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Research paper

Priority river metrics for residents of an urbanized arid watershed

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HIGHLIGHTS

- The general public provided extensive and thoughtful input on river monitoring goals.
- Native flora and fauna were usually preferred, despite not knowing specific species.
- Visible defacement such as garbage rivaled the importance of ecological features.
- Findings are reported as metrics accessible to natural and social scientists.

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ABSTRACT

In river and stream assessment and management, a persistent question is isolating appropriate indicators of resource condition. We employ qualitative research techniques to identify features of rivers and streams important to the general public in an urbanized arid watershed of the southwestern US, based on interview and focus group data. After detailed analysis of transcriptions, findings were member-checked with new study participants and further revised. Theme frequencies are reported to provide an indication of participants' informational priorities. Recurrent ecological themes were Water, Vegetation, and Fish and Wildlife; recurrent human themes were Garbage and Graffiti, Odor, Infrastructure, Other People, and Noise. Themes are further described along with illustrative quotes from participants. We interpret participant input into actionable metrics which could serve to track resource condition. Results are compared to previous research and current monitoring practice. The findings are particularly relevant for scientists and managers interested in the perspectives on rivers and streams held by residents of urbanized watersheds in arid landscapes.

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1. Introduction

In arid regions, water resources are a frequent focus of environmental management. In the US, perhaps nowhere else is water scarcity more acutely felt than in the Southwest. Furthermore, the consensus is that the Southwest will become even more arid within a period of years to decades (Seager et al., 2007). The instream flows and associated riparian ecosystems that remain disproportionately contribute to biodiversity as compared with other land cover in the area (Naiman, Décamps, & Pollock, 1993). Rivers support a variety of recreational activities, and provide a water supply for municipal, agricultural, and industrial uses. A systematic way of assessing the condition of arid river resources would assist with the difficult tradeoffs inherent in management, for example, balancing instream and extractive water uses.

A consistent approach to assessing the condition of river resources requires a focus on specific, measureable features. Traditionally, the details of selecting these features have been left to biophysical scientists such as ecologists. Yet acknowledging a need for public input in river management (e.g., Kondolf & Yang, 2008: Ch. 4) implies a necessity that the metrics of river condition be publicly relevant. Some biophysical scientists engaged in monitoring recognize that what is measured should be things people value (e.g. Jackson, Kurtz, & Fisher, 2000; National Research Council, 2000) but-perhaps due to the specialized and technical nature of deriving actionable river metrics-social scientists have not frequently addressed this issue.

In this study we utilize social science techniques to systematically identify important river features, relying directly on input from residents of an arid case study location. We purposefully solicit feedback from the general public rather than high profile river stakeholders who may not represent general public interests.

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The features emerging from this input provide a foundation for our interpretation of specific river metrics. These metrics represent information relevant to the research participants while providing a detailed reference for scientific monitoring, modeling, mapping, and communication. Our goal is to inform at least some of the difficult decisions involved in monitoring program execution. Challenges such as the subjectivity of what is ultimately measured given the wide range of possibilities and constraints have been detailed by biophysical scientists (Hughes, 1993; Hughes & Peck, 2008), but may not be obvious to those who have not had to address them. We believe additional gains in thoughtful monitoring design can be made by examining strategic decisions with the benefit of social science research.

Most of our participants resided in an urban setting. While their comments did not exclusively pertain to the urban environment, much discussion did focus on urban river conditions. The importance of urban ecosystems is receiving increased recognition (e.g., a special issue of Landscape and Urban Planning, 2013, 109(1)). In the US, over 80% of people live in urban locations; in the Southwest the value exceeds 90% (US Census, 2010a). Human modifications are a given, but rivers and streams still provide some of the last dynamic natural areas in the urban landscape. Problems of urban environmental management can be considered distinct from rural or wilderness locations since urban areas are proximate to large human populations, thus careful management has a potential for high impact.

