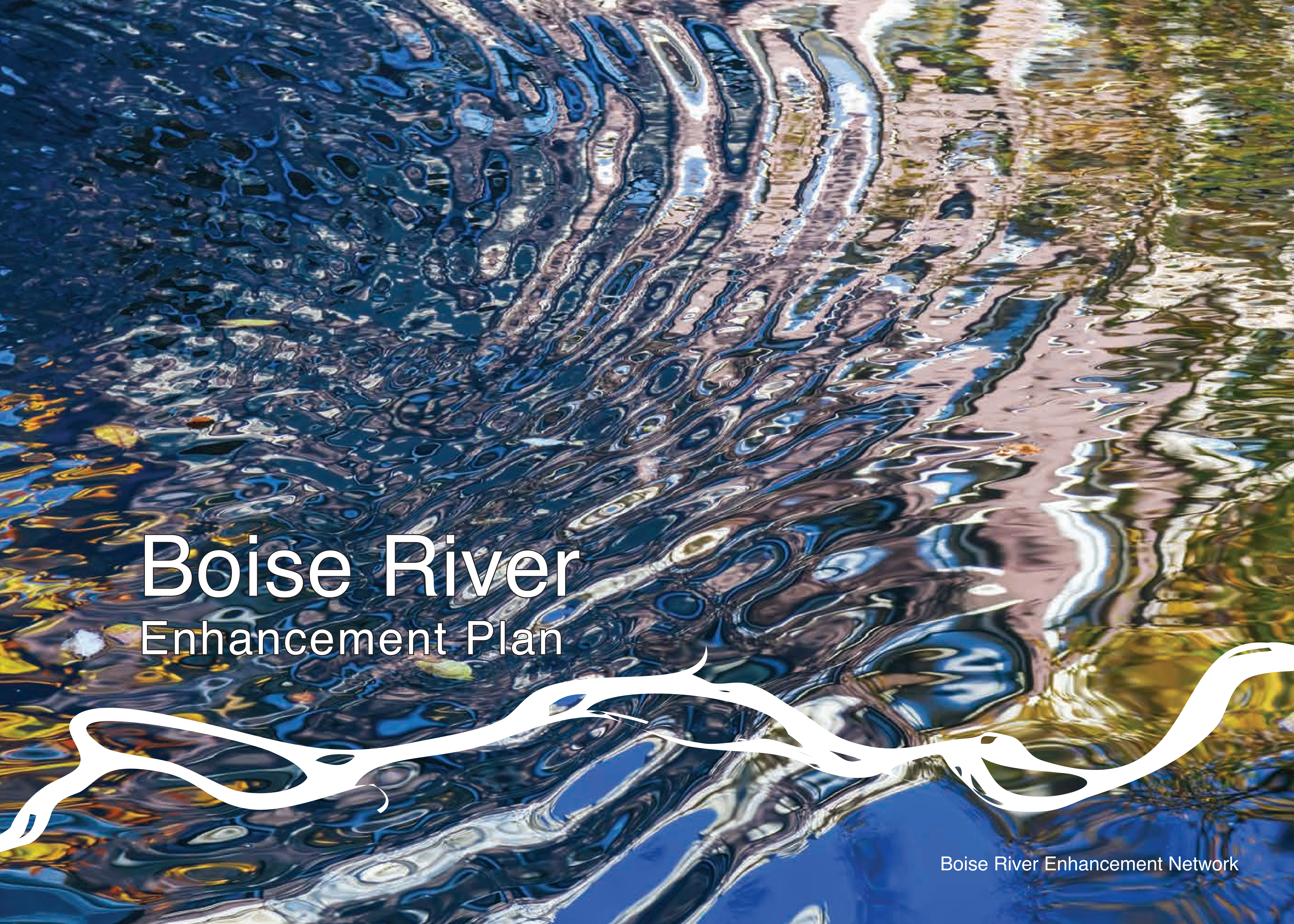

Boise River

Enhancement Plan

Boise River Enhancement Network

Table of Contents

The Boise River P.1-11


(Photo: Charles Knowles/Shutterstock)

Part 1 of this plan describes the background and setting of the river, the current need for cooperative planning, the vision for the river and the process through which this plan was created.

The plan is designed to convey important and complexconcepts through simple text and visual aids. Though supported by previous studies and expert opinion, it is not filled with detailed source information. This information can be found in the appendices and BREN meeting minutes (available online).

Essential Features P.12-29


(Photo: Leo. A. Geis)

Part 2 is divided into four major ecological subject areas identified as critical for enhancement of the river: Geomorphology, Fisheries and Aquatic Habitat, Wetland and Riparian Habitat and Water Quality.

Each section includes a narrative, clearly identified key issues within the subject area and the most appropriate and effective enhancement opportunities identified through the planning process.

Realizing the Vision P.30-40


(Photo: Gary O. Grimm/BREN Network)

Part 3 addresses how the enhancement vision can be realized through summarizing past and current efforts within the watershed, examples from other watersheds and identifying which types of projects bring the greatest benefits to multiple ecological subject areas. The plan identifies how, what and where enhancement can be achieved to bring the most effective benefits to the river.

BOISE RIVER ENHANCEMENT NETWORK

"We are a network of people that live, work and play in the Boise River watershed and are dedicated to promoting the ecological enhancement of the river"

Boise River Enhancement Plan

Preferred Citation:

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Prepared for:
Boise River Enhancement Network

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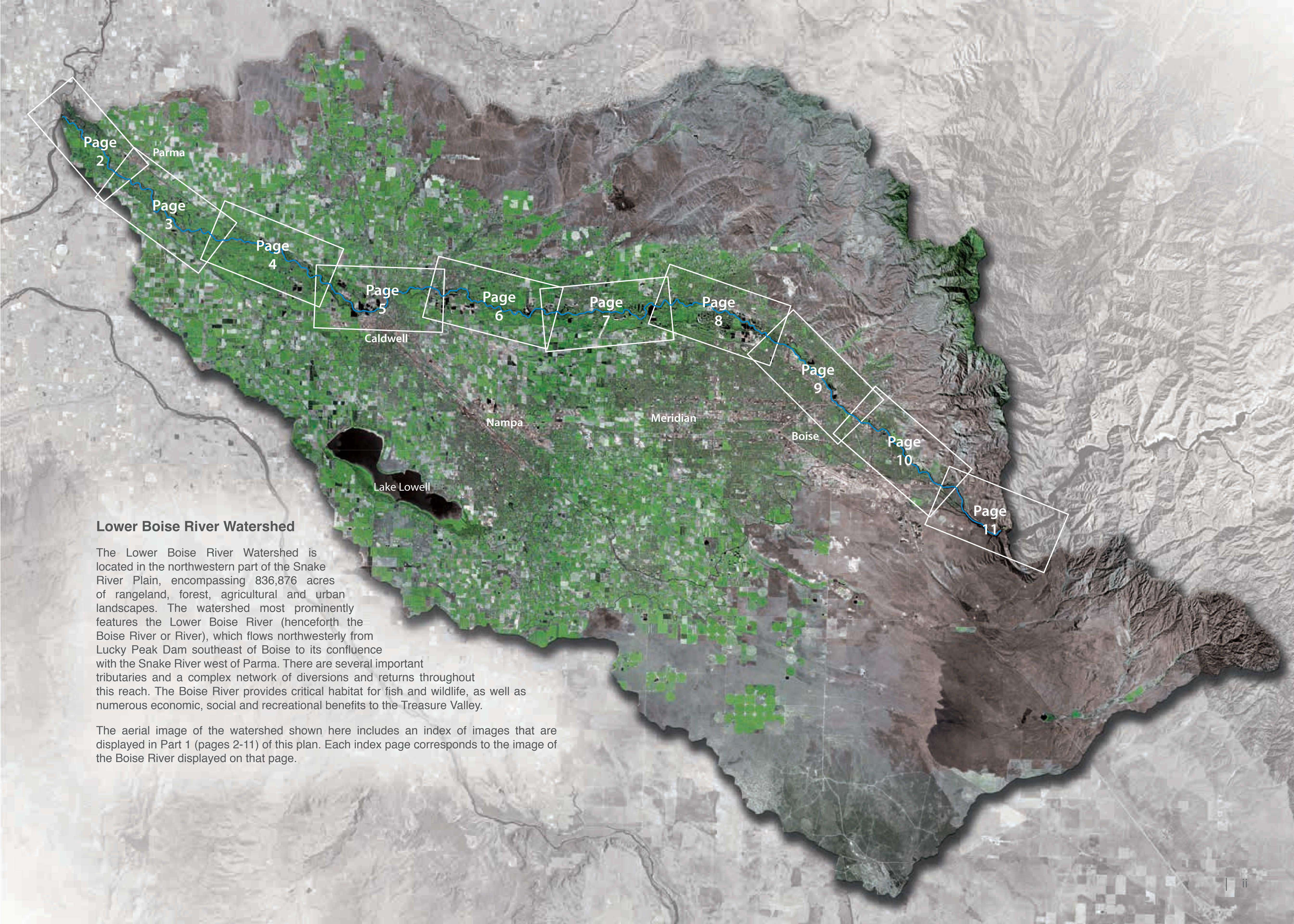
Cover photo: Boise River. IDAK/Shuttestock



Lower Boise River Watershed

The Lower Boise River Watershed is located in the northwestern part of the Snake River Plain, encompassing 836,876 acres of rangeland, forest, agricultural and urban landscapes. The watershed most prominently features the Lower Boise River (henceforth the Boise River or River), which flows northwesterly from Lucky Peak Dam southeast of Boise to its confluence with the Snake River west of Parma. There are several important tributaries and a complex network of diversions and returns throughout this reach. The Boise River provides critical habitat for fish and wildlife, as well as numerous economic, social and recreational benefits to the Treasure Valley.

The aerial image of the watershed shown here includes an index of images that are displayed in Part 1 (pages 2-11) of this plan. Each index page corresponds to the image of the Boise River displayed on that page.

Part 1

Introduction — Boise River

Why is this Plan Needed?

At an October 2011 Boise River Workshop, over 120 participants identified the most important next step to enhance the Boise River; "Continue this group and develop a plan."

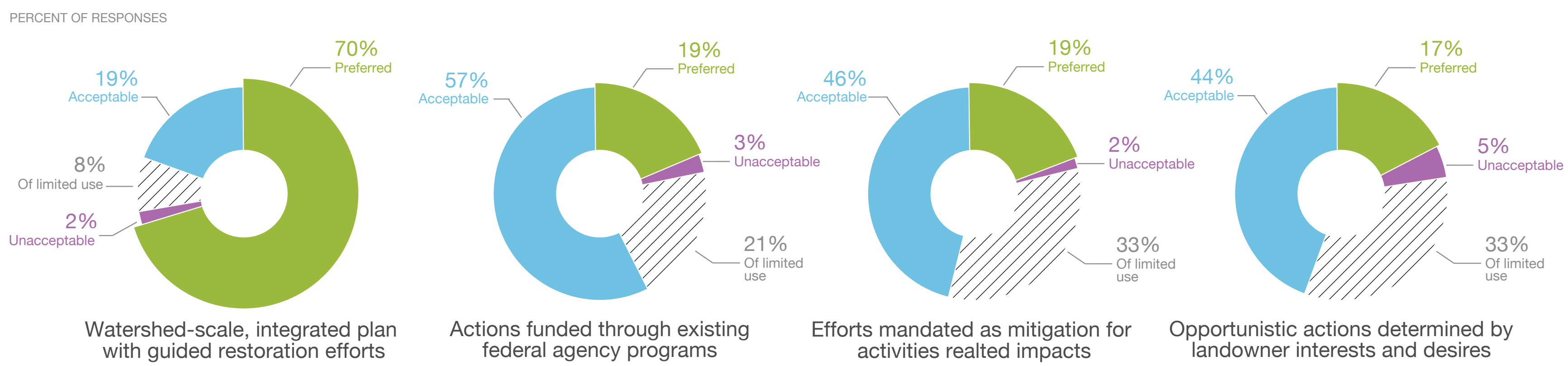
In early 2011, interested local stakeholders came together to plan a workshop on environmental enhancement opportunities on the Boise River. All interested individuals and organizations were welcome to participate to foster an open and inclusive planning process. An Organizing Committee that included non-profit and for-profit staff, volunteers and agency representatives agreed on the goal of the workshop, "To increase opportunities for public and private ecosystem enhancement of the Lower Boise River by establishing networks, building knowledge, envisioning possibilities and tackling challenges."

The workshop, titled "From Vision to Reality," brought 106 of the area's practitioners, experts, academics, decision makers, and active citizens together for a substantive discussion about the challenges and opportunities for environmental enhancement of the Boise River. The results of the workshop, as measured from breakout session input and an online survey, identified key enhancement goals and interests, challenges to enhancement, approaches to enhancements and key next steps. Participants identified that the most important next step to enhance the Boise River was to "Continue this group and develop a plan."

Following the workshop, a group of interested organizations came together to form the Boise River Enhancement Network (BREN). This group received a grant from the Bureau of Reclamation's WaterSMART program to establish a watershed group and write a watershed enhancement plan. BREN then used the results of the workshop to design a process and to identify key subject areas on which to focus the effort. This plan is a result of these efforts to provide the essential next step in the enhancement of the Boise River.

Approaches to Restoration

Please rate the following approaches to restoration/enhancement on the Boise River (Preferred, Acceptable, Of Limited Use, Unacceptable).



The Lower Boise River Watershed

Watershed Summary

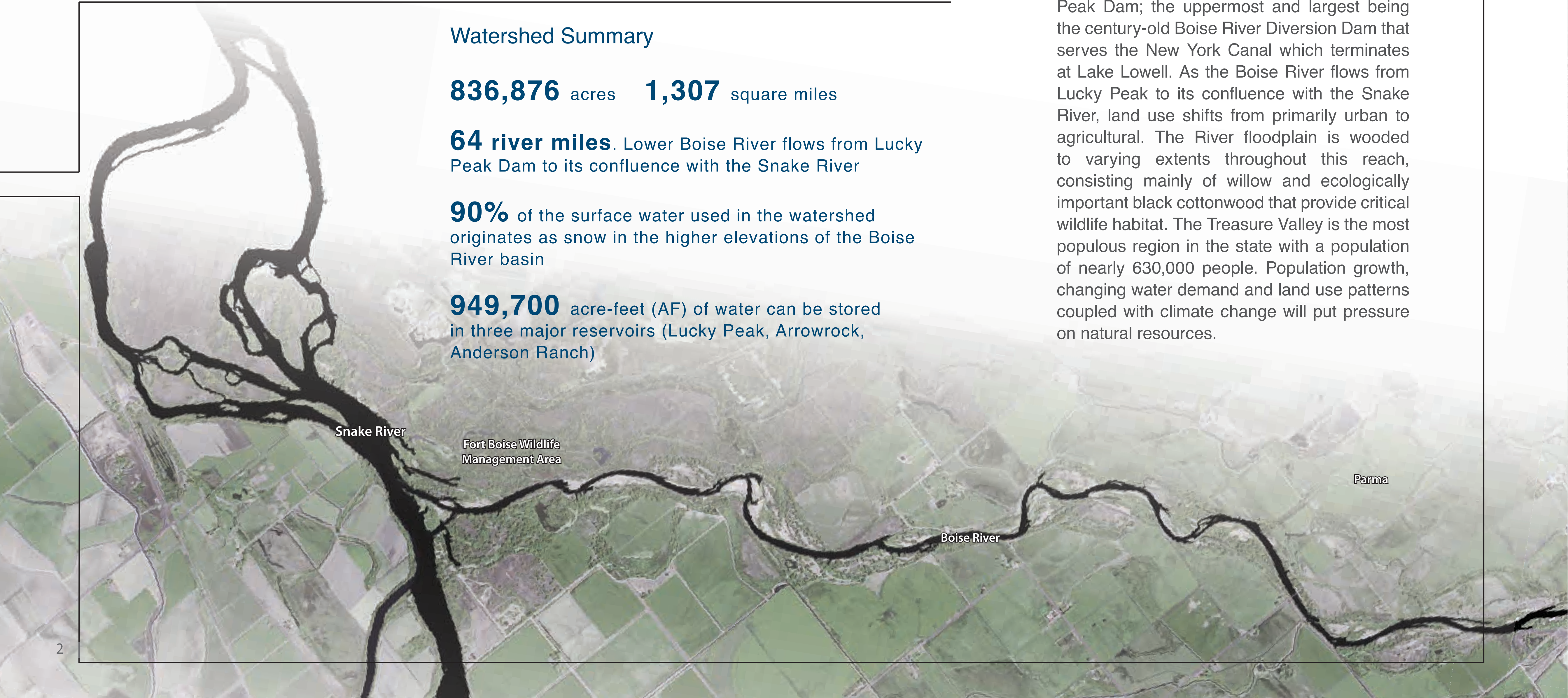
836,876 acres **1,307** square miles

64 river miles. Lower Boise River flows from Lucky Peak Dam to its confluence with the Snake River

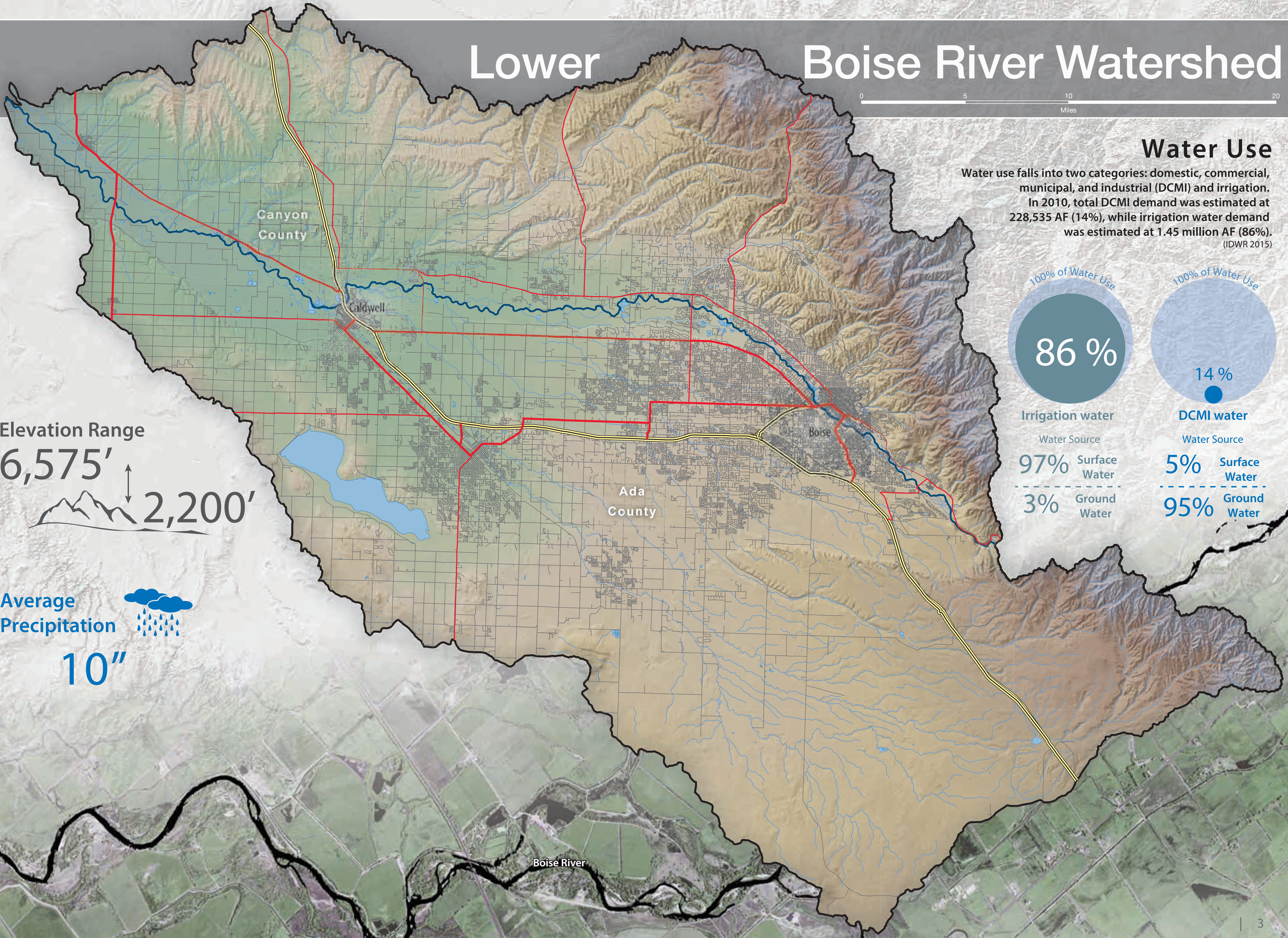
90% of the surface water used in the watershed originates as snow in the higher elevations of the Boise River basin

949,700 acre-feet (AF) of water can be stored in three major reservoirs (Lucky Peak, Arrowrock, Anderson Ranch)

The Lower Boise River Watershed begins at the Lucky Peak Dam where the Boise River emerges from the foothills southeast of Boise. Lucky Peak is one of three storage reservoirs located above the watershed that were constructed by the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers to provide irrigation, hydroelectricity and flood control to the Treasure Valley. Several irrigation diversion dams are also located below Lucky Peak Dam; the uppermost and largest being the century-old Boise River Diversion Dam that serves the New York Canal which terminates at Lake Lowell. As the Boise River flows from Lucky Peak to its confluence with the Snake River, land use shifts from primarily urban to agricultural. The River floodplain is wooded to varying extents throughout this reach, consisting mainly of willow and ecologically important black cottonwood that provide critical wildlife habitat. The Treasure Valley is the most populous region in the state with a population of nearly 630,000 people. Population growth, changing water demand and land use patterns coupled with climate change will put pressure on natural resources.



Lower Boise River Watershed



Water Use

Water use falls into two categories: domestic, commercial, municipal, and industrial (DCMI) and irrigation. In 2010, total DCMI demand was estimated at 228,535 AF (14%), while irrigation water demand was estimated at 1.45 million AF (86%). (IDWR 2015)

100% of Water Use

86 %

Irrigation water

Water Source

97% Surface Water

3% Ground Water

100% of Water Use

14 %

DCMI water

Water Source

5% Surface Water

95% Ground Water

Elevation Range

6,575′ ↕ 2,200′

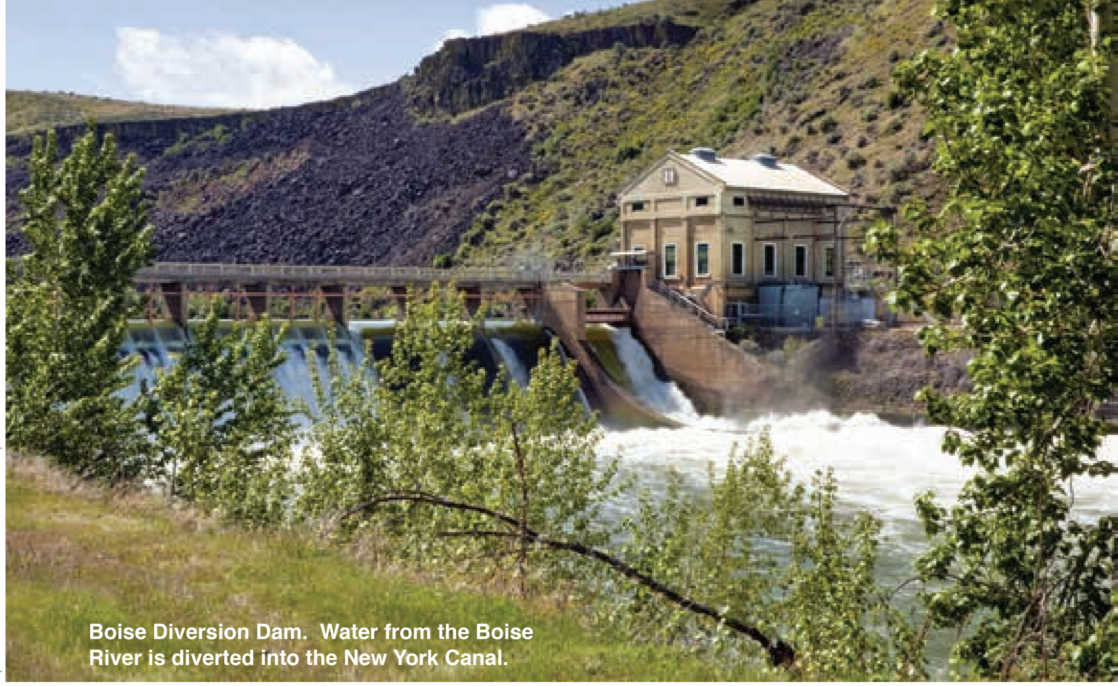
Average Precipitation

10″

How the River Works

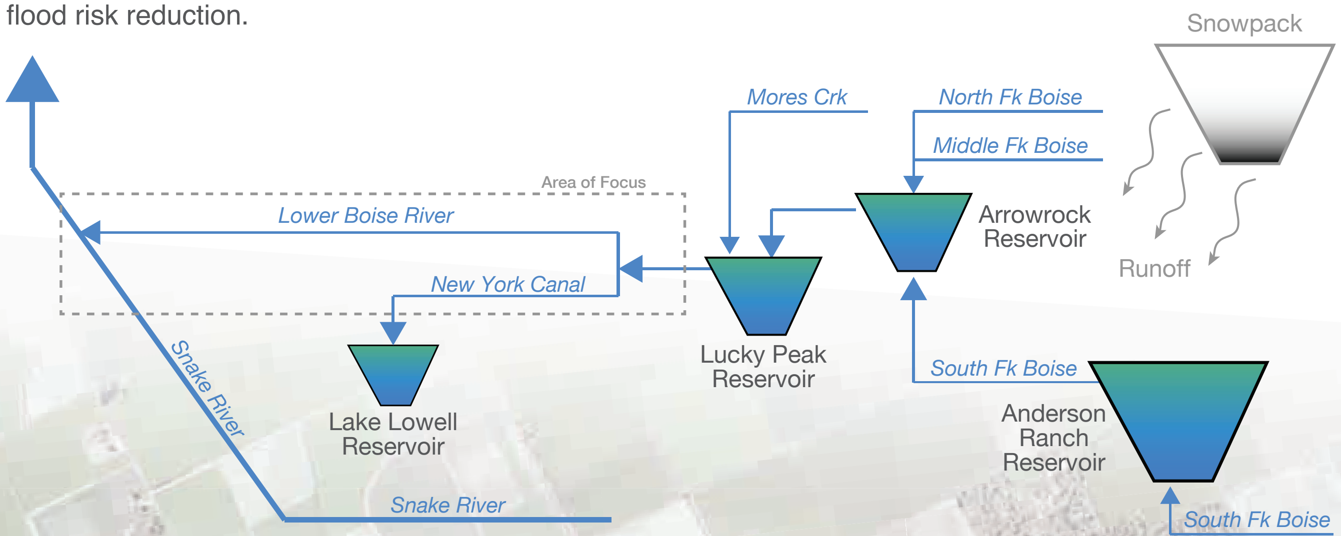
The headwaters of the Boise River are formed by snow and rain in the mountains of south-central Idaho, including the Boise, Sawtooth, Smokey and Soldier mountains. This winter snowpack represents the natural storage for the Boise River. Climate change threatens the future size of this natural reservoir. The three forks of the upper watershed (North, Middle and South) converge just east of Boise before the river emerges from the mountains to the plain. Between 1909 and 1955, three large dams with a storage capacity of around 950,000 acre-feet were constructed primarily for irrigation with a secondary purpose of flood risk reduction.

The River historically experienced a different flow regime than it does today due to the flow regulation provided by the storage reservoirs. Historic peak flows averaged over 13,000 cfs and were recorded over 35,000 cfs (1895). Since the completion of Lucky Peak Dam in 1955, peak flows have averaged around 4,500 cfs with a maximum discharge of just below 10,000 cfs (1983). Without the existing dam infrastructure, recent late fall and winter flows would have averaged around 1,000 cfs; regulated winter flows average below 500 cfs.

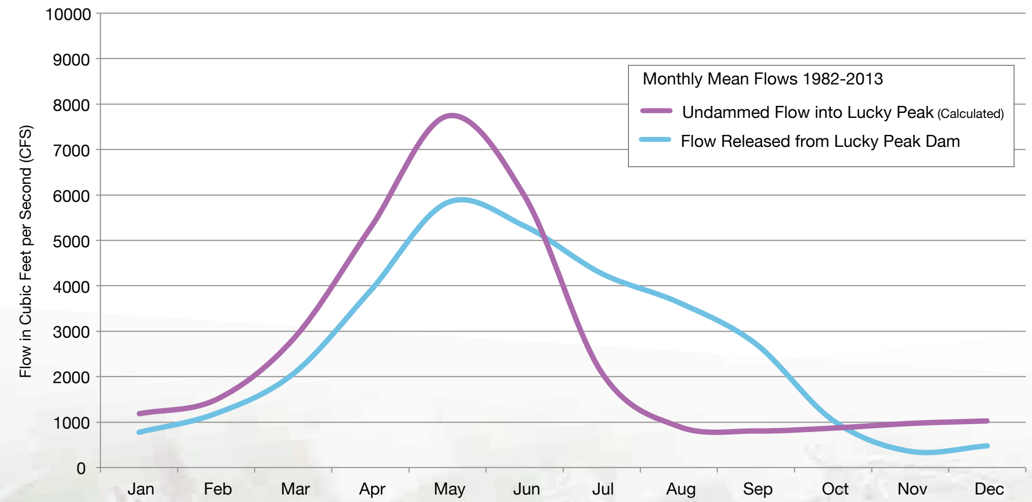


(Photo: Charles Knowles/Shutterstock)

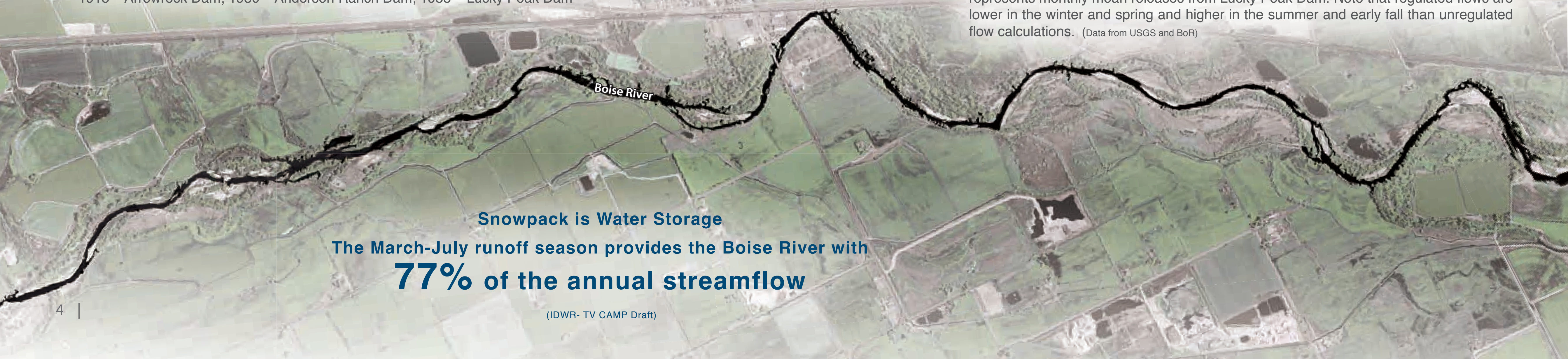
Boise Diversion Dam. Water from the Boise River is diverted into the New York Canal.



The Boise River System of Dams, Reservoirs and Major Diversions.
Major Dam Construction Timeline: 1909 – Boise River Diversion Dam and the New York Canal; 1915 – Arrowrock Dam; 1950 – Anderson Ranch Dam; 1955 – Lucky Peak Dam



Mean Monthly Flows Comparison. The purple line is a calculated discharge in the river at Lucky Peak Dam site if the existing dams were not in place. The blue line represents monthly mean releases from Lucky Peak Dam. Note that regulated flows are lower in the winter and spring and higher in the summer and early fall than unregulated flow calculations. (Data from USGS and BoR)

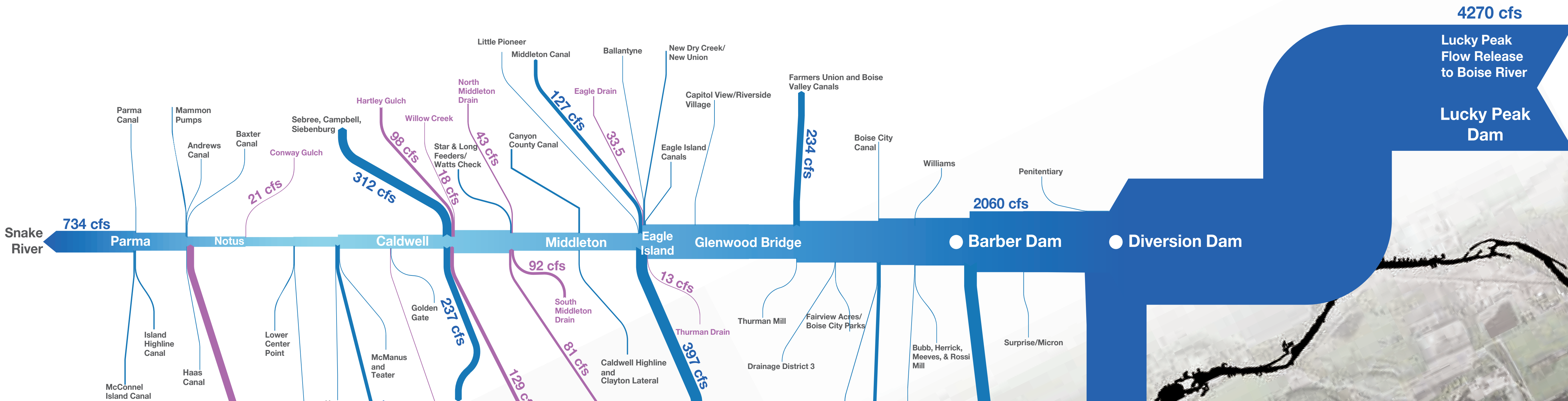


Snowpack is Water Storage

The March-July runoff season provides the Boise River with

77% of the annual streamflow

(IDWR- TV CAMP Draft)



Boise River Diversions and Returns

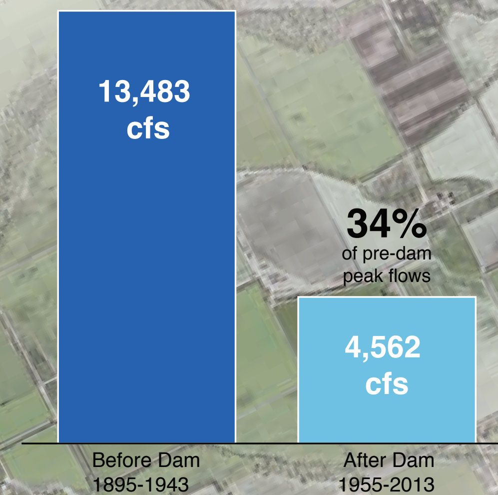
Flow diagram is scaled to the amount of flow in each section of the river, at each diversion and at each return. The amount of flow is shown in cubic feet per second (cfs). Flows are shown for mean values during July 2014.

Lucky Peak released 4,270 cfs into the river. 2,200 cfs was diverted to the New York Canal. Additional diversions remove a majority of the river flows. When the Boise River merges with the Snake River the flow was 734 cfs; or 17% of the flow released from Lucky Peak.

FLOW cfs   RETURN cfs

Not shown in the diagram is the interaction between the surface water and the groundwater. Groundwater plays an important role in the river system. IDWR has identified the need for comprehensive aquifer management planning to ensure water demand can be met in the future.

(Data from Idaho DEQ)



Mean Peak Flow in Boise River Before and After Lucky Peak Dam

(Data from Susan Stacy "As the River Rises" and USGS.)

A Regulated River

The irrigation water derived from the Boise River has shaped the Treasure Valley and brought prosperity and production to the arid landscape. The water stored in the upper reservoirs is released throughout the irrigation season and diverted through a vast and complex network of canals and returns. The economic benefits of this system are tremendous. However, it has had a dramatic effect on the River ecosystem. Groundwater and surface water quality and quantity, channel form, sediment transport processes, floodplain connection and habitat value have all been altered.

What the River Provides

The Boise River ecosystem historically provided abundant fish and wildlife habitat. Salmon and other native fish occupied its waters and the wooded floodplain provided critical wildlife habitat in an arid landscape. The river has always provided for human inhabitants as well; it first provided a water supply, transportation, hunting grounds, fishing opportunities and material resources for Native Americans, followed by fur traders, prospectors and early settlers. Most recently it has provided the irrigation water that has fueled the economic growth of the Treasure Valley. The River has gone through three distinct periods: it was once wild and untamed, then controlled and heavily polluted, and now it is in a period of stewardship and improvement. Over the past 50 years, the River's health has improved dramatically through stakeholder investment. Today, the Boise River continues to water hundreds of thousands of acres. Its associated wetland and riparian systems filter and dilute pollutants, attenuate floods and erosion and provide habitat for many species of birds and other wildlife. The Boise River supports an urban and rural fishery that includes native and non-native fish, cold water salmonids and desirable game fish.

There are numerous recreational opportunities both in and near the water. The River is now a much-loved amenity to residents and is acknowledged as contributing to the regional economy, public health and quality of life.

Despite everything that the River provides, citizens, scientific experts and agency personnel recognize that the river is not realizing its potential. In an online survey as part of the 2011 workshop, 90% of survey participants rated the Boise River's health as "limited and needs improvement" or "significant environmental issues exist, but the River is not imperiled." This plan identifies how ecological enhancement can improve the health and function of the Boise River, protecting the investments stakeholders have made and creating a living legacy for future generations to enjoy.

(Photo: IDAK/Shutterstock)

(Photo: alexmisu/Shutterstock)

What are your enhancement goals and interests?

In breakout work sessions participants were asked to describe their interests and goals for river enhancement. The tag cloud of words represents the scale of each response with the percentage in parenthesis.

PERCENT OF RESPONSES

Floodplain (12%)
Water Quantity (2%)
Client Needs/Desires (3%)
Fishery/Aquatic Habitat (20%)
River as Community/Natural Value (7%)
Recreation (5%)
Access (9%)
Birds and Wildlife (10%)
Water Quality (19%)
Terrestrial Habitat (12%)

(Data from the 2011 Boise River Workshop)

(Photo: Ken Miracle/BREN Network)

(Photo: IDAK/Shutterstock)

The Boise River provides numerous ecosystem services such as water supply, recreation and aesthetics. Its associated wetland and riparian systems filter and dilute pollutants, attenuate floods and erosion, and provide habitat for many species of birds and other wildlife.

A Boise River that provides diverse habitat and multiple uses, benefiting the ecosystem and citizens now and into the future.

VISION

What Could the River Be?

A healthy, functioning Boise River will offer improved benefits to the entire watershed. Envision a river that flows through broad and diverse wetland and riparian habitats on a connected floodplain that supports fish and wildlife and buffers against adjacent land uses; its waters containing complex habitat and clean, cool water and a healthy fishery, while supplying ample water for urban and agricultural uses. An enhanced Boise River will provide numerous recreation and educational opportunities, be an economic driver of prosperity in the Treasure Valley, and serve as an example of what can be accomplished by sustainable, collaborative management.

(Photo: Gary O. Grimm/BREN Network)

ENVISION A BOISE RIVER THAT OFFERS:

Cool, Clean Water

- Healthy fish communities and associated fisheries
- Improved water supply for urban and agricultural uses
- Clean water for safe swimming and wading

A Healthy Ecosystem

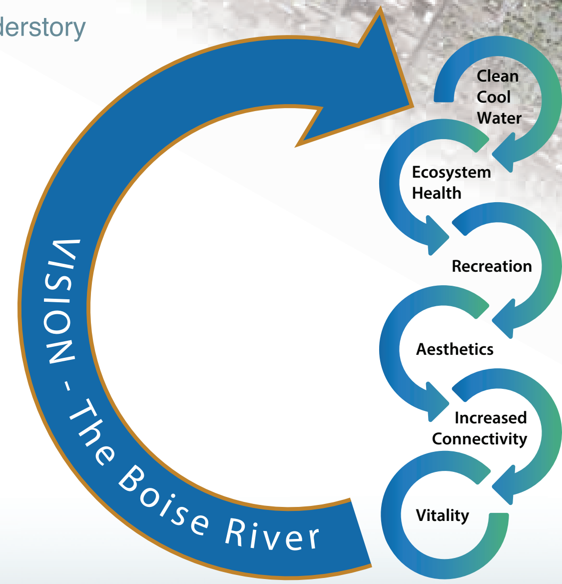
- Protected areas that preserve natural function
- A connected floodplain that enhances habitat and reduces flood risk
- Improved instream habitat complexity that helps fish
- Increased native vegetation that benefits birds and wildlife
- A sustainable black cottonwood forest that shelters a diverse, native understory
- High quality wildlife habitat

Sustainable Recreation

- A healthy fish community and robust fisheries
- Better swimming and boating
- Safe public access with low impact on the ecosystem
- Increased recreation opportunities through multipurpose projects
- A place to connect with nature and with each other

Centerpiece of the Treasure Valley

- Enhancement of the river that benefits all citizens
- A healthy Boise River supports a healthy economy
- Our stewardship will inspire other cities
- Future generations will benefit from today's efforts



Plan Development

This plan was developed through an extensive literature review and stakeholder feedback process. Existing literature and data pertaining to the Boise River was assembled and organized into a database.

From the existing literature and research, summary reports were created for four ecological subject areas: Geomorphology, Fisheries and Aquatic Habitat, Wetland and Riparian Habitat and Water Quality. These summary reports were presented to stakeholders at four workshops, posted online and reviewed by expert panels. The subject papers were then revised and the most pertinent issues and solutions identified for application in the Enhancement Plan.

These subject papers inform and serve as four appendices to the Enhancement Plan. Additional appendices include: a high-level geomorphic assessment performed as part of the BREN effort, case studies of who is doing what within the watershed, BREN governance and outreach documentation, and project concepts from other watersheds. The appendices provide the citations, justification and detail behind the Enhancement Plan. The Draft Plan was released to the public, presented to public and private groups, and underwent a comment and review period that involved significant outreach.

Plan Construction

1. Exisiting Literature, Reports, Plans
2. Analyze Data and Organize
3. Network Input Workshops Online Surveys
4. Expert Review
5. BREN Sponsored Research: Geomorphology Study
6. Coordinating Team Input
7. Case Studies Solutions Alternatives
8. Existing Projects Itemize Ongoing Work in the Boise River
9. Community Feedback Stakeholder Meetings Feedback Sessions

Summarize

Summarized Assessments:
Geomorphology
Fisheries
Riparian/Wetland
Water Quality

Revise Drafts

Final Assessments:
Geomorphology
Fisheries
Riparian/Wetland
Water Quality

Enhancement Plan

Draft Enhancement Plan

Draft plan outreach:

9 week comment period
22 presentations
More than 500 people reached
TV, radio and newspaper coverage

Enhancement Plan

Final Enhancement Plan with Appendices

A Plan for the River

There is a diverse set of stakeholders in the Lower Boise River Watershed – municipalities; water users; local, state and federal agencies; water delivery entities; recreationists; Tribes; water and power companies; land owners; non-profit organizations; and others – each of which have their own goals, jurisdictions and constituents. Insufficient coordination and cooperation among stakeholders has hindered efforts to address critical watershed issues, including habitat loss, floodplain development, water pollution and ecosystem function. The Boise River's future health relies on proper comprehensive management that focuses on the critical issues and utilizes effective solutions. Cooperative planning is essential for successful management and enhancement of the Lower Boise River.

The goal of this Enhancement Plan is to provide an overview of the ecological condition of the river, and to identify the key issues and most effective enhancement opportunities in the areas of Geomorphology, Fisheries and Aquatic Habitat, Wetland and Riparian Habitat and Water Quality. The Plan also identifies those projects that bring the greatest benefits to multiple ecological subject areas and the collaborative approach necessary to achieve the vision. Important next steps include continuing outreach, research, funding and identification of site-specific actions.

VISION

Describes a realistic vision for an enhanced Boise River.

ECOLOGICAL CONDITION

Summarizes existing information on the current river condition and identifies key issues affecting multiple ecological subject areas.

ENHANCEMENT

Identifies and prioritizes enhancement opportunities. Identifies enhancement projects that benefit multiple subject areas.

COLLABORATION

Explores examples of successful collaboration to enhance rivers. Identifies next steps (e.g. funding, research, site-specific actions). Defines BREN's collaborative approach.

Part 2

Essential Features — Boise River

Arrowrock and Lucky Peak Reservoirs
The Lower Boise River begins below Lucky Peak Dam. This is the last of three upstream dams that regulate flow for the Boise River. The image is looking downstream from just above Arrowrock Dam (foreground), across Lucky Peak with the Boise Valley in the background.
(Photo: Leo A. Geis)

Key Issues and Solutions for the River

Part 2 is divided into the four essential ecosystem components or "Essential Features" that are the focus of this plan: Geomorphology, Fisheries and Aquatic Habitat, Wetland and Riparian Habitat and Water Quality. Each section includes a narrative, key issues and enhancement opportunities pertaining to each subject area. The intent is to reduce each subject area down to its most essential elements that apply on a broad scale; there are numerous site-specific opportunities that cannot be detailed in this plan. The focus is on the most important issues and corresponding enhancement opportunities that result in the highest functional benefits to the river. Barriers to implementation include coordination, funding, and scientific and engineering challenges, among others. Land use planning, economic and political forces all play a role. Projects that focus on "win-win" actions are most likely to be successfully implemented. Some solutions are complex and difficult to implement, others are simple and can be realized with fewer resources.

Each section is based on a corresponding appendix developed through a literature review and stakeholder feedback process, wherein the sources, justification and details can be found. Readers should use the Essential Features to identify the concepts to be addressed, then utilize the appendices to garner more detailed information. Often, site-specific investigations are necessary to implement enhancement actions.

1 Geomorphology page 14

2 Fisheries & Aquatic Habitat page 18

3 Wetland & Riparian Habitat page 22

4 Water Quality page 26

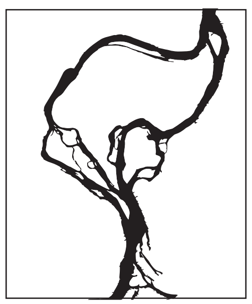
Essential Feature 1

Geomorphology

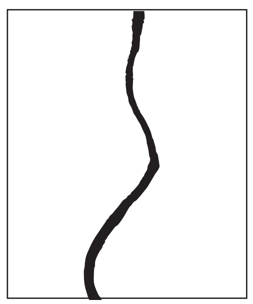
Boise River Enhancement Plan

The river has been transformed from a meandering, braided gravel bed river that supported large runs of salmon, to a channelized, regulated river that flows through an urban and agricultural landscape. Alterations to the floodplain and hydrograph have resulted in a suite of geomorphic changes to this alluvial river system. Parts of the river exhibit a floodplain that has been narrowed or disconnected from the current hydrology, a hyporheic zone (where the local groundwater table and surface water are interacting) that has been reduced in area, channel substrate that has become armored or embedded, instream habitat that has been simplified, and sloughs and side channels that have been reduced. The changes to the hydrology and floodplain have created a geomorphic environment that is not aligned with the current hydrology, resulting in impacts to several ecosystem processes. Although there are pervasive conditions that affect the entire river, each reach and site has its own specific conditions that need to be evaluated on the appropriate scale.

Current channel capacity ranges between 3,500 cfs and 10,000 cfs, although channel capacity varies in time and space due to changing conditions. Prior to channelization, high flows spread across the historically wide floodplain. Over the years, levees have been built and enlarged by individual land owners, cities, counties and local flood districts. Large snags, vegetation and debris are removed from sections of the river for recreation safety and flood risk reduction. The river channel lacks the roughness elements and instream complexity that historically provided habitat for fish and other aquatic organisms. The current channel form results in velocities that preclude refuge for salmonids in many locations during the spring and summer and create an abundance of shallow pool or glide habitat in the late fall, winter and early spring.



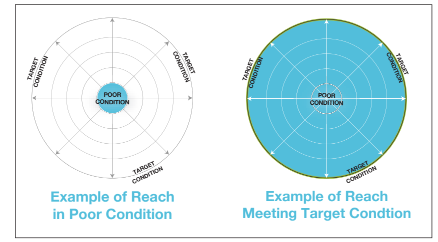
Braided/Complex River Channel



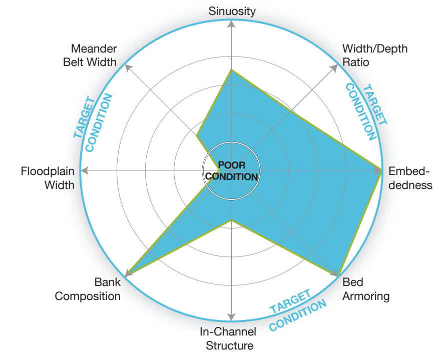
Channelized/Regulated River Channel

What is Geomorphology?

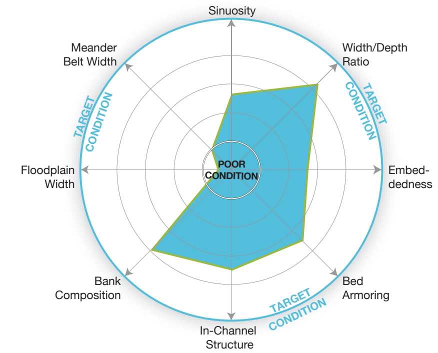
Geomorphology is the study of how the earth's surfaces change over time. In the case of the Boise River, geomorphology includes changes to the river's shape (form) as well as erosion, deposition and riparian function (processes) that drive those changes over time.



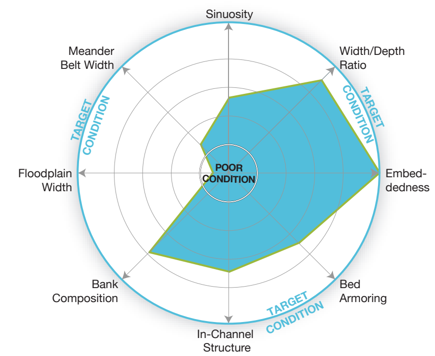
Reach 1



Reach 2



Reach 3



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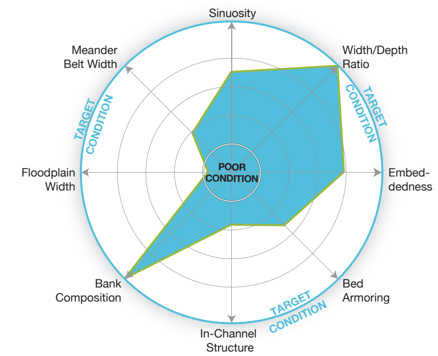
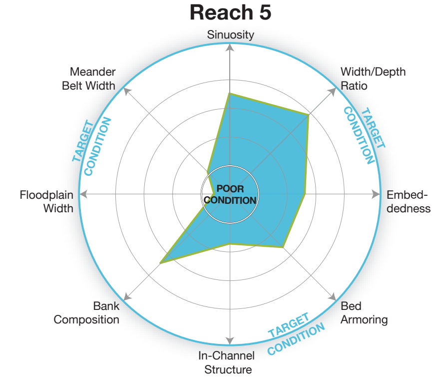
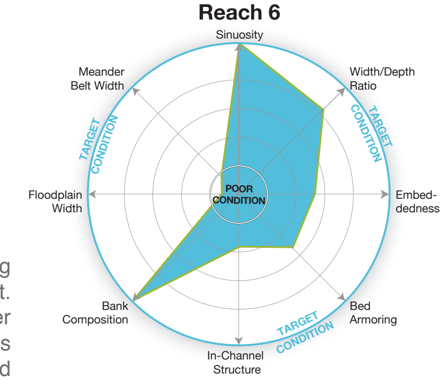


Reach 5



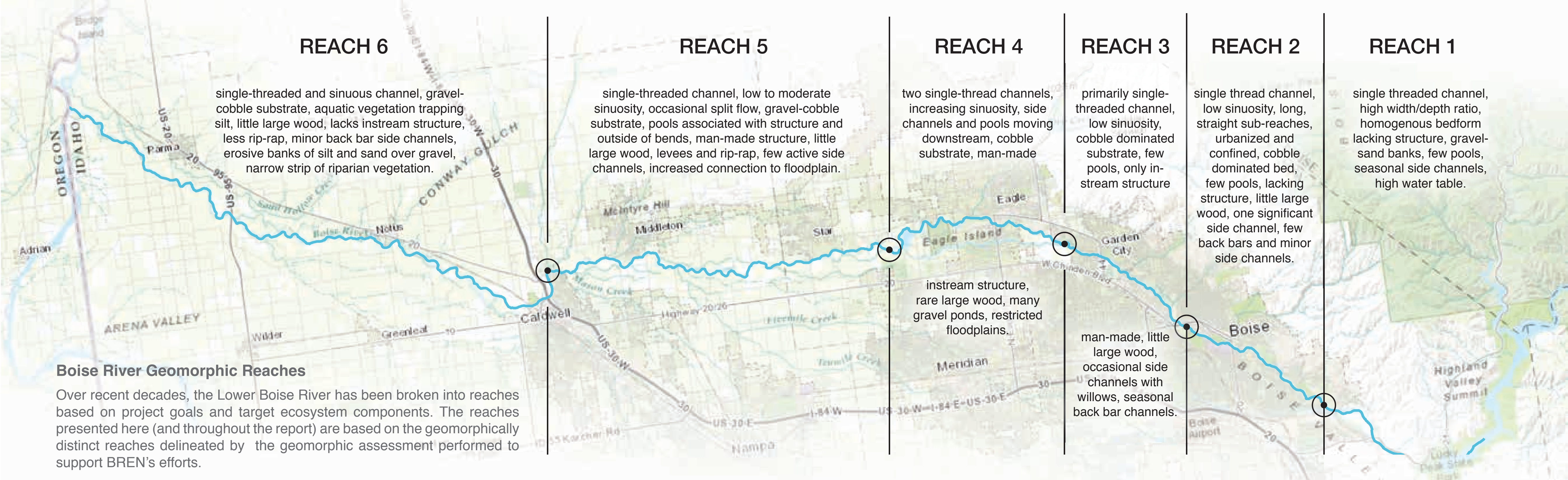
Reach 6



Geomorphic Character of River Reaches

Target conditions considered existing hydrology but not necessarily development. Given existing hydrology and other existing geomorphic conditions, targets were identified representing what could reasonably be expected to occur over the long-term given a best-case scenario. An appropriate goal would be to work toward those targets systematically and opportunistically when and where possible.

The targets should be used to aim projects in the most appropriate direction, but should not be used as objectives. The expectation should be to move closer toward targets not necessarily to meet targets across the board (which may never be 100% achievable). Where targets are met, diligent protection of these functions is a priority. (Data From Richardson and Gulinger 2015)



REACH 6

single-threaded and sinuous channel, gravel-cobble substrate, aquatic vegetation trapping silt, little large wood, lacks instream structure, less rip-rap, minor back bar side channels, erosive banks of silt and sand over gravel, narrow strip of riparian vegetation.

REACH 5

single-threaded channel, low to moderate sinuosity, occasional split flow, gravel-cobble substrate, pools associated with structure and outside of bends, man-made structure, little large wood, levees and rip-rap, few active side channels, increased connection to floodplain.

REACH 4

two single-thread channels, increasing sinuosity, side channels and pools moving downstream, cobble substrate, man-made instream structure, rare large wood, many gravel ponds, restricted floodplains.

REACH 3

primarily single-threaded channel, low sinuosity, cobble dominated substrate, few pools, only in-stream structure man-made, little large wood, occasional side channels with willows, seasonal back bar channels.

REACH 2

single thread channel, low sinuosity, long, straight sub-reaches, urbanized and confined, cobble dominated bed, few pools, lacking structure, little large wood, one significant side channel, few back bars and minor side channels.

REACH 1

single threaded channel, high width/depth ratio, homogenous bedform lacking structure, gravel-sand banks, few pools, seasonal side channels, high water table.

Boise River Geomorphic Reaches

Over recent decades, the Lower Boise River has been broken into reaches based on project goals and target ecosystem components. The reaches presented here (and throughout the report) are based on the geomorphically distinct reaches delineated by the geomorphic assessment performed to support BREN's efforts.

(Photo: Gary O. Grimm/BREN Network)

Confined River Channel - the channel in this reach exhibits confinement, poor channel form, lack of complexity and straightening.

Complex River Channel - the channel in this reach exhibits complexity, sinuosity and connected floodplain. Blue areas are low below the water surface in high flow conditions. Brown areas are well above the water surface.

Issues Affecting Geomorphology

The Boise River's geomorphic setting is generally not connected with current hydrology.

1. **Channel confinement and simplification**
   The floodplain system has been encroached upon by development, agriculture, transportation infrastructure and flood control measures reducing geomorphic function.

2. **Altered flow regime**
   Regulated flows differ in magnitude, duration and timing from the natural hydrology that formed the river channel and floodplain.

3. **Substrate**
   Embeddedness and armoring have developed within the system as erosion and bank sediment transport processes are not functioning well.

4. **Channel form**
   The thalweg (the deepest part of the channel) is poorly defined and there is low instream hydraulic complexity with high width-depth ratio at low flows and high instream velocity at high flows.

Geomorphology Enhancement Opportunities

Enhancement of the river relies heavily on reconnecting the main channel with the floodplain, enlarging the hyporheic zone and improving sediment transport processes. Actions to improve natural river processes and enable the river to restore natural forms on its own will bring the greatest ecosystem benefit. Enhancement of the river must focus on current and possible future conditions and not seek to restore historic conditions.

1 Protect

Protect land, water and instream structure supporting favorable geomorphic conditions.

Protect areas within the active floodplain and/or meander belt width that have not been developed including agricultural land.

Protect existing natural instream structure (e.g. large wood), especially those structures creating hydraulic complexity by forming/ maintaining split flows, side channels and large pools.

2 Improve natural river processes

Improve natural river processes enabling the river to restore natural forms on its own.

Allow the river to erode its banks and migrate in strategic locations.

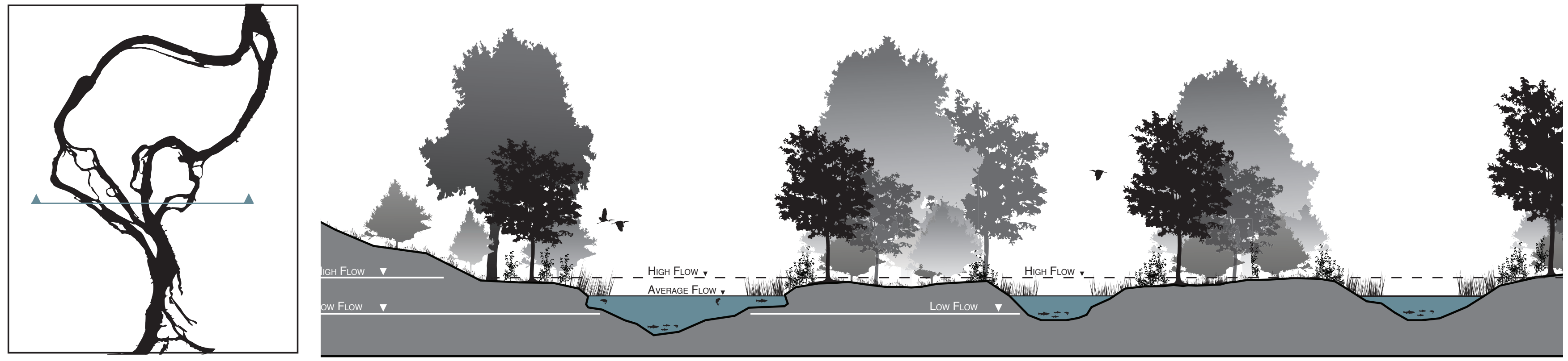
Enhance flows; particularly peak flows that promote channel dynamics and low flows that provide minimal habitat.

Partner with irrigators to improve existing irrigation diversion dams enabling more natural flow and sediment transport.

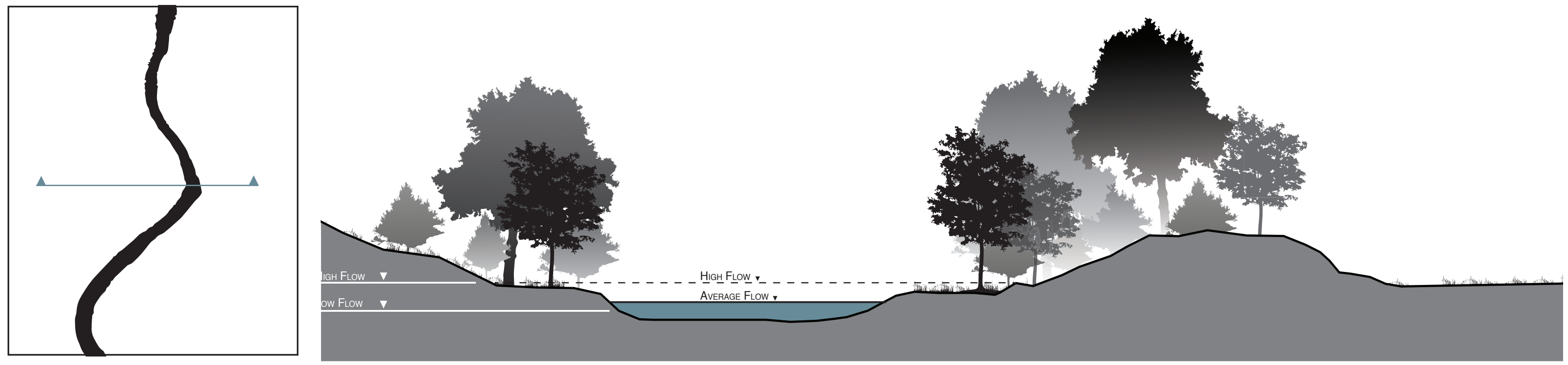
Lower or set-back levees where feasible enabling greater floodplain interaction.

Establish an appropriate meander belt width where feasible.

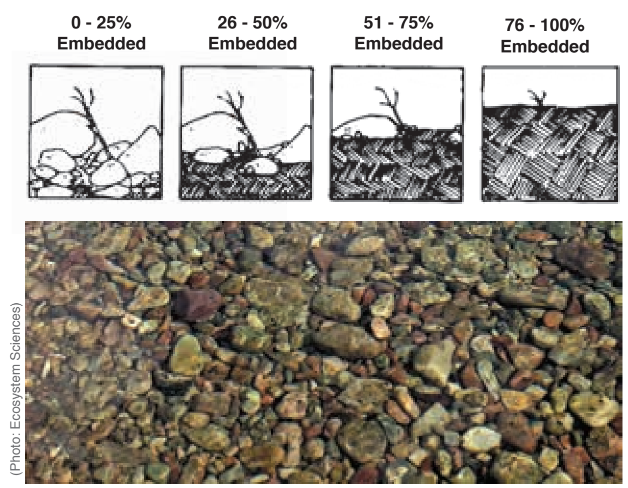
Reduce embeddedness by filtering silt and sand from stormwater by routing stormwater flow through existing or constructed wetlands.



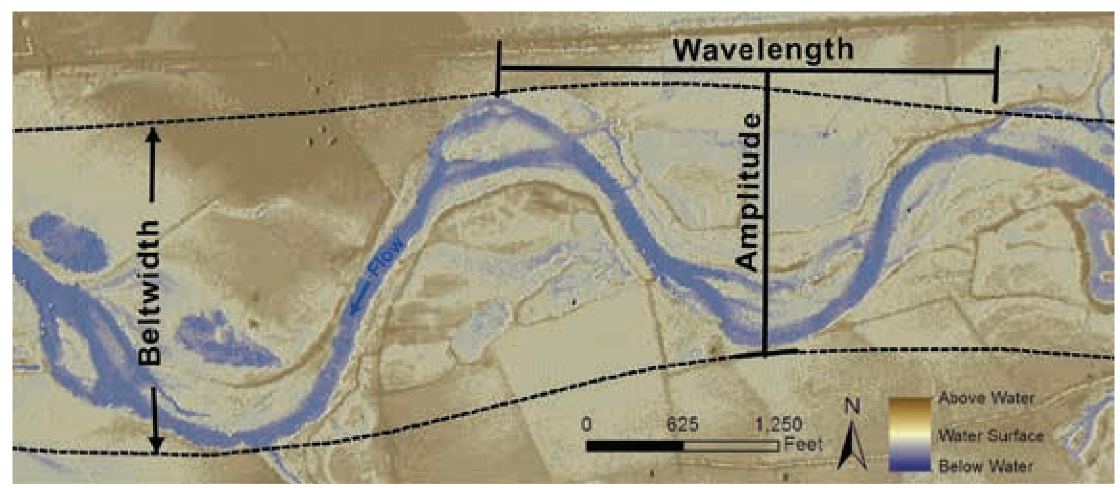
Complex River Channel: A more complex river channel with lower width to depth ratio, a well-defined thalweg, instream structure, side channels and riparian vegetation on the banks represents a target condition. At low flows, cover is provided by instream structure and vegetation; at high flows, the floodplain is accessed.



Confined Channel: Much of the river has a wide, shallow channel with that lacks structure and a thalweg (deepest portion). At low flows, the water's edge is pulled away from the banks and cover for fish and other organisms is diminished. At high flows the river is confined by levees, unable to access the floodplain.



Embeddedness - Refers to the extent to which rocks (gravel, cobble and boulders) and snags are covered or sunken into the silt, sand or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased.



Establish an appropriate meander belt width where feasible. The meander belt width is a theoretical value based on the maximum amplitude of one meander bend independent of levees or other infrastructure. The amplitude of meander bends typically grows until it reaches a maximum at which time the meander is cut off leaving behind an oxbow channel scar. Establishing an appropriate belt width will allow the river to function more naturally within a specified corridor while allowing a separate area for development and agriculture outside the belt width. (from Richardson and Guilinger 2015)

Geomorphology Enhancement Opportunities

(Photo:Gary O. Grimm/BREN Network)

Issue: A wide, shallow section of the Boise River. The section lacks a well-defined thalweg, instream structure, diverse bedform, floodplain connection, pools and cover for aquatic life.

(Photo: Rob Richardson)

Solution A: Well engineered logjams and boulders placed in the channel can create split flows. Point bars form behind and back bar side channels around them and are active at a wide range of flows.

(Photo: Rob Richardson)

Solution B: Low-profile barbs can improve channel complexity. The picture above is taken between two low-profile barbs constructed of logs with native bed material backfill. The barbs were designed to overtop at bankfull flow. Note the slow water between the barbs and the well-defined thalweg.

(Photo: Liz Paul)

Issue: Rip Rap is used to reduce erosion and protect land and infrastructure along the Boise River.

(Photo: GeoEngineers)

Solution: Root wads can be an alternative to rip-rap and other bank structures. When coupled with riparian plantings and lowering of floodplain surfaces, the floodplain can be reconnected to the channel and habitat value increased for many species.

3 Force river processes

Force river processes enabling the river to create improved forms.

Where appropriate, build engineered log jams or boulder obstructions at the head of strategic point bars to force a percentage of flow across the back of the bar creating a back-bar side channel that is active across a wide range of flows.

Build engineered log jams to force channel migration into areas of accessible floodplain and away from developments or other vital infrastructure.

Build engineered riffles with V-shaped cross-sections focusing flow into high-velocity chutes scouring pools downstream of the riffle. This type of application can create vertical instream complexity where lateral dynamism (channel migration and bar building) is unrealistic due to constraints or unachievable due to channel confinement.

Reduce overall instream width-to-depth ratio by adding bank structure, creating islands (split flow) and improving riparian conditions. Lower width-to-depth ratios improve thalweg development and improve shade and bank cover.

4 Construct forms that the river can maintain

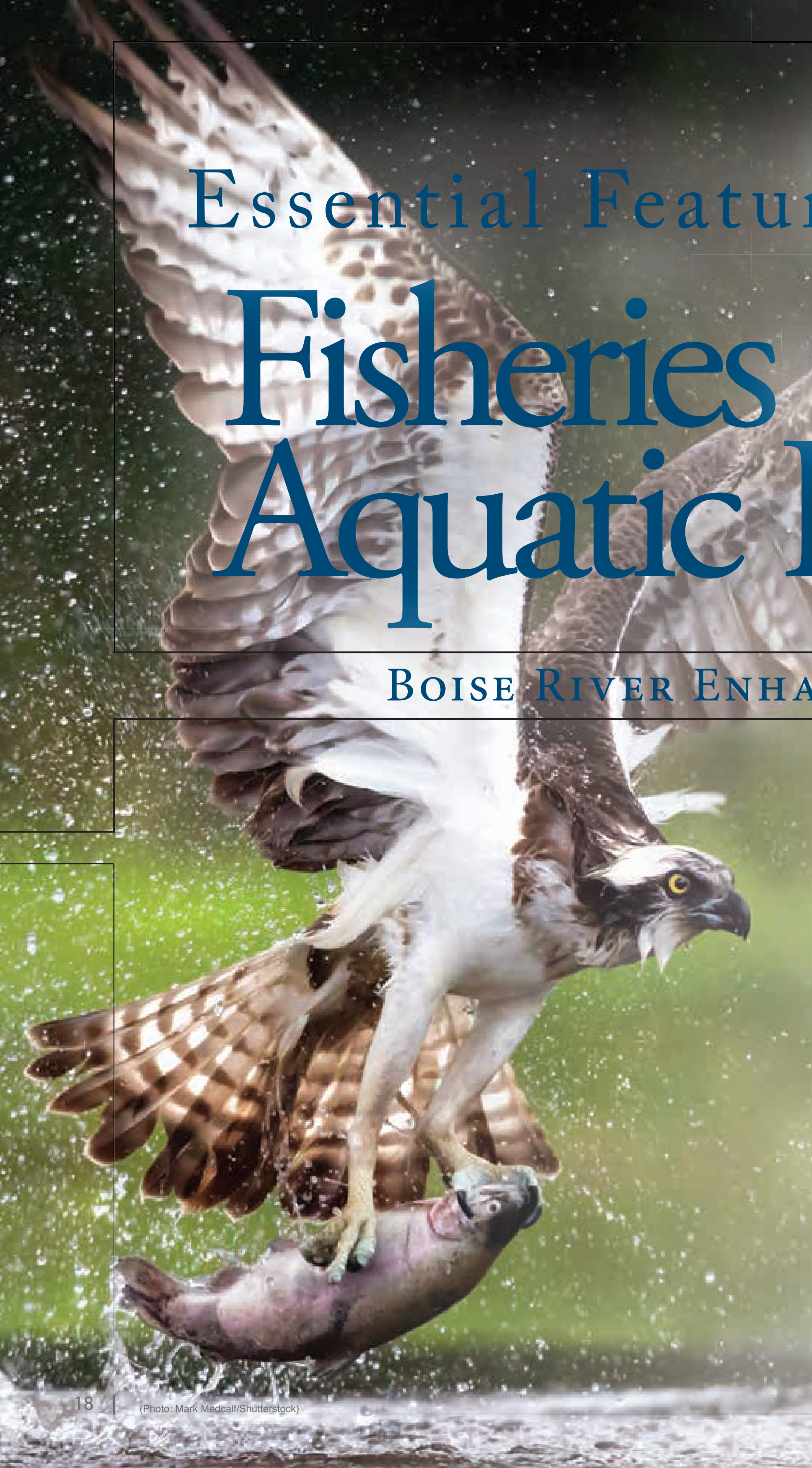
Excavate side channels. Side channels can simultaneously enhance geomorphic function, improve hydraulic complexity and reduce flood risk.

Place whole trees and pieces of large wood into off-channel features. Large wood in side-channels, sloughs and alcoves promotes scour pool development during high flows, stabilizes banks, and provides shade/cover.

Essential Feature 2

Fisheries and Aquatic Habitat

Boise River Enhancement Plan



(Photo: Mark Medcalf/Shutterstock)

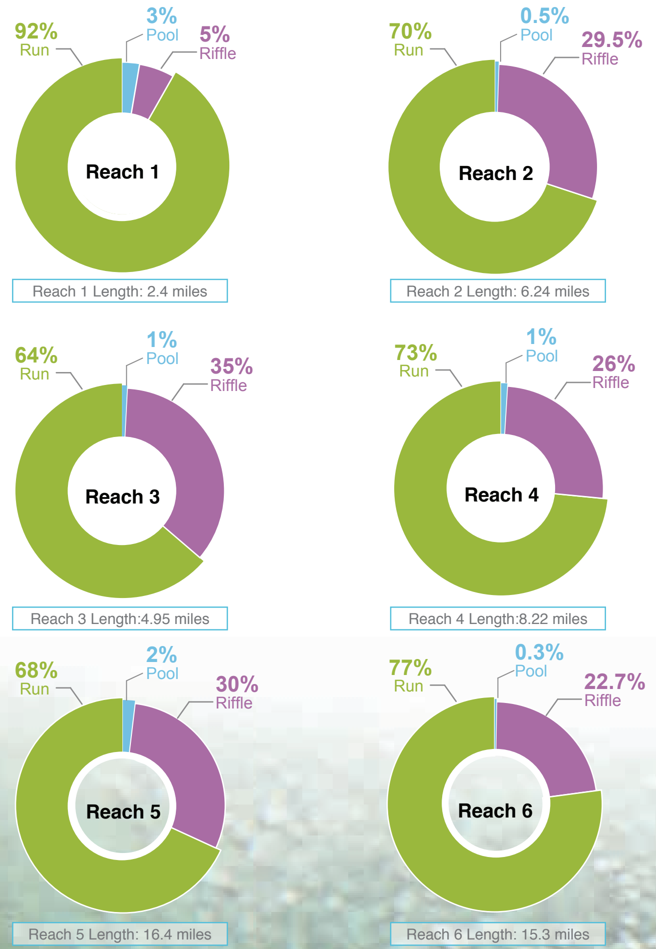
Flow regulation from dams and irrigation infrastructure, channelization, floodplain development, introduced species and pollution has changed the fish and aquatic habitat of the River. Restoring native fish populations to historic levels is not a reasonable goal. However, the current fish and aquatic habitat provides important natural, cultural and economic resource values to the region. Improvements made to these resources over the past 25 years demonstrate that meaningful enhancement can be achieved; however, significant stressors remain within the system providing enhancement opportunities.

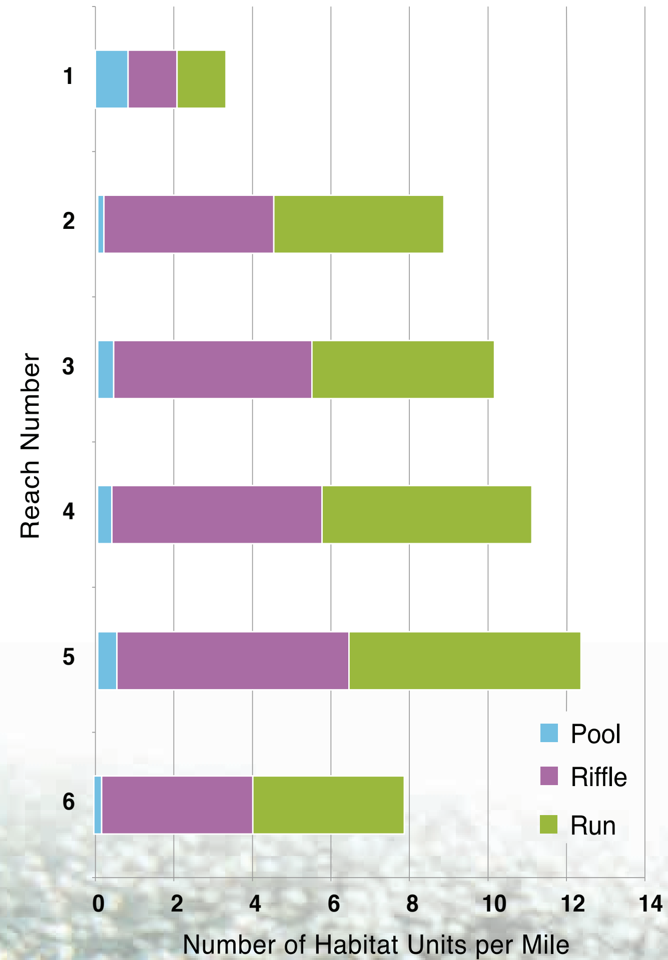
Twenty-two species of fish have been identified in the River. The upper 30 miles, from approximately Lucky Peak to Star, supports a cold-water fish community with higher biotic integrity than from Star to the confluence with the Snake, which supports cool and warm-water fish communities. The cold-water game fishery is composed of wild and hatchery rainbow trout, exotic brown trout and mountain whitefish. Salmonid populations have increased dramatically since 1994. These increases can be attributed in part to higher and more consistent winter flows and improved water quality. The cool-warm water fishery is less well-understood. Introduced smallmouth bass, channel catfish and largemouth bass have established within the lower reaches or seasonally migrate upstream from the Snake River.

Decreased spring peak flows and increased summer flows, similar to many western river systems managed for flood control and irrigation water delivery, have reduced salmonid habitat. The reduction in spring peak flows results in decreased river bed mobilization, which leads to high embeddedness (when cobbles and other stream bed substrates are covered or closely packed by fine sediments). Elevated summer discharge coupled with channel confinement, lack of instream cover, roughness elements and complexity have led to stream velocities and habitat conditions that are not optimal for trout during much of the irrigation season (May – October). Decreased flows outside of the irrigation season (November – April) dewater near shore habitat leading to a loss of cover and habitat complexity for juvenile and adult fish, thus lowering fish survival. Riparian and wetland habitat along the River's banks and side channels are in need of enhancement. The location and quality of salmonid spawning habitat is unknown and requires investigation. Instream structure and cover is lacking and enhancement of these elements will benefit fisheries. Full-channel-spanning instream structures can inhibit or block upstream fish movement, as well as downstream sediment movement, but can create fish habitat. Fish can be entrained in the many diversions along the River, though the degree and location of entrainment is poorly understood. Poor water quality in lower sections of the River, including elevated temperatures, phosphorus and suspended sediment levels, impair the fish and other aquatic life. Land use, particularly urban development of the floodplain, poses a significant threat to the long-term health of the system.

Instream Habitat

The Boise River is approximately ¾ run habitat, ¼ riffle habitat and only a few pools (+/- 1%) during the irrigation season. Diversity of habitat (as measured by the number of habitat units per mile) varies along the river. Habitat measurements presented below were made along the thalweg (deepest part of the channel) in June and August 2013 by IDEQ.





Riffle-Run-Pool definitions

Riffle—shallow water with a turbulent water surface. The turbulence is caused by completely or partially submerged obstructions, often on the stream bottom.

Run—uniform, non-turbulent flow. Runs are deeper than riffles with a faster current velocity than pools.

Pool—reduced water velocity, water deeper than the surrounding areas, and the bottom is often concave in shape forming a depression in the profile of the stream's thalweg that would retain water if there were no flow in the channel.

Definitions adapted from: DEQ (Idaho Department of Environmental Quality). 2013. Beneficial Use Reconnaissance Program Field Manual for Streams. Boise, ID: DEQ.

Issues Affecting Fisheries and Aquatic Habitat

Although the aquatic habitat of the River has improved over the past 30 years, many stressors remain that reduce habitat quality.

1 Channel confinement and simplification

The River lacks instream cover (especially outside the irrigation season), habitat complexity, a well-defined thalweg (deepest part of the channel) and appropriate amounts of low-velocity resting areas preferred by many fish species, especially trout.

Riparian vegetation along stream banks needs enhancement and is displaced from the wetted area outside the irrigation season.

Urban and rural development continues to reduce the function and value of aquatic habitats by modifying the floodplain.

2 Water quality

Elevated temperature and sediment load decrease fish habitat quality.

3 Infrastructure

Instream structures can block fish passage and canals can entrain fish.

4 Altered flow regime

Altered flows influence sediment transport processes and habitat quality.

5 Substrate

Normal sediment recruitment is reduced due to upstream capture by dams. Bed mobility is reduced by embeddedness and armoring. In the lower reaches, abundant fine sediment inputs negatively impact fish habitat.

(Photo: El Choclo/Shutterstock)

Fisheries and Aquatic Habitat Enhancement Opportunities

Many opportunities to enhance habitat for fish and other aquatic organisms have been identified. Low winter flows are likely limiting the fishery and increased winter discharges would therefore benefit the resource; the extent of such benefits requires study. Protection of existing riparian and wetland habitat associated with the River is a priority, while enhancement of existing habitats, especially those that increase habitat complexity, would bring additional benefits.

There are several specific enhancement opportunities that could improve aquatic habitat. Reconnecting side channels may improve spawning and rearing habitat, though there are concerns about water quality impacts and the effectiveness of these projects. Leaving large wood in the river, placing boulders, and construction of artificial habitat elements would increase habitat complexity and cover for fish and other aquatic organisms; however these actions come with public safety concerns. Recruitment and development of cottonwood and willow riparian forest could be increased through creating appropriate surfaces or restoring river access to appropriate surfaces. Water quality could be improved through cooperative efforts that include the irrigation community, municipal, state and federal governments. Reconnecting and re-establishing the floodplain through setting levees back, excavation, conservation easements and municipal zoning would bring widespread benefits. Increasing the number of long-term monitoring stations and the data collected, the frequency of monitoring and involving the community in the process, including a centralized database the public can access, would increase support and awareness. These enhancement opportunities require collaboration and cooperation to achieve their goals.

Complex channel, roughness elements, cover:

The main channel currently lacks roughness elements (rock, large wood, etc.) that provide habitat diversity, cover and velocity breaks for salmonids. This can create high velocities with little cover for salmonids during the irrigation season. Snorkeling surveys in the 1980's observed rainbow trout predominantly utilized habitat near the banks and near large wood, while brown trout were almost exclusively found near large wood or rocks– highlighting the need for instream habitat elements.

These roughness elements also provide habitat for other aquatic organisms, including salmonid food sources. Outside the irrigation season, the water's edge is pulled away from riparian vegetation and cover, leading to increased fish mortality. A more complex channel will improve these conditions, as well as bring water quality, geomorphic and riparian benefits.

(Photo: Liz Paul / BREN)

(Photo: Trout Unlimited, Golden, CO)

Walling Creek (above left) flows just north of Marianne Williams Park. The City of Boise re-engineered the creek to reconnect it to the River instead of allowing it to flow into the Penitentiary Canal, as it had in the past. Reconnecting side channels and creating off-channel habitat are enhancement options that address the loss of channel complexity over the last 100 years. Where leaving large wood in the river is not practical, placing boulders in the river can create roughness and increase complexity of the stream channel. The boulders can narrow and deepen the channel and increase scour and deposition areas. Areas of turbulence and pools created by boulders can provide habitat and cover for fish year-round. On Clear Creek (above right) outside of Golden, CO, the local Trout Unlimited chapter placed boulders in the stream as part of a restoration project in 2009. The project has been met with widespread praise and has led to further projects in other reaches.

Fish Passage and Entrainment

Instream structures can inhibit or block fish passage and canals can entrain (i.e. when fish enter canals or other areas that are unnatural or harmful) fish. Once key fish passage barriers and entrainment locations are identified, several enhancement options exist. Fish ladders have traditionally been used to provide fish passage (see Rock Creek example), but other options exist including engineered riffles (see Wychus Creek example), etc. Several types of fish screens are utilized to prevent fish but not water from entering canals (see Morrell Creek examples). Each site has its own suite of conditions that determine the most appropriate design.

(Photo: River Design Group)

(Photo: River Design Group)

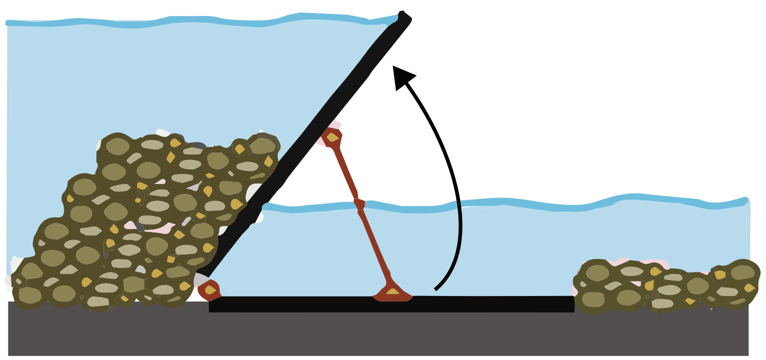
Rock Creek, OR. A fish ladder was constructed to provide fish passage around an irrigation structure.

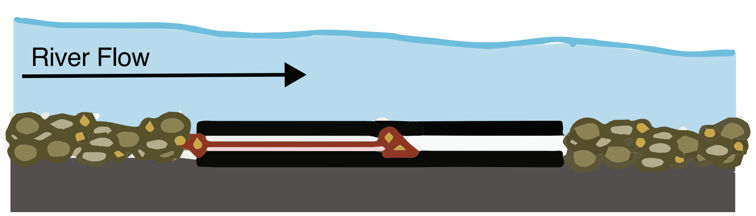
(Photo: River Design Group)

Morell Creek, OR. Both rotary drum (left) and flat panel screens were used on different diversions to prevent fish entrainment.

(Photo: River Design Group)

Wychus Creek, OR. A diversion structure that was a fish passage barrier (upper photo) was upgraded to provide fish passage by creating a "rock ramp" or engineered riffle (lower photo).





Boise Whitewater Park: an example of instream structure, fish passage and upgraded diversion for canal water conveyance

Photo: Cody Harrigan

Simplified diagram of lay-flat stanchion dam (wicket dam, images to the left). When in use each stanchion is raised to impound water and sediment (top). When not in use, each stanchion is lowered reestablishing "normal" flow and sediment transport (bottom).

Boise River Whitewater Park wave (image on right). Sections of the dam can be raised or lowered incrementally to shape waves, impound water for irrigation purposes, or increase flow and sediment passage. This type of diversion upgrade provides for recreational improvement, improved fish habitat and passage, improved geomorphic function and a more reliable and safe irrigation structure. The project also involved utilizing a former gravel pit for flood conveyance. This project by the City of Boise is an example of how ecological enhancement of the River can be achieved without sacrificing recreation, irrigation, or flood risk considerations.

1. **Protect**

   Protect existing functional, unconfined areas where the floodplain is connected to the stream channel. Identify remaining segments of less confined channel and floodplain; act to maintain these areas through purchase or easement.

2. **Increase channel complexity**

   Increase channel complexity through active interventions. Increase complexity and cover where possible with instream habitat enhancements and removing or setting back confining elements (e.g. levees). Re-establish and create side channel habitat and daylight (bring into an above-ground channel) tributaries to create confluence areas. Deeper, narrower channels will help with water quality (e.g. temperature).

3. **Modify elements of the flow regime**

   Work with water managers to identify opportunities to modify the flow regime to benefit fish.

4. **Evaluate and upgrade irrigation infrastructure**

   Determine which structures are the largest barriers to fish passage and which canals entrain the most fish. Upgrade these structures to increase fish passage and reduce entrainment.

5. **Intercept stormwater and irrigation returns**

   Intercept stormwater and irrigation return water before it reaches the River. Increase water quality by removing fine sediments and other pollutants before they reach the River.

(Photo: IDAK/Shutterstock)

Essential Feature 3

Wetlands and Riparian Habitat

Boise River Enhancement Plan

Due to a long history of land alteration, wetland and riparian areas along the Boise River and the region have been reduced in extent and function. The River channel has been confined and historic wetland and riparian floodplain areas have been filled or separated from the channel by levees and rip-rap, especially in the urban upper reaches. In the downstream areas, many historic sloughs have been converted for agricultural use or drained completely, although some agricultural drains have created wetlands. Today, numerous old gravel pits and ornamental ponds have created a large amount of open water habitat in off-channel locations along the River, but few have vegetated wetlands associated with them. Road construction, urbanization, floodplain development and flood control are currently larger threats to wetlands than historic factors. Grazing, recreation, dam operation and flood control all impact the function of existing wetland and riparian habitats. The historic floodplain forests were a mix of cottonwood (*Populus balsamifera ssp. trichocarpa*), willow (*Salix spp.*), alder (*Alnus incana*), water birch (*Betula occidentalis*), Wood's rose (*Rosa woodsii*) and other riparian shrubs that extended far beyond the current width. Regeneration of black cottonwood (and to a lesser degree willow) has been negatively impacted by flow alteration, the lack of appropriate parafluvial surfaces (those formed by the river within the channel and scoured by flow events) and land development on the floodplain. More expansive and functional riparian floodplain forests will enhance the ecologic integrity of the river ecosystem.

Several other issues affect the function of existing wetlands and riparian areas. Flood risk reduction is a large issue due to development within the floodplain. Trees on the stream bank and large wood in the River continue to be removed for flood risk and recreational safety reasons. Invasive, non-native species, including false indigo (*Amorpha fruticosa*), several grasses, (e.g. reed canarygrass [*Phalaris arundinacea*]), purple loosestrife (*Lythrum salicaria*), and various deciduous trees have colonized the riverbanks and decreased the function and value of these critical habitats. Despite the large amount of information that does exist, a comprehensive survey of the wetlands and riparian areas of the Boise River has never been performed, and is needed. Among many experts, conservation and protection of existing functional and high quality wetland and riparian areas is the highest priority action. IDFG and other professionals have identified high priority sites for conservation and protection including Fort Boise, Barber Pool Conservation Area, Eagle Island, the reach between Barber Pool and Warm Springs

Development and Landuse Change: Road construction, urbanization and floodplain development are the largest threats to riparian and wetland areas along the river. Spring Meadows Riverfront Park (now Bethine Church River Trail) was designed to create a place for people to enjoy, while improving flood conveyance and increasing habitat diversity within the setback zone. While development reduced the riparian area, floodplain surfaces were lowered to increase floodplain connection in the area that remained. (Design and Images by Resource Systems Inc.)

Cottonwood: The black cottonwood (*Populus balsamifera ssp. trichocarpa*) riparian forest provides important habitat along the River. The cottonwood forest was historically vast and had an understory comprised of willow, alder, birch and rose; this has been replaced by a mix of native, non-native and invasive species. Black cottonwoods are viewed as a keystone species in the system, as many wildlife species, especially wintering and nesting bald eagles, rely on cottonwoods for critical habitat. Great blue herons build their rookeries in cottonwood galleries. These large trees shade the river and provide cover for numerous species. Flow regulation (especially the absence of large flow events), a lack of appropriate surfaces within the floodplain and floodplain loss have led to a severe reduction in cottonwood recruitment along the River.

(Photo: Potapov Alexander/Shutterstock)

Issues Affecting Wetland and Riparian Habitat

Wetland and riparian areas adjacent to the Boise River have been highly reduced in quality and quantity from historic levels.

1 Wetland and riparian areas reduced and lost

Historic dam construction, flow modifications, water diversion, channel confinement, draining and filling of wet areas, urbaization and conversion to agriculture led to a loss of wetland and riparian areas. Road construction, urbanization and floodplain development continue to decrease the wetland and riparian areas adjacent to the river.

2 Existing wetland/riparian condition is being impaired

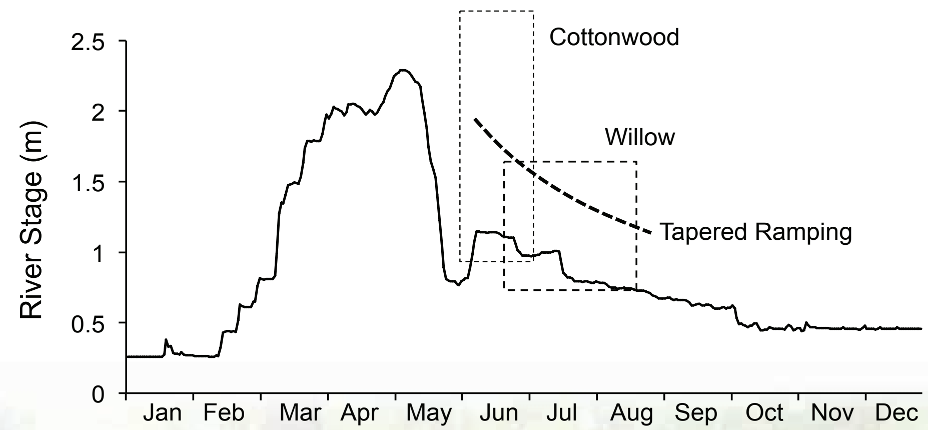
Grazing, recreation, dam operations, and flood risk management actions impact the function of existing wetland and riparian areas.

3 Riparian forest species are not reproducing by seed

Regulated flows, channel confinement, and lack of appropriate surfaces have severely reduced the ability of native riparian species seed to germinate and establish.

4 Invasive, non-native plant species are abundant

Invasive, non-native weed species, false indigo, several grasses, and purple loosestrife (Idaho noxious weed) have colonized the riverbanks and decreased the function and value of these critical habitats.



Riparian Tree Recruitment and River Flows: Cottonwoods and willows require high flows that innundate bare surfaces at the correct elevation above the river for their seeds to establish. The boxes above represent the elevations and flows required to meet criteria. Additionally, the dashed line represents the falling limb, or ramping pattern, required for successful establishment. River flows in 2012 on the Boise created an event where these conditions were approached. (from Tiedemann and Rood 2015 in press)

(Photo: IDAK/Shutterstock)

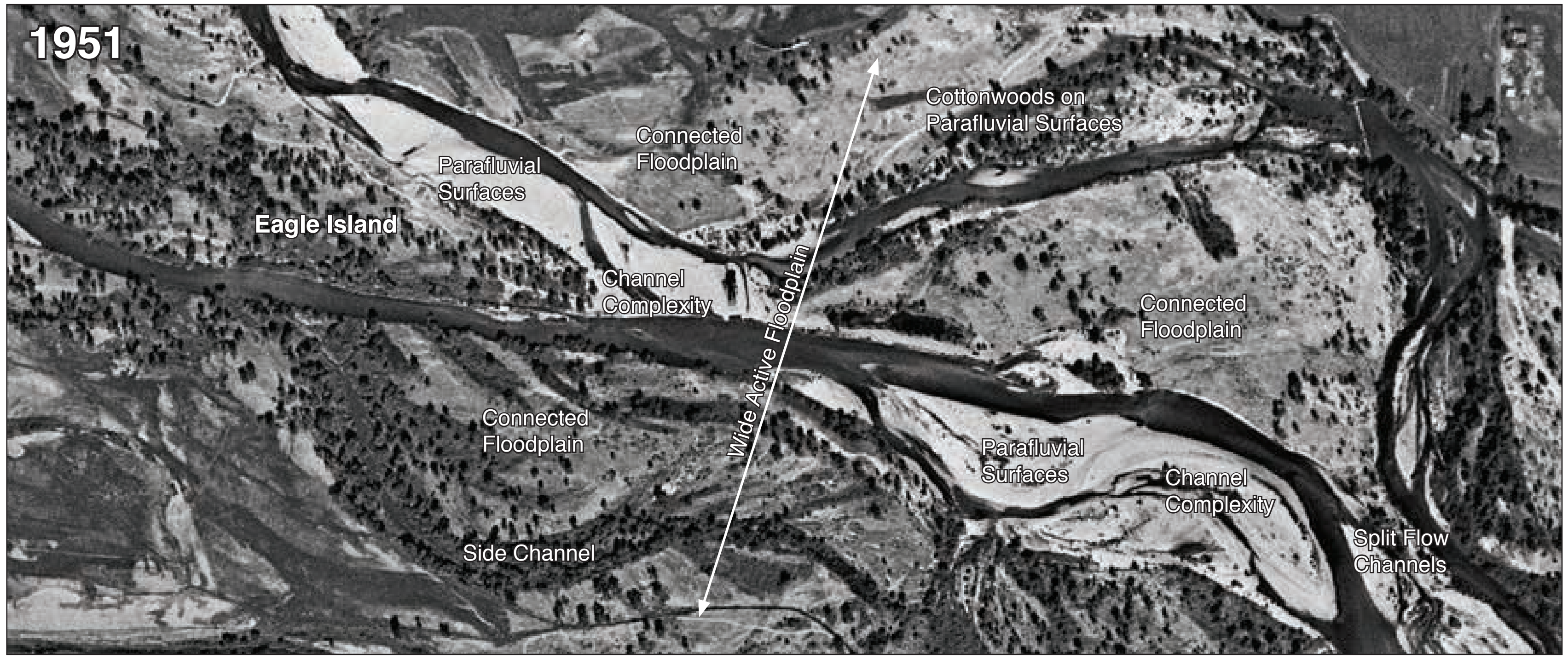
Golf Course, the reach below Garden City, and along the Boise River from Caldwell to Notus. Other enhancement tools include flood easements, re-contouring of the floodplain (including engineering floodplains to promote cottonwood recruitment), planting native species and clearing of non-native and invasive species.

(Photo: Gary Grimm)

Perkins Nature Area: An example of protection and enhancement. Duane Perkins and his wife Anna owned property on Eagle Island since the 1960's. At over 90 years old, Mr. Perkins decided to protect his land forever as a nature area. The Land Trust of the Treasure Valley, the trustee of this parcel, has pledged to uphold his desire for a nature area. A management plan is in place, including invasive plant removal and opportunities for enhancement. The prospect of utilizing the property as an outdoor lab for students is being explored.

(Photo: Gary Grimm/BREN Network)

Heron Rookery: The black cottonwood riparian forest provides important habitat. Black cottonwood trees in particular are directly related to the existence of heron rookeries. In addition to Great Blue Herons, double-crested cormorants also nest within the rookery. Rookeries are an important indicator of ecosystem health.



Head of Eagle Island / River Channel 1951: Aerial Image of the Boise River near the head of Eagle Island in 1951 before the completion of Lucky Peak Dam. The area had a complex floodplain scoured by high flows surrounded by an agricultural landscape.

Head of Eagle Island / River Channel 2011: Aerial Image of the Boise River near the head of Eagle Island in 2011, more than 50 years after the completion of Lucky Peak Dam. The river channel is simplified and the floodplain disconnected and confined by urban development and flood control.

Hyatt Hidden Lakes Reserve

The Hyatt Hidden Lakes Reserve contains 28 acres of wetland habitat, 6 of which have qualified for wetland banking credits by The Wetlands Group, LLC. The Reserve is also the site of a pilot project implemented by the City of Boise and the Ada County Highway District to demonstrate appropriate methods for decentralized stormwater treatment using amended soils, sand filtration and wetland treatment. The Hyatt Hidden Lakes Reserve provides diverse habitat and refuge for birds and animals within its urban setting.


(Photo: Gary O. Grimm)

Marianne Williams Park

Marianne Williams Park is an example of a project that incorporates re-connecting the floodplain to river, off-channel wetland and riparian habitat creation and recreation enhancement. In 2012, the City of Boise (with help from The Land Group and The Wetlands Group) removed levees and designed floodplain surfaces to be inundated under the current hydrologic regime. Since construction, the River has flooded the park, reducing flow velocities, providing flood conveyance and recharging groundwater. Riparian and wetland vegetation has established and continues to develop within these areas to the benefit of fish, wildlife and recreation.


(Photo: Liz Paul / BREN)

Invasive Species

False Indigo (*Amorpha fruticosa L.*) is one of several invasive plant species that grows along the Boise River, easily outcompeting most native woody shrub species. In 2013, the Land Trust of the Treasure Valley partnered with Wells Fargo to remove substantial amount of false indigo from their property on Eagle Island. Other non-native/ invasive plants of concern in the riparian corridor include purple loosestrife (*Lythrum salicaria*) and poison hemlock (*Conium maculatum*); management of these species is a priority.


(Photo: Mike McConnell)

Purple Loosestrife


(Photo: Washington State University)

False Indigo

Protection of existing functional areas from development and reconnection of the floodplain with the river channel are the essential strategies to enhance wetland and riparian habitat.

1 Protect

Protection of existing functional floodplains, wetlands and riparian habitat areas.

High quality wetland and riparian sites on public land could be protected by special status designations combined with long term enhancement and stewardship plans.

High quality wetland and riparian sites on private land could be purchased or easements acquired by land trusts or other public or private institutions and long-term enhancement and stewardship plans put in place.

Municipalities could create ordinances that protect floodplain areas from further development.

2 Remove levees and re-contour the floodplain

Removing or setting back levees that disconnect the floodplain from the river and lowering floodplain elevations allows wetland and riparian areas to re-establish. Well-designed floodplain and stream bank surfaces can promote natural regeneration of riparian forests.

3 Flood easements

Areas having high flood risk could be purchased and vulnerable development cleared from the area. This could reduce flood risk and increase the area available to establish wetland and riparian habitat.

4 Invasive and non-native weed control

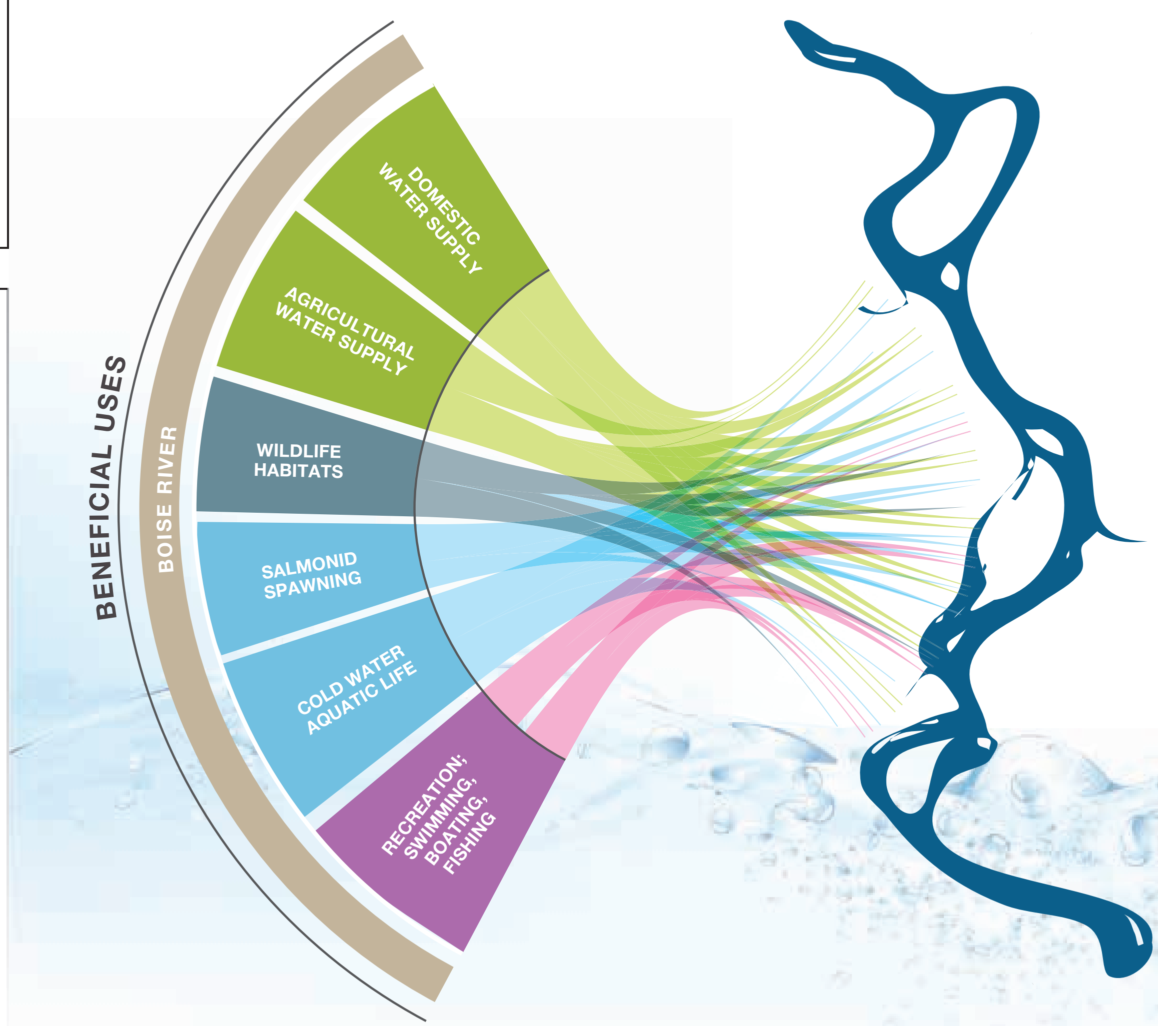
Non-native species have spread throughout the River and detract from wetland and riparian function and value. Implement a comprehensive invasive and non-native weed control program.

Essential Feature 4

Water Quality

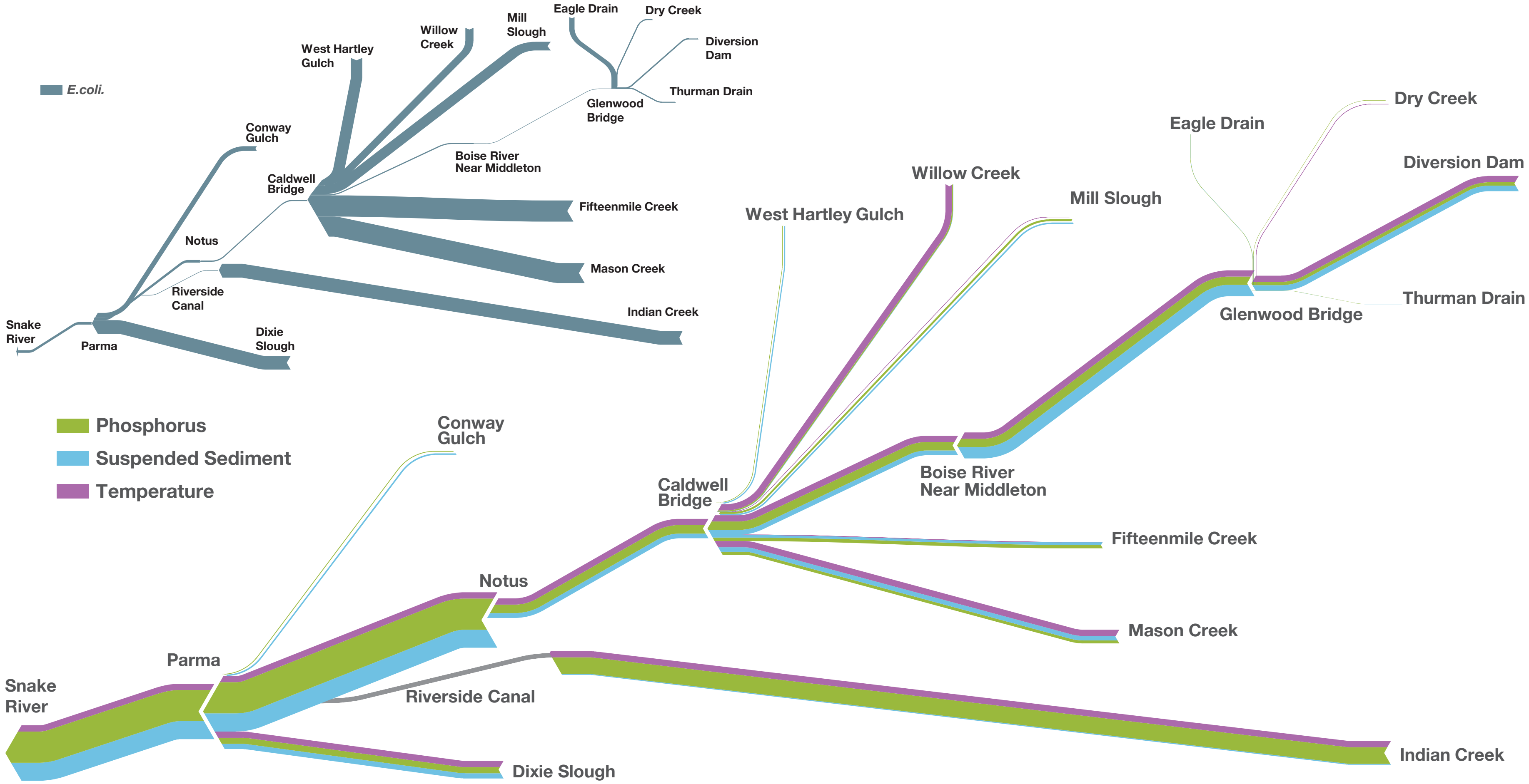
Boise River Enhancement Plan

Clean water is essential for human consumptive use, swimming, boating, aesthetics and to support healthy fisheries, wildlife habitats and ecosystem function. Water quality is affected by discharge and runoff from cities, industry, agricultural lands, feed lots, and other land uses as well as channelization and flow alteration to accommodate development and water supply. The time of year, source of pollutants and flow volume can influence the concentration and loads of pollutants within the Boise River; this is further complicated by the complex interconnected system of tributaries, canals, laterals and drains.



Pollutant/Issue	Water Quality Criteria
Low Dissolved Oxygen	Cold Water Aquatic Life > 4 mg/L; Modified Aquatic Life > 4 mg/L Salmonid Spawning > 6 mg/L or 90% saturation 1 day minimum Intergravel > 5 mg/L for 1-day minimum or over 6 mg/L for 7-day average
E. coli	Geometric mean concentrations <126 colony forming units/100 mL
pH	between 6.5 and 9.5
Sediment	Total suspended sediment TMDL targets for select reaches of the Boise River are 50 mg/L for < 60 days and 80 mg/L for < 14 days. Proposed tributary targets are 20 mg/L for < 120 days.
Temperature	Cold Water Aquatic Life <22°C daily max and <19°C daily mean Salmonid Spawning <13°C daily max and <9°C daily mean
Total Phosphorus	As a tributary to the Snake, the Boise River must reach target concentrations of 0.07 mg/L May-September at its confluence as set by the Snake River-Hells Canyon TMDL. A TMDL for the Boise River is forthcoming.

The primary pollutants/issues of interest for the Lower Boise River are bacteria (*E. coli*), low dissolved oxygen, phosphorus, temperature and sediment. Water quality standards are set by the Idaho Department of Environmental Quality and established under Idaho Code IDAPA §58.01.02. The Clean Water Act requires the state to develop a pollutant management plan, called a Total Maximum Daily Load (TMDL), for waters that do not meet standards. TMDLs have been adopted for the mainstem Boise River and are proposed for a number of tributaries. In general, water quality conditions in the Boise River diminish in a downstream direction, with standards being exceeded most frequently between Middleton and Parma during the irrigation season.



Pollutant Load Contribution Diagrams: Scaled pollutant load contributions (a factor of flow and concentration) in the Boise River and tributaries as a percent of loads at Parma during the irrigation season. Temperature loads have not been established; therefore the line indicates listing only. The *E. coli* diagram (upper left) represents concentrations only. (Data from IDEQ and USGS)

Return flow to the Boise River at the Mason Creek confluence: Several tributaries and drains return irrigation water to the Boise River.

Primary Water Quality Issues in the Boise River

LOW DISSOLVED OXYGEN

Importance: Adequate levels of dissolved oxygen (DO) are vital to fish and other aquatic life. Recent monitoring shows DO levels fell below criteria in the Boise River near Parma for short periods in June, July and August 2014.

Sources: Low dissolved oxygen levels can be a result of elevated temperatures and/or excessive algae growth caused by phosphorus.

BACTERIA (*E.coli*)

Importance: The presence of *Escherichia coli (E. coli)* bacteria in water can indicate the presence of pathogenic microorganisms that can be harmful to human health.

Sources: Potential sources of *E. coli* include leaky sewage lines and septic systems; runoff from manure application to croplands; livestock grazing of riparian pastures; and stormwater runoff.

PHOSPHORUS

Importance: Increased phosphorus levels can result in elevated algae growth that negatively impacts DO levels, pH, macroinvertebrate and fish abundances and community composition, and recreational conditions.

Sources: Discharge from municipal and private wastewater treatment facilities; over application of fertilizer and agricultural runoff; animal manure; and natural decay of vegetation.

SEDIMENT

Importance: Excess sediment erodes gills and impairs fish feeding; reduces light penetration and plant growth; binds with other pollutants and affects temperatures; and covers spawning areas.

Sources: Excess erosion from land disturbing activities, such as agriculture and development; flood irrigation practices; urban stormwater runoff; removal of streamside vegetation; and runoff after wildfires.

TEMPERATURE

Importance: Cold water fish and aquatic organisms are adapted to specific temperature ranges; exceedances can lead to stress, decreased spawning success and even mortality. Cold water holds more DO and slows the growth of bacteria/algae.

Sources: Removal of trees and vegetation that provide shade; stormwater runoff from warm surfaces; water retention and distribution; channelization and flow alteration; and excess sediment.

Water Quality Enhancement Opportunities

Enhancement solutions aim to prevent pollution on-site as well as intercept pollution before it enters the River.

1 **On-site Stormwater Management Practices**

Manage stormwater on-site through natural landscape features and green stormwater infrastructure such as permeable pavers, tree trenches and silva cells, bio-swales and bio-retention areas. These actions reduce runoff and eliminate standing water.

2 **Agricultural Best Management Practices**

Irrigation systems for some crops can be converted to sprinklers or drip, reducing runoff and conserving topsoil. Conservation tillage, cover crops and proper pesticide application also reduce pollution.

3 **Improved Waste Management**

Actions to reduce nutrients and bacteria from urban sources include upgrading sewage lines/septic systems and reducing stormwater runoff. For agricultural sources, actions include prescribed grazing, waste containment systems and precise application of manure on croplands.

4 **Re-use of Irrigation Drain Water**

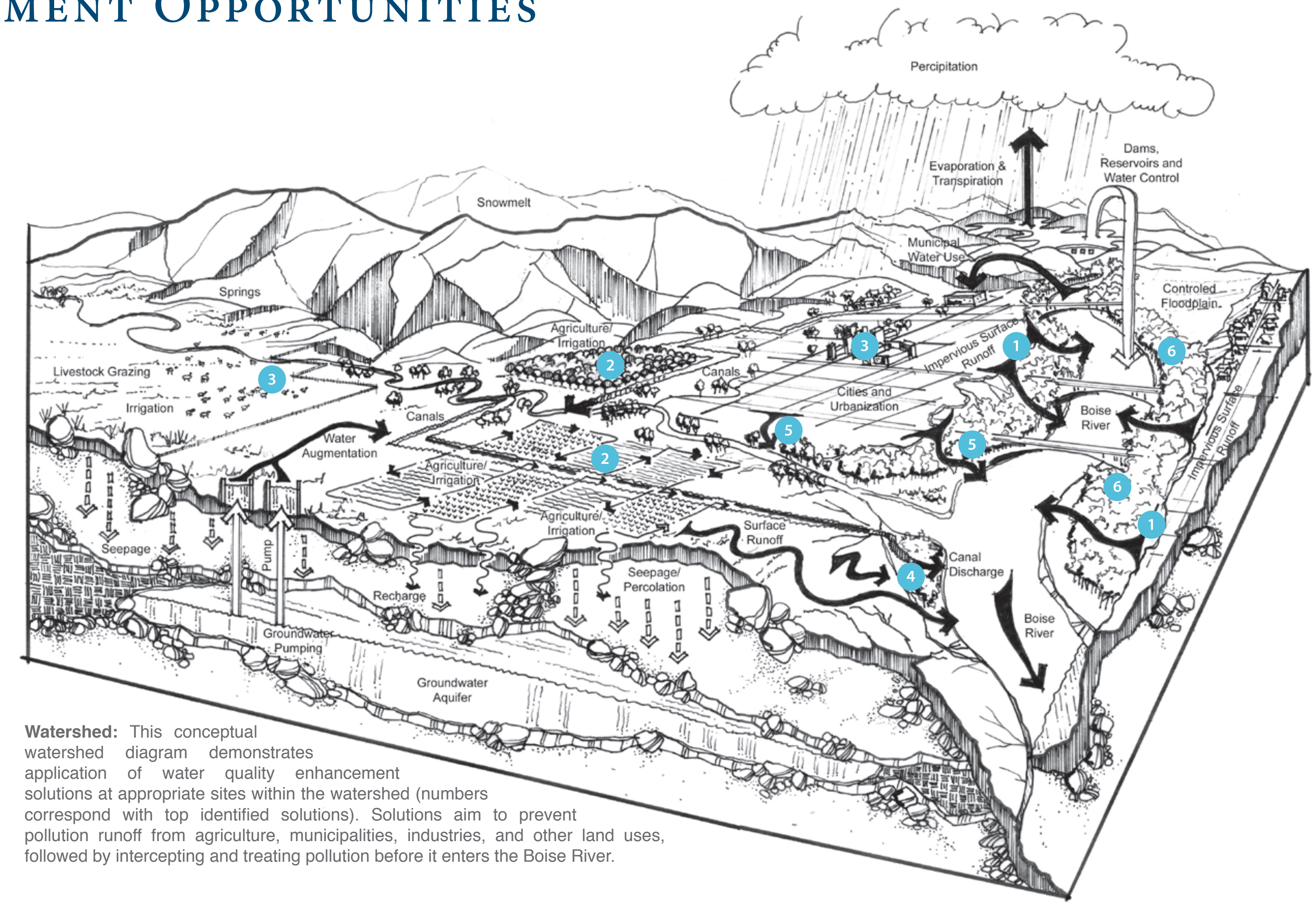
Capture and reuse of irrigation water can reduce pollutants such as sediment, phosphorus and pesticides from entering tributaries and the River.

5 **Sediment Basins and Constructed Wetlands**

Sediment basins and wetlands are effective at removing nutrients, sediment and other pollutants from both agricultural and urban runoff via naturally occurring biological, chemical and physical processes.

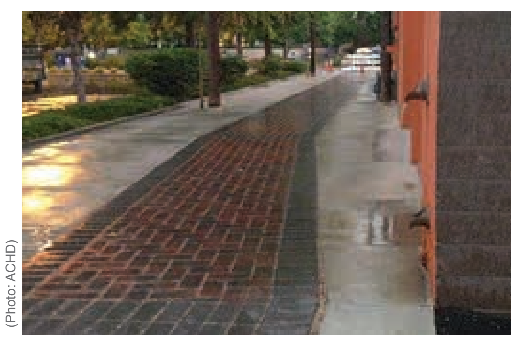
6 **Riparian Buffer Enhancement**

Enhancement or planting of streamside vegetation, where applicable, will help buffer water from sediment and nutrient runoff and provide shading, which reduces thermal loading.



Watershed: This conceptual watershed diagram demonstrates application of water quality enhancement solutions at appropriate sites within the watershed (numbers correspond with top identified solutions). Solutions aim to prevent pollution runoff from agriculture, municipalities, industries, and other land uses, followed by intercepting and treating pollution before it enters the Boise River.

Recent Enhancement Examples



(Photo: ACHD)

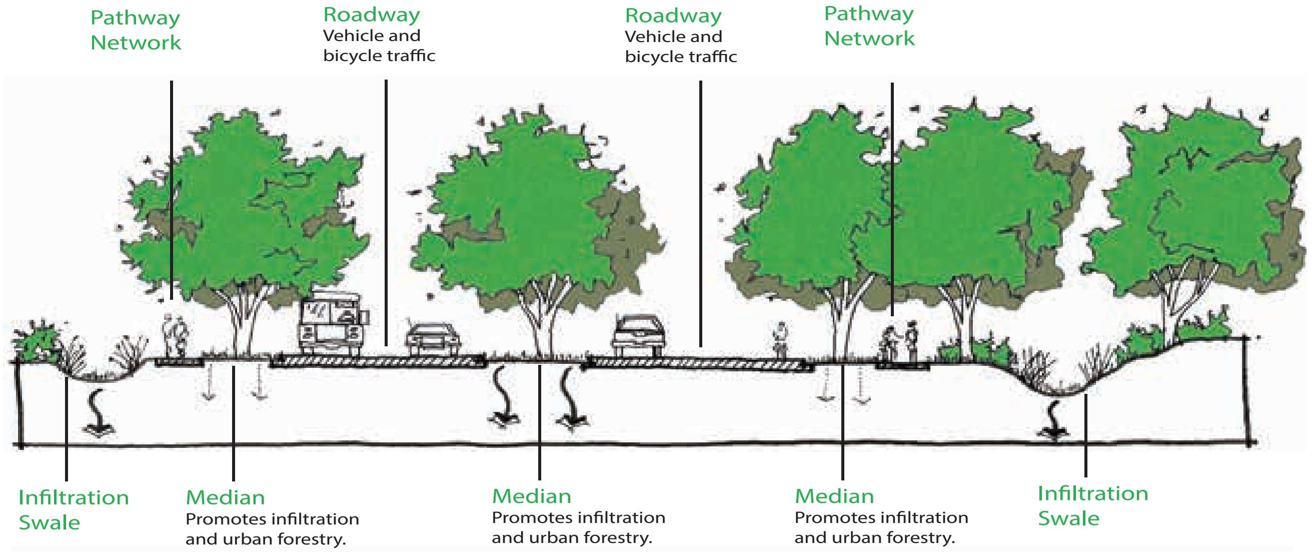
Green Stormwater Infrastructure, permeable pavers, Boise. Installed in 2015 by the Ada County Highway District (ACHD), the pavers help eliminate standing water through infiltration and clean rain and snow melt; they are both cost-effective and aesthetically pleasing.

(Photo: Tamsen Binggeli/BREN)

No-till farming, Somerville Farm, Canyon County. The Canyon Soil Conservation District supports numerous water quality projects through financial and technical support and by providing rental equipment for strip-till and no-till farming. This method of farming helps conserve soil leading to less runoff, fertilizer use and pesticide use.

(Photo: Rob Tiedemann)

North Alkali Drain Water Quality Improvement Pilot Project, Parma. Implemented in 2014 by Integrated Watershed Solutions, this project tests whether a sedimentation basin in combination with constructed wetlands can remove significant quantities of sediment and phosphorus from irrigation return waters. Initial results show effective removal of both pollutants.



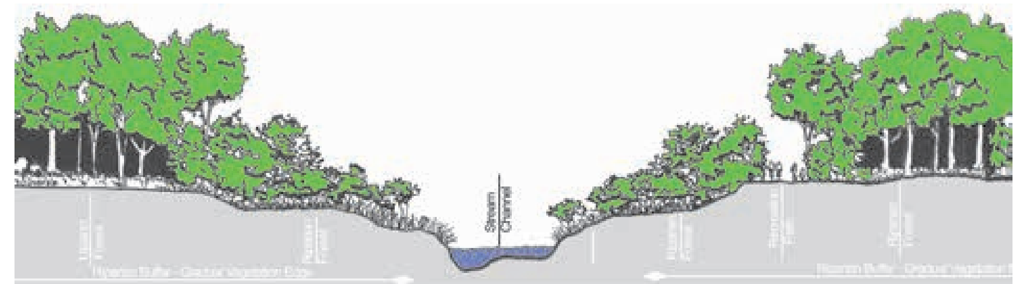
Green boulevards to manage stormwater. Green boulevards contain trenches and swales that promote infiltration of most urban runoff and moderate storm events. Larger storm events are moved along the swale to areas of wetlands and ponds for treatment.

"On-Site" Enhancement Solutions. Managing pollution on-site is the best way to improve water quality and many on-site techniques have been utilized for decades. The goal is to reduce or eliminate polluted runoff. This can be accomplished through the use of the natural landscape and/or infrastructure that infiltrates and treats polluted water, or through practices that reduce pollution sources, such as conversion to sprinkler or drip irrigation (less water = less runoff); precise application of manure, fertilizer and pesticides; and upgrading leaky sewage lines and septic systems. On-site enhancement requires support from local landowners and not all techniques are appropriate for all areas. For example, sprinkler or drip irrigation is not appropriate for some crops and it can have a localized impact on groundwater.

"End-of-Pipe" Enhancement Solutions. While these techniques can be implemented on-site to prevent pollution, they can also be utilized further downstream to intercept pollution before it enters a water body. Sediment basins and constructed wetlands, such as the North Alkali Drain Project and the CB River Spring Ranch wetland, can remove large amounts of sediments and nutrients from polluted water. However, they require ongoing maintenance, such as dredging and harvesting of wetland plants to continue to remove pollutants. Re-use of irrigation return water is another way to intercept pollution and is already occurring to a limited extent in the watershed; irrigation districts have the right to reclaim water generated by their systems and some water rights are established off of drains. Irrigation water re-use combined with sediment basins and constructed wetlands could address water quality concerns for downstream users. Effects on water rights and groundwater interaction must be considered when implementing these techniques.

(Photo: Liz Paul/BREN Network)

Outfall from CB River Spring Ranch wetland complex near Parma. Wetland systems can be used to clean water. The wetland complex at CB Spring Ranch receives irrigation drain water from over 1,200 acres of upstream farmland.



Riparian Buffers that are broad and diverse provide maximum benefits compared to narrow buffers.

Riparian Buffer concept for Indian Creek.

Riparian Buffers intercept surface run-off and are effective at removing nutrients and sediment. The width, height and species composition all influence the functionality and value of riparian buffers. Riparian buffers also provide bank stabilization, benefit channel morphology, enhance food webs and provide critical wildlife habitat.

(Photo: Liz Paul/BREN Network)

Agricultural field using flood irrigation, Ada County. Conversion to sprinkler irrigation can reduce runoff and erosion. This type of project could be used as part of a water quality trading program.

Water Quality Trading has emerged as an innovative approach to achieve water quality goals. Cites and industries are regulated under the Clean Water Act as "point-source" dischargers and their facilities face increasingly stringent pollutant limits. Trading allows facilities to purchase environmentally equivalent (or superior) pollution reductions generated by "non-point sources" through watershed enhancement, such as streambank revegetation, agricultural best management practices, sediment basins or constructed wetlands. Trading requires long-term maintenance and monitoring to ensure compliance and these techniques often result in the same water quality improvement and provide watershed-wide benefits at a lower cost than traditional engineered solutions. New TMDLs for temperature and phosphorus are being developed for the River; water quality trading may be a tool to meet current and future limits driven by these TMDLs.

Part 3

Realizing the Vision

Boise River

Meaningful Enhancement Through Collaborative Efforts

The Boise River conservation community has the capacity and expertise to substantially improve the River ecosystem. However, in the absence of a collaborative approach and a coordinated plan, enhancement projects have often occurred where opportunities or funding is available, rather than in areas of greatest ecologic priority. Further, river enhancement can be complex and, at times, contentious. Collaboration brings people together, builds good working relationships and allows many groups to work together on high priority projects that one or few entities couldn't undertake on their own.

(Photo: Trout Unlimited)

The Ted Trueblood Chapter of Trout Unlimited has implemented several projects along the Boise River and its tributaries (including the above photo from Heron Creek) to improve habitat for trout, such as gravel augmentation for spawning, riparian planting, and bank stabilization projects.

