015).

Similarly, the values and functions supported by NWV need to be derived from a broad range of stakeholders using appropriate techniques to facilitate engagement (Moggridge et al., 2019; Sterling et al., 2019; Liguori et al., 2021). Community understanding and support for environmental flows is an important part of social license and the ability to effectively
| Component | Sub-component | Description |
|-----------|---------------|-------------|
| a) Ephemeral herbfields | Functions and values | Ecological, socio-cultural and economic functions and values |
| Biodiversity | Characteristics of community type | Species germinate and grow on recession of water; typically high species richness and high cover (in healthy examples) with rapid turnover of species composition; can form distinct bands of vegetation; often dominated by short-lived species that germinate from persistent seed banks (though later successional species can persist for longer); diversity and cover are important attributes; seed banks are crucial |
| | Example species: (semi-arid inland south-eastern Australia) | Ruppia spp., Potamogeton spp., Vallisneria spp., Charophytes |
| Resilience | Ecological resilience | Composition, abundance and viability of seed banks at individual locations |
| | Spatial resilience | Landscape distribution and configuration of community types with different levels of ecological resilience |
| Trends | Temporal | Assemblages transition between naturally variable wet-dry phases; limits of acceptable variability would need to be defined |
| | Spatial | See spatial resilience |
| Drivers/Pressures | Flow requirements/pressures: (potential explanatory variables) | Temporary inundation. Recession rates need to maintain adequate soil moisture to enable species to complete life-cycles and set seed; season of water recession will influence species composition; frequency/inter-flood dry period needs to maintain seed bank viability |
| | Non-flow drivers/pressures: (potential explanatory variables) | Disturbance (e.g., pigs, horses); grazing (non-native and native); extent of litter cover; shading; climate (influence of evaporation/rainfall on soil moisture); salinity; temperatures |
| b) Submerged macrophytes | Functions and values | Ecological, socio-cultural and economic functions and values |
| Biodiversity | Characteristics of community type | Presence of water; low species richness and high cover may be characteristic; may be dominated by vegetative reproduction; structure and cover are important attributes |
| | Example species: (semi-arid inland south-eastern Australia) | Ruppia spp., Potamogeton spp., Vallisneria spp., Charophytes |
| | Attributes (e.g., composition, structure, process): (potential vegetation response metrics) | % cover; structural complexity |
| Resilience | Ecological resilience | Cover of submerged macrophytes and capacity for vegetative regeneration or germination from seed banks at individual locations |
| | Spatial resilience | Landscape distribution and configuration of community types with different levels of ecological resilience |
| Trends | Temporal | Relative stability over time within the limits of natural flow variability |
| | Spatial | See spatial resilience |
| Drivers/Pressures | Flow requirements/pressures: (potential explanatory variables) | Permanent to semi-permanent water; following complete drying may require at least 6 months inundation for submerged vegetation to re-establish; water level typically needs to be maintained >50 cm and <2 m (can exceed these bounds for short periods; may need to be <1 m if water is very turbid); influenced by water quality (turbidity, salinity, pH, algal blooms, blackwater events) |
| | Non-flow drivers/pressures: (potential explanatory variables) | Mechanical disturbance (carp, waterbirds, boats); temperature |

TABLE 1 | Example application of the proposed framework for (a) ephemeral herbfield vegetation and (b) submerged macrophyte vegetation. Components used to characterise the condition of non-woody vegetation (see also Figure 1) would be defined by workshopping with stakeholders. Example specific characteristics are provided based on ephemeral herbfields and submerged macrophytes in arid inland south-eastern Australia.

implement environmental water management actions (Dare et al., 2014), with community understanding and support inevitably linked to personal values (Gonzalez Lopez and Amerigo Cuervo-Arango, 2008). To reflect the diversity of values, functions also need to encompass a range of services from ecological, such as habitat and regulation, to economic production and other social and cultural functions such as information, aesthetics, education and wellbeing (de Groot et al., 2002; Capon et al., 2013).

Using the conceptual model in Figure 1 components of condition can be structured in a framework that explicitly incorporates i) ecological, socio-cultural and economic functions and values, ii)
biodiversity at multiple levels of ecological organisation and across a range of attributes, and iii) resilience to changes in flow, climate and other non-flow drivers, and to assess the trends in these components across multiple temporal and spatial scales.

Table 1 provide an example of the information that could be collated to help characterise condition for two NWV communities, ephemeral herbfield vegetation, and submerged macrophyte communities. This applies the concepts from Figure 1. While these examples are both at the community level of ecological organization a similar process could be undertaken for species or landscape mosaics. Socio-cultural and economic functions and values are underrepresented in the current examples and require further research. By having a structured framework, that considers both ecological data and societal values, guidance can be given to water managers to help inform the development of benchmarks, watering objectives and monitoring metrics. There are, however, key pieces of information required to apply such a framework.