The critical question we address is: what is the breadth and depth of river features biophysical scientists should measure and/or model that is of direct relevance to people? Choices that impact rivers are continuously being made. Identifying publicly relevant features is crucial in order to represent social values in river status and assessment. Although various sources contribute partial insights, documentation of the range of features people value is virtually nonexistent. Some river attributes, such as water itself, are traded in markets. However there are also a broad range of so-called "nonmarket" river attributes such as ecological amenities and scenic views relevant for quality-of-life. Nonmarket attributes of rivers do not have easily observed units or price tags. In favorable data circumstances these attributes can be explored through tactics such as nonmarket valuation (e.g. Freeman, 2003). Several valuation studies have addressed river-related attributes in the Southwest (e.g., Bark, Osgood, Colby, Katz, & Stromberg, 2009; Berrens, Bohara, Silva, Brookshire, & McKee, 2000; Colby & Wishart, 2002; Larson & Perrings, 2013; Weber & Stewart, 2009; Weber, Mozumder, & Berrens, 2012). However research designs have only treated a limited set of variables per study, and results are sometimes limited to specific groups. A separate branch of literature elucidates categories of importance for rivers, such as naturalness, access, and aesthetics (see Asakawa, Yoshida, & Yabe, 2004; Gobster & Westphal, 2004; Smith & Moore, 2011). Understanding categorical motivations for river values adds insight, but is an imperfect guide to identifying key features themselves. What is considered more or less aesthetic? What metrics need to be included in a description of "naturalness"?

We know of only two prior studies involving social science research that consider an array of publicly important river features: Schiller et al. (2001), and Ringold, Boyd, Landers, and Weber (2009). In this paper we continue research on this topic, comparing and contrasting with these prior studies in the discussion. We utilize qualitative research techniques to identify recurrent participant themes. From these we interpret specific metrics to represent the status of the resource. These metrics guide specific measurements that could be made at a given river location. Our findings have application to a range of river monitoring and management questions for the study region and may reflect perspectives held by residents of other urbanized watersheds in the arid Western US.

2. Case study location

All study participants were residents of southern Arizona, with the vast majority residing within the Santa Cruz River watershed, and Tucson in particular. Tucson is the largest population base in the Santa Cruz watershed, situated at an elevation of about 800 m above sea level, with just over 1 million inhabitants in the metropolitan area. Tucson is enriched in hispanic/latino culture, with 40% of persons from that racial group as compared with 15% nationally (US Census, 2010b). Less than 30 cm of rain fall in Tucson in an average year, concentrated in summer monsoon and winter rainy seasons. The geography is Sonoran Desert basin and range.

Although surface water is scarce in the region, flowing rivers do exist. The Santa Cruz River itself is perennial in its uppermost reaches in the San Rafael valley of Southeastern Arizona, and in Northern Sonora, Mexico. The river was perennial within recorded history downstream in downtown Tucson (Logan, 2002). The Tucson reach was heavily impacted by downcutting induced by natural floods, human-assisted channelization to mitigate flooding, and groundwater development, removing the historic riparian area (Webb, Leake, & Turner, 2007: Ch. 21, esp. p. 254). Most hydrological accounts indicate the 1940s as when groundwater-dependent perennial flow ceased in the Tucson reach of Santa Cruz River, as a result of centrifugal pumps for agricultural irrigation, a continuing irrigation method in the region. However, two reaches north of Mexico have become perennial in modern times due to the discharge of treated wastewater. Three major treatment plants discharge into the channel downstream of Mexico, one just north of the border, and two in northwest Tucson. These reaches replace some of the vegetative communities and other habitat that previously existed. For additional watershed background see Norman et al. (2010).

3. Methods

3.1. Conceptual approach

In engaging research participants our overarching approach was to ask them to focus on physical, measureable features of rivers and streams of direct importance to them. If a participant were to mention a topic such as water quality, we would probe to learn more about why water quality was important to that person, such as important manifestations of high or low water quality. Furthermore, we would verify that these manifestations were of direct relevance. For example, dissolved oxygen is a technical water quality term which is unlikely to have direct meaning to a layperson, but which was occasionally mentioned. Through follow-up and probe questions the reason why dissolved oxygen was considered important could be determined, e.g. as a potential indicator for whether or not the water would support fish. Thus we endeavored to isolate features of direct importance to participants as opposed to underlying or intermediate ecological features or processes. Our research is an empirical application of the "Final Ecosystem Services" conceptual framework described by previous authors (Boyd & Banzhaf, 2007; Boyd & Krupnick, 2013; Ringold, Boyd, Landers, & Weber, 2013). Encouraging participants to think about and express final outcomes rather than intermediate factors promotes clarity on what it ultimately relevant to them, and eliminates double counting of potentially interdependent features, such as dissolved oxygen and fish.

Collecting public input to inform river monitoring required both a breadth and depth of public input. This directed us toward qualitative methods of focus groups and interviews since they allow wide-ranging commentary as well as in-depth discussion with participants. In a focus group, multiple perspectives can be