Water Science and Application 7

A Peculiar River

Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon

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Introduction

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INTRODUCTION

...the Deschutes is of especial interest to geographers, as it exhibits certain peculiarities not commonly met with.

This observation by geographer *Israel C. Russell* [1905, p. 20] replayed in our minds repeatedly during our studies of the Deschutes River in central Oregon. Studies by Russell and others alerted us to some peculiar aspects of the Deschutes, such as the remarkably steady spring-fed flow and extensive groundwater system. These attributes led other early chroniclers to describe the river's flow as being "...more remarkably uniform than that of any other river in the United States comparable with it in size, and its economic value is almost incalculable" [*Henshaw et al.,* 1914, p. 12]. Some of that value has been realized over the past century with the development of agriculture, hydropower, water supply, river recreation, and a blue-ribbon recreational fishery, the latter complementing a Native American fishery that has persisted for millennia.

Nevertheless, we were not prepared for other peculiarities, such as the role of extreme events in controlling channel and valley geomorphology, the paucity of historic changes to the lower river after nearly fifty years of upstream impoundment, and the remarkably low rates of sediment production and transport within the basin. In hindsight, we can see that all these aspects of the river system are connected and perhaps even predictable, given sufficient understanding of rivers and river processes. For us, however, these connections were unexpected and forced us towards achieving "consilience" in our understanding of the Deschutes River, which in the words of inductionist *Whewell* [1840] is the "jumping together" of "facts and fact-based theory across disciplines to create a common groundwork of explanation."

The purpose of this monograph is to describe this groundwork of understanding by linking together several separate but related studies from a variety of disciplines into an integrated view of the geology, hydrology, geomorphology, and ecology of the Deschutes River. Although presented together, these studies did not result from an organized plan to understand the entire Deschutes River basin. Instead, the research was initially prompted by the Federal Energy Regulatory Commission (FERC) relicensing of the Pelton-Round Butte Hydroelectric Project (FERC Project No. 2030) (Figure 1), and centered on a specific question focused on a particular reach of river: "What effect has flow regulation and reduced sediment input had on the Deschutes River downstream of the Pelton-Round Butte dam complex?" Given the abundant literature on this issue for a variety of rivers, we expected this study to reveal evidence of channel armoring and incision downstream of the dam complex. To our surprise, this did not turn out to be the case-there is little evidence of change in channel bed texture and morphology since dam construction, even with the 1996 passage of the largest flood in 135 years. Only then (in the process of defending our unexpected results) were we inspired to step back and look at the river system from a broader perspective.