Many of the enhancement solutions identified in this plan are not easily accomplished. Small projects are worthwhile as they can be achieved in a short time frame, illustrate concepts, involve citizens and agencies in river enhancement, and require less funding. Larger enhancement efforts intended to influence ecosystem processes require significant effort and expense but can have wide and long-lasting benefits. They often require involvement of multiple agencies and stakeholders, extensive political and public outreach, collaboration and compromise between numerous entities, and a programmatic approach over several years. Because of the level of investment required to achieve large-scale ecosystem enhancement, it's essential to undertake projects that provide multiple benefits. This can be achieved when the focus is on ecosystem process and function.

Part 3 identifies projects that provide multiple benefits and identifies organizations that have completed enhancement projects and where the projects are. Data gaps and important next steps are identified. Case studies from cooperative large-scale enhancement work in other watersheds are presented. Finally, the role the Boise River Enhancement Network will play in fostering enhancement through a collaborative approach is described.

> "Collaboration is the key if we are going to meet the many water challenges we face across the West."
>
> -Commissioner Michael L. Connor, BoR WaterSMART Program

Multiple Benefits

Boise River Enhancement Plan

The literature review, public input and expert review panel identified the key issues and most appropriate and effective enhancement solutions for each essential feature of the river ecosystem. Although each issue and site needs to be carefully analyzed on a case by case basis, including the political, economic and ecologic setting, actions that result in multiple benefits will provide the greatest enhancement of the river ecosystem. The river provides a diverse array of services to many user groups. Focusing on projects with multiple ecosystem benefits while providing for existing and future uses are most likely to be identified as "win-win" and successfully implemented.

Several issues are common across the ecological subject areas: channel modification; confinement and simplification; floodplain development and lack of connection to current hydrology; and poor water quality, among others. Ecosystem components are linked through physical and biological processes. By protecting and enhancing ecosystem function, all of the river components benefit.

The following approaches provide multiple benefits:

1. **Protect well-functioning areas and former floodplains that could be reconnected to the river.** The literature and experts agree: protection of functional areas is preferable to creation, restoration and enhancement of impaired landscapes. A secondary priority for protection is areas where the floodplain has been disconnected from the river, but reconnection is feasible. Setbacks, conservation easements, land acquisitions, special zoning or protective designations, land owner education and public land management are ways to protect these areas.

2. **Improve channel form and complexity with in-channel actions.** A complex stream channel with appropriate width-to-depth ratio and a diverse assemblage of habitat elements will benefit geomorphic function, fisheries, aquatic habitat and water quality. Actions include: upgrading instream structures to improve water delivery and reduce maintenance costs while benefiting sediment transport, fish passage (and reducing entrainment), habitat complexity and recreation opportunities; reducing the amount of wood removed from the river; and the placement of boulders, log jams or other instream structure elements.

3. **Improve riparian habitat and floodplain function by performing projects on existing floodplains and terraces.** Projects on floodplains and terraces can be implemented to reconnect the floodplain to the river's current hydrology. Flood risk can be reduced and riparian habitat increased in area and function. Excavation of floodplain surfaces, lowering or setting back existing levees and berms, and removing barriers to stranded side channels are effective strategies. Performing riparian and wetland enhancement projects like planting of natives and removal of invasive and non-natives will further enhance riparian habitat.

4. **Improve water quality by reducing pollution at the source.** Improved water quality benefits fisheries and aquatic life, geomorphic processes, and creates a safer environment for citizens to enjoy the river. On-site actions include proper maintenance and timely retirement of septic systems and sewage lines; the use of green stormwater infrastructure or other stormwater pollution reduction techniques; and agricultural best management practices such as prescribed grazing, irrigation improvement, conservation tillage and precise application of manure, fertilizer and pesticides.

5. Improve water quality by utilizing "end of the pipe" techniques. Re-use of irrigation drain water and construction of settling ponds, wetlands and treatment facilities that intercept, filter and/or treat polluted water will improve water quality in the Boise River. These kinds of projects are attractive for off-site mitigation or pollution credit trading. Enhancement or planting of streamside vegetation, where possible, will also help buffer the river from sediment and nutrient runoff and provide shading.

(Photo: The Land Group)

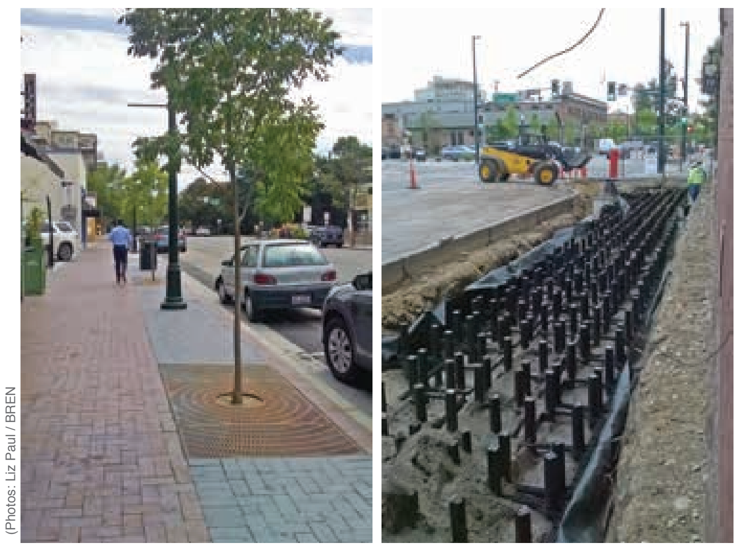
Riparian buffer enhancement at Brighton Park Place includes a wide and diverse buffer that extends along both sides of pathway and allows for periodic inundation of water. This is a cooperative project by the City of Boise, The Land Group and The Wetland Group.

(Photo: Derek Risso)

Channel confined by levee and rip-rap. Along much of the Boise River the channel is confined and simplified. Levees and rip-rap are designed to prevent channel migration and confine water to the main channel. The former floodplain is then disconnected from the river. Moving these types of structures back from the main channel and allowing the river to access the existing ground brings multiple benefits, including wetland and riparian development, increased habitat for fish and wildlife, and flood conveyance.

(Photo: Derek Risso)

Connected floodplain. This channel along the Boise River shown at low flow conditions is active at higher flows on a seasonal basis. Wetland and riparian vegetation is abundant along its edges, filtering pollution, creating habitat for wildlife, increasing flood conveyance and providing refuge for fish from high velocity flows.



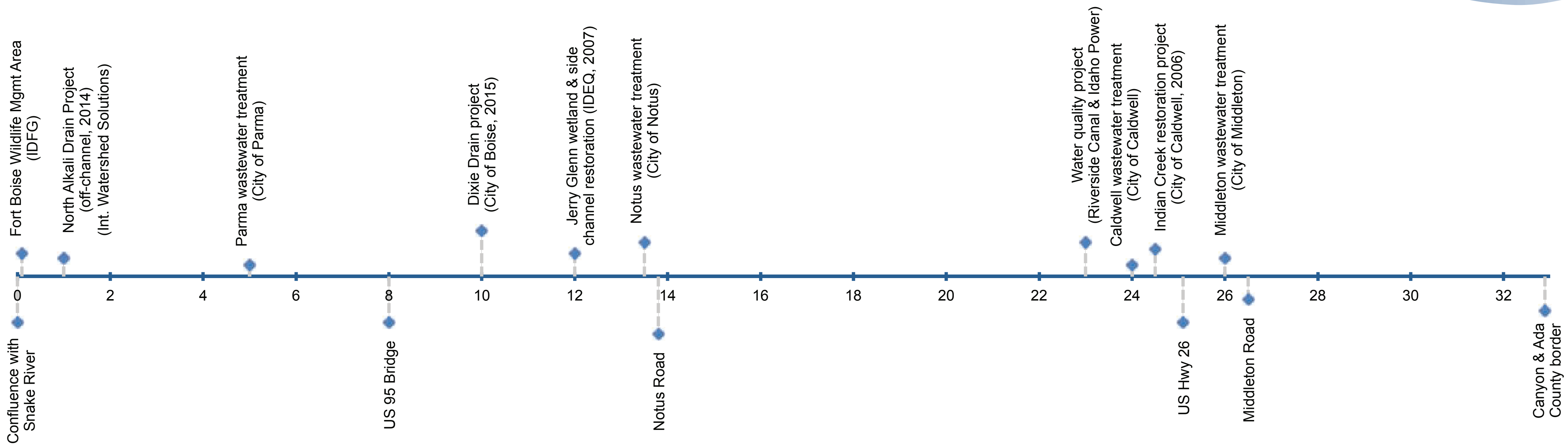
(Photos: Liz Paul / BREN)

Example of a cooperative green stormwater infrastructure project in downtown Boise. The Treasure Valley's tree canopy mitigates 125 million gallons of stormwater annually, saving $1.1 million in infrastructure costs. Green stormwater infrastructure projects, such as tree systems (under construction and completed shown above), permeable pavers, bio-swales and bio-retention areas intercept and treat stormwater before it enters the Boise River.

Enhancement Projects

Who is Doing What and Where

Canyon County



Enhancement Projects by river mile for Canyon County and Ada County with associated location markers, primary project partners and date of implementation.

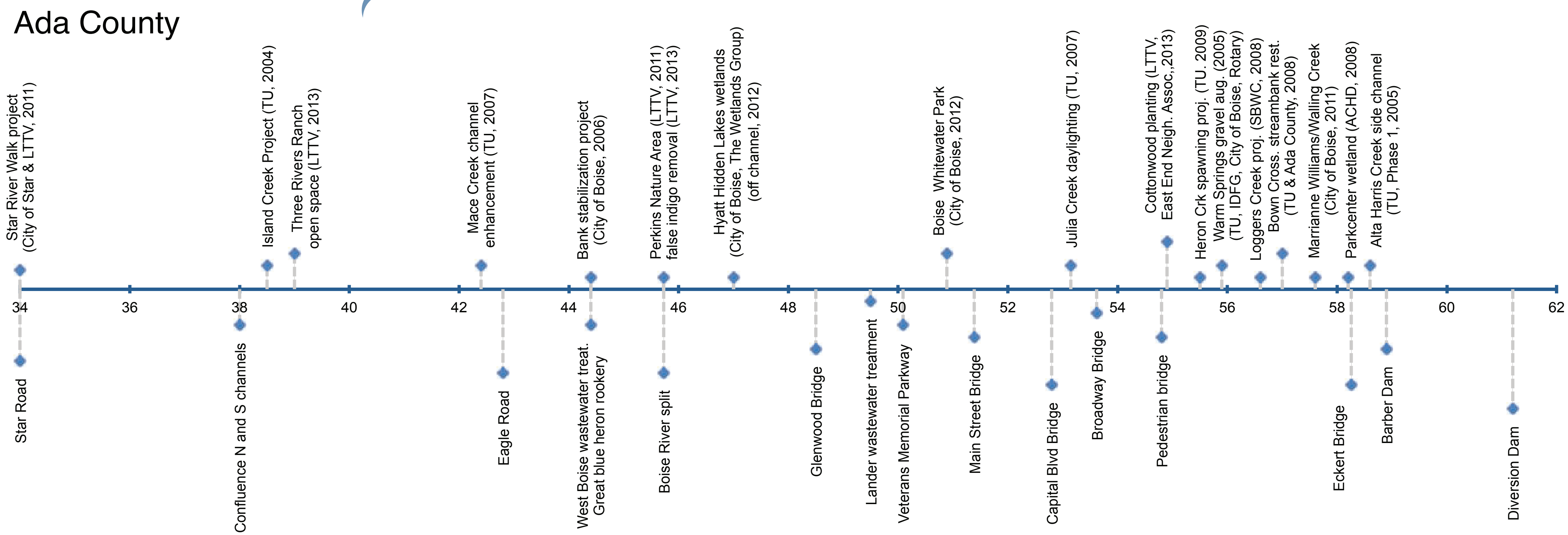
(Photo: Gary O. Grimm)

Meaningful enhancement will require coordinated efforts by multiple entities. This comprehensive plan will help focus enhancement on areas of greatest ecological priority.

The Boise River flows through two counties and eight cities. Three more cities are located on tributaries. As a result, the Boise River is shaped by the actions of multiple agencies and stakeholders. Over the past 30 years, numerous enhancement projects have been implemented to improve fisheries, water quality, and wetland and riparian habitat. Public and private interest in enhancement is increasing.

The public and private entities each play vital roles including:

- Identifying enhancement opportunities
- Planning, designing and implementing enhancement projects
- Contributing funding, expertise, volunteers and in-kind services (that can be leveraged for funding)
- Reviewing and issuing permits for projects
- Advocacy and education
- Monitoring the condition of the river
- Adopting policies (plans, laws and ordinances) that may aid enhancement projects



Data Gaps

There have been many investigations into the health and function of the River system. However, most have been narrowly focused, site specific and are now dated.

Enhancement actions can only be well designed and implemented when river processes and components are well understood. Throughout the planning process current data gaps were identified. Many are specific to the subject areas addressed in this Plan. Factors outside of the ecological systems influence river function and quality and need to be understood for effective long-term planning, including:

- Value of ecosystem services of the Boise River
- Recreation study including access, impact on resources, economic and health benefits
- Climate change preparedness and drought planning

Geomorphology

- Current channel geometry in relation to hydrology
- Site specific geomorphic analyses that identifies enhancement opportunities
- Accurate flow and inundation modeling below Glenwood Bridge
- System-wide substrate study, including sediment sources

Fisheries and Aquatic Habitat

- Assessment of fish populations, health, growth and mortality
- Aquatic habitat study, including survey of fish rearing and spawning areas
- Comprehensive assessment of benthic and macroinvertebrate species
- Monitoring and periodic peer review of fishery and associated habitat data
- Entrainment and fish passage study and prioritization of existing infrastructure for upgrade

Wetland and Riparian Habitat

- Comprehensive wetland and riparian survey
- Comprehensive wildlife use and habitat survey
- Invasive and non-native species survey
- Cottonwood/riparian analysis of current limiting factors and future conditions

Water Quality

- Comprehensive map of surface hydrology
- Expanded water quality monitoring (especially temperature and dissolved oxygen) over multiple season/ years throughout watershed
- Analysis of water quality in relation to discharge
- Expanded water quality analysis of point and non-point sources
- Monitoring of water quality trends in relation to BMP implementation
- Groundwater analysis, including extent, surface water and groundwater interaction, seasonal variation in groundwater movement, and septic system evaluation

(Photo: IDAK/Shutterstock)

Next Steps in Enhancement Planning

Information Sharing, Education and Outreach

- Create an action plan for volunteers, including a checklist of actions and citizen science projects
- Engage citizens through educational programs, gatherings and lesson plans
- Document and recognize actions relative to River enhancement, such as land-use plan approvals, county ordinances, and implementation of enhancement work
- Identify governmental and non-governmental entities and their roles
- Create an online map depicting jurisdictional, ownership, and/or regulatory boundaries
- Identify gaps in management and what is or is not being done
- Better understand who is doing what where
- Better understand who needs to be contacted for projects to be implemented
- Identify funding sources
- Ensure the right people/agencies are working together
- Facilitate coordination and collaboration
- Provide data, information and the BREN database via an interactive website
- Create a digital Enhancement Plan that includes hyperlinks to references
- Facilitate the sharing of project documents (budgets, work plans, reports, etc.)

Enhancement Project Identification and Prioritization

- Perform a reach-by-reach ecologic analysis and prioritization, including identification of agencies and organizations involved with that part of the river
- Establish a process to identify where projects can best be implemented and a post-project evaluation system
- Expand planning area to include river tributaries

Secure Funding to Plan and Implement Projects

- Explore cooperative funding opportunities
- Seek broad sources for funding and partnerships to include industries and businesses
- Design a programmatic enhancement plan that can be funded and implemented over a long time frame (20 years)

Successful Collaborative Watershed Enhancement

The following case studies highlight successful enhancement through collaborative efforts. All of these programs involve partnerships with landowners and funding through multiple sources; most include state and federal funding mechanisms that are not available within the Lower Boise Watershed. Therefore, creative collaboration among stakeholders is critical to fund and implement enhancement projects within the Lower Boise.

Case Study 1: Long Tom Watershed, Oregon

The Long Tom Watershed is located in western Oregon and drains the eastern side of the Coast Range. In 1998, the Long Tom Watershed Council was formed as a collaborative effort between a diverse group of stakeholders including farmers, foresters, anglers, businesses, scientists and conservationists. The Council primarily implements habitat restoration projects, such as fish passage, plantings for shade and habitat, and restoration of prairies, wetlands and oak savannas. In 2015, the Long Tom Watershed Council partnered with 10 private and non-profit entities, 10 public agencies, 64 private landowners and over 200 volunteers to implement enhancement projects, including replacement of 2 fish migration barriers; enhancement of 460 acres of rare oak, prairie and wetland habitat; and planting of over 40,000 native trees and shrubs within the watershed. The Long Tom Watershed Council also has an extensive survey and monitoring program to better understand the state of the watershed and to track program outcomes; this has helped leverage funds. The Council receives a significant amount of funding from the Oregon Watershed Enhancement Board (OWEB), a state agency that provides enhancement grants.

(Photo: Long Tom Watershed Council)

Ferguson Creek, a tributary to the Long Tom River.

Case Study 2: Henry's Fork Watershed, Idaho

The Henry's Fork watershed in eastern Idaho and western Wyoming encompasses 1.7 million acres and over 3,000 miles of rivers, streams and canals. Wild trout and aquatic habitat in Henry's Fork,

(Photo: Henry's Fork Foundation)

Henry's Fork of the Snake River, Idaho.

a tributary to the Snake River, has been of critical importance to the Henry's Fork Foundation (HFF) since its founding in 1984. HFF works collaboratively with landowners, state and federal agencies, irrigators, hydroelectric companies, conservation groups and other partners to preserve river access, maintain flow for wild trout while meeting water rights allocations and implementing enhancement projects. To facilitate cooperation and promote respect among diverse stakeholders, HFF and the Fremont-Madison Irrigation District created the Henry's Fork Watershed Council in 1994 to help resolve conflicts and to develop watershed-wide coordination and planning for research and enhancement. Funding for Watershed Council projects and administration was initially provided through the Henry's Fork Watershed Fund, established by the State of Idaho. In recent years, funding for Council activities has been obtained from grants, state and federal agency contributions, and private donations.

Case Study 3: Sandy River Basin, Oregon