First, condition needs to be described at different levels of ecological organisation and explicitly relate to wet-dry phases. In highly dynamic systems, such as wetlands that cycle through wet-dry phases (Boulton et al., 2014), different points in the wet-dry phase should inform condition. The relative importance or influence of various phases is likely to vary for different wetland types or communities, for example, the inundated phase for submerged vegetation compared with flow recession and the drawdown phase for some ephemeral herbfields. Thapa et al. (2020) examined the productivity response of four vegetation communities to four phases of the wet-dry cycle and acknowledge the need to expand response patterns to wet-dry cycles to other biological attributes such as flowering, seed set and germination. In relation to levels of ecological organisation, a high proportion of studies investigating vegetation responses to flow regimes focus on the level of community (CJC unpublished data). More work is required to define the characteristics of condition at other levels of ecological organisation, such as area, spatial configuration, as well as flow and vegetated connectivity at landscape scales.

Second, expected response trajectories for NWV outcomes need to be defined. These trajectories need to be explicit about the timescale across which responses are expected to occur (Ryo et al., 2019), for example, species may germinate only weeks after inundation, while target cover values or the full complement of species in the seedbank may only be expressed after multiple wet-dry inundation events across multiple years. The state of vegetation prior to management interventions will also impact expected response trajectories (Bond et al., 2018). The flow and non-flow conditions conducive to meeting expected response trajectories also need to be explicitly stated (Bino et al., 2015). For example, a series of drought years with below-average rainfall and above-average temperatures will interact with expected outcomes from environmental flow. Similarly, land use factors such as grazing pressure (Nicol et al., 2007; Souther et al., 2019), animal disturbance (Vilizzi et al., 2014) and nutrient runoff (Smith 2003) are also likely to impact outcomes from environmental flows. Expected responses also need to provide an indication of the shape of the trajectory, be that a return to some “pre-disturbance” condition state, slowing the rate of decline, or facilitating transition to novel but functional systems (Hobbs et al., 2014).

Third, there needs to be a better understanding of the ecological, socio-cultural and economic functions and values provided by different types of vegetation outcomes as well as appropriate metrics to address these (Capon et al., 2013; Campbell et al., 2021). An additional important consideration is the way in which values and appropriate participation are incorporated as highlighted by Moggridge et al. (2019) and Douglas et al. (2019) in relation to the integration of cultural values into water planning.

Characterisation of NWV condition needs to move beyond single-state, ecologically derived definitions to capture ecological, socio-cultural and economic functions and values (de Groot et al., 2002; Capon et al., 2013), incorporate scale (Rolls et al., 2018) and dynamic temporal trajectories (Ryo et al., 2019), consider trade-offs or transitions to novel ecosystem types (Hobbs et al., 2014), while not losing sight of the inherent value of biodiversity (Dudgeon 2014). Adequate characterisation of condition is required to successfully evaluate dynamic NWV outcomes to environmental flows. The ability to evaluate outcomes is critical in terms of learning by doing to inform future management activities (Conallin et al., 2018; Watts et al., 2020). Evaluation also improves the theoretical basis for predicting outcomes (Bullock et al., 2011; Brudvig et al., 2017; Török and Helm 2017), is an important component in achieving the aims of restoration projects (Prach et al., 2019), such as environmental flows, and for effective communication of and engagement with outcomes (Conallin et al., 2018). Improving the health of our rivers, wetlands and floodplains is important not only in terms of supporting ecosystems but in terms of the deep connection people have with these environments that affects their physical and mental wellbeing (Russell et al., 2013; Reeves et al., 2021). How we characterise and evaluate condition may have benefits to both ecosystem health and how people connect with environmental flows and the rivers, wetlands and floodplains to which they’re delivered.

RECOMMENDATIONS

We conclude by proposing recommendations for the future of NWV monitoring and evaluation, particularly at large spatial scales:

- Develop indicators of condition at different levels of ecological organisation that incorporate biodiversity, ecological, socio-cultural and economic functions and values, and resilience
- Undertake monitoring and evaluation across multiple levels of ecological organisation to address biodiversity, functions and values and resilience, for example:
  - Population or species level: e.g., monitoring of individual species or populations of interest, such as rare and threatened species, species significantly contributing to the character of Ramsar sites, important food or habitat for fauna, or species identified for other values such as importance to aboriginal people.
  - Community level: e.g., monitoring, at both the field level and via remote sensing, of community assemblages and dynamics at multiple spatiotemporal scales in terms of the contribution to biodiversity and functional processes.
o Vegscape level: e.g., monitoring of spatiotemporal configuration of ecosystem patches and evaluating the requirements for long-term resilience, for example, what and how much, where and when?
• Undertake research to establish the links between different levels of ecological organisation and the influence of flow and non-flow drivers, e.g., species or community assemblages associated with different ecosystem types, different flow regimes, and other non-flow drivers
• Establish trajectories of expected responses for defined outcomes that incorporate different flow scenarios and scenarios for key non-flow drivers such as climate
• Invest in better understanding the ecological, socio-cultural and economic functions and values of NWV, e.g., how these change in space and time, appropriate indicators for monitoring, and appropriate ways of integrating values.
• Establish processes to synthesize outcomes and knowledge across multiple levels of ecological organisation

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

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AUTHOR CONTRIBUTIONS

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