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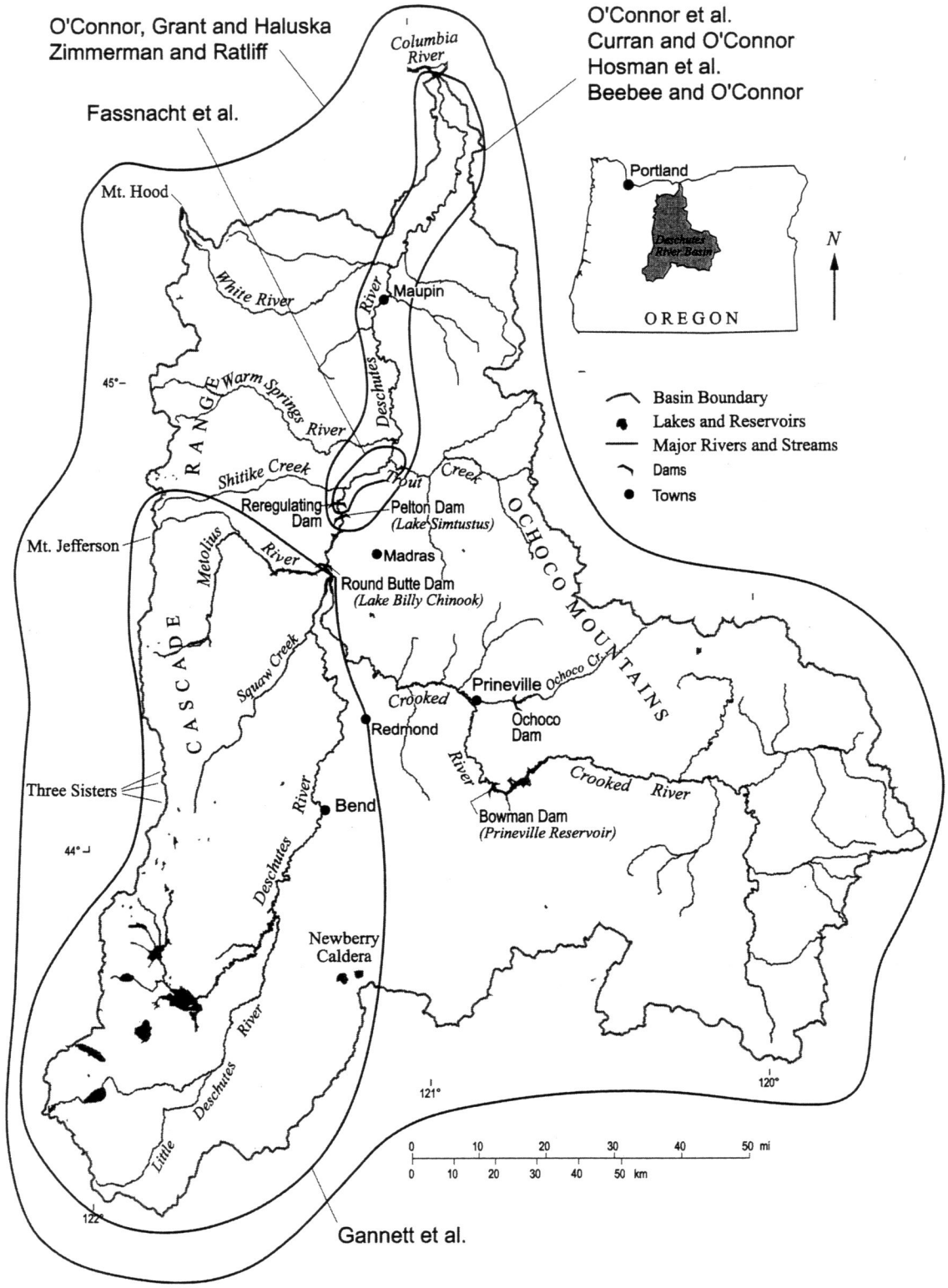

Figure 1. Map of the Deschutes River basin, Oregon, showing areas reported on by individual contributions to this volume.

This wider view, carried out in a range of studies, illuminated the role of geologic setting and history in limiting the effectiveness of modern processes, such as those likely to be affected by dam operations, in shaping the present channel and valley bottom of the Deschutes River.

Some might argue that we conducted our research backwards—that the likelihood of such research surprises might have been smaller if we first understood the broader setting of the river basin before launching into detailed analyses of reach-scale conditions. But such an approach might not have been more efficient. The first reach-scale studies targeted the specific issues that needed to be addressed for understanding the downstream effects of the Pelton-Round Butte dam complex. The results indicating that the response of Deschutes River was different from most dammed rivers focused our broader-scale studies toward understanding the landscape-level mechanisms involved. Without these targets, results of these basin-scale studies might not have been relevant to the specific issues generated by the dam relicensing. In reality, the process was iterative, requiring investigators to think about processes and events at multiple temporal and spatial scales. Inevitably, we revisited studies and reinterpreted results multiple times until we achieved what we feel is some measure of "consilience" in our understanding of the Deschutes River. Together, these studies and their reports paint a coherent picture of the river.

Why report this work in a single volume? One pragmatic reason, of course, is that readers interested in various aspects of the geology, geomorphology and hydrology of the Deschutes River will be able to find overview papers as well as detailed reports between one pair of book covers. But as we struggled to convince ourselves and others that this body of work represented more than an interesting case study, we came to understand that such a volume is the only way in which an integrated perspective of a unique river system can be presented without the intellectual fragmentation of separate offerings spread throughout the literature. We were inspired by the unexpected connections of observations and findings at many different temporal and spatial scales that developed between studies, the "jumping together" in the words of Whewell.

In our view, development of these atmosphere-to-basin-to-cobble linkages was a major product of our efforts on the Deschutes River—one that transcends just the Deschutes River and is applicable to understanding rivers worldwide. While such an approach is not necessarily new, only in a volume such as this can we fully lay out these connections as well as the underlying studies. Our intent is that this volume serves as an example of a holistic approach to understanding rivers—one that recognizes that each river is unique and will respond differently to environmental conditions depending on its current landscape setting as well as its history. This type of approach is increasingly needed, not just to evaluate the hundreds of dams scheduled to be relicensed in the next decades, but also to provide the technical underpinning to decisions related to new dam construction

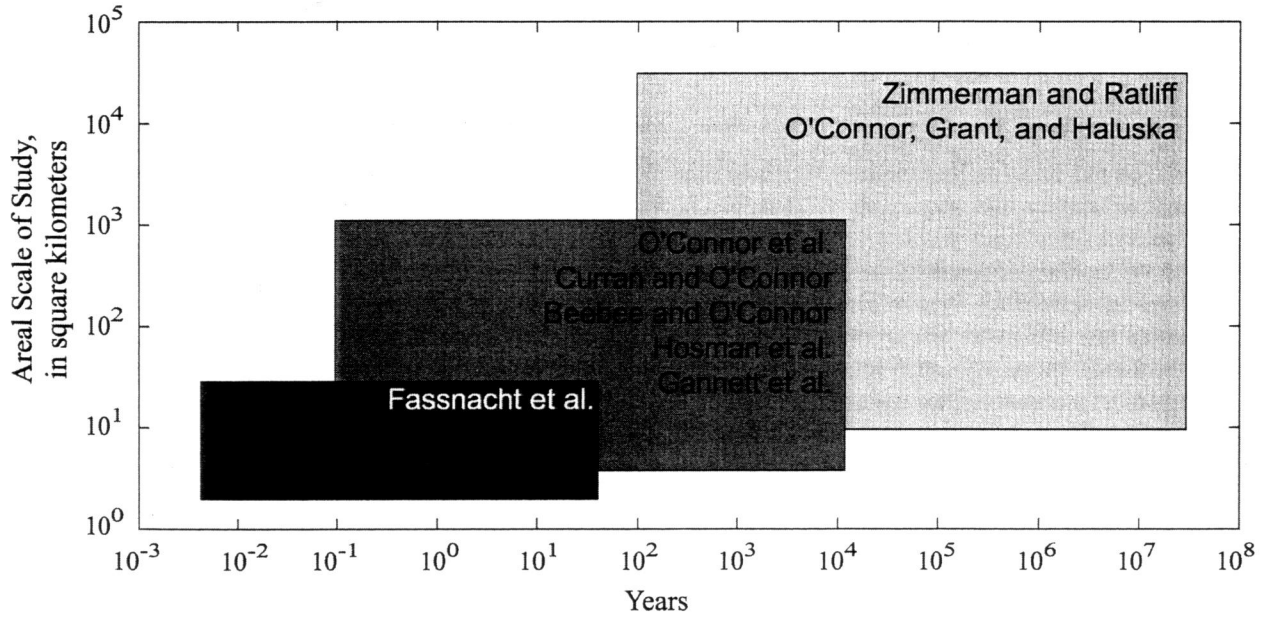

Figure 2. Approximate temporal and spatial domains of volume contributions.

(particularly in the developing world), dam removal, and river restoration efforts worldwide. If we had to distill the message of this volume down to a single line, it would read: A river is not a river is not a river; nor are all dams created equal; but an understanding of the geological and geomorphic context around both rivers and dams provides a sound framework for interpreting their behaviors and effects.

This volume is composed of nine separately authored papers arranged in three sections. The contributions were ordered so that findings and results from early papers form points of departure for subsequent papers. Consequently, the temporal and spatial scales of described features and processes generally diminish as the reader progresses through the book (Figure 2). The first section is a series of three overview papers describing the geology, hydrology, and fish of the Deschutes River basin. The second section contains four papers focusing on the geomorphology and geologic history of the 160 km of the Deschutes River downstream of the Pelton-Round Butte dam complex. The final section is composed of two papers that specifically address the effects of the dam complex on the lower Deschutes River, and evaluates these results with respect to global observations of the effects of dams on rivers. Each section is preceded by a brief introduction summarizing linkages between individual contributions.

Finally, we come back to Russell's observation that the Deschutes River is of "especial interest" because of its peculiarities. We hope that the papers contained in this volume are of interest because of the remarkable peculiarities of the Deschutes River and the understanding that we have developed of the river basin over the last seven years of studies. Moreover, we hope that this volume is of interest because of the linkages between the studies in the volume, and how, in total, such studies frame an understanding of a river. After all, few readers will visit or conduct research on the Deschutes River, but many will strive to understand other rivers, each peculiar in its own way.

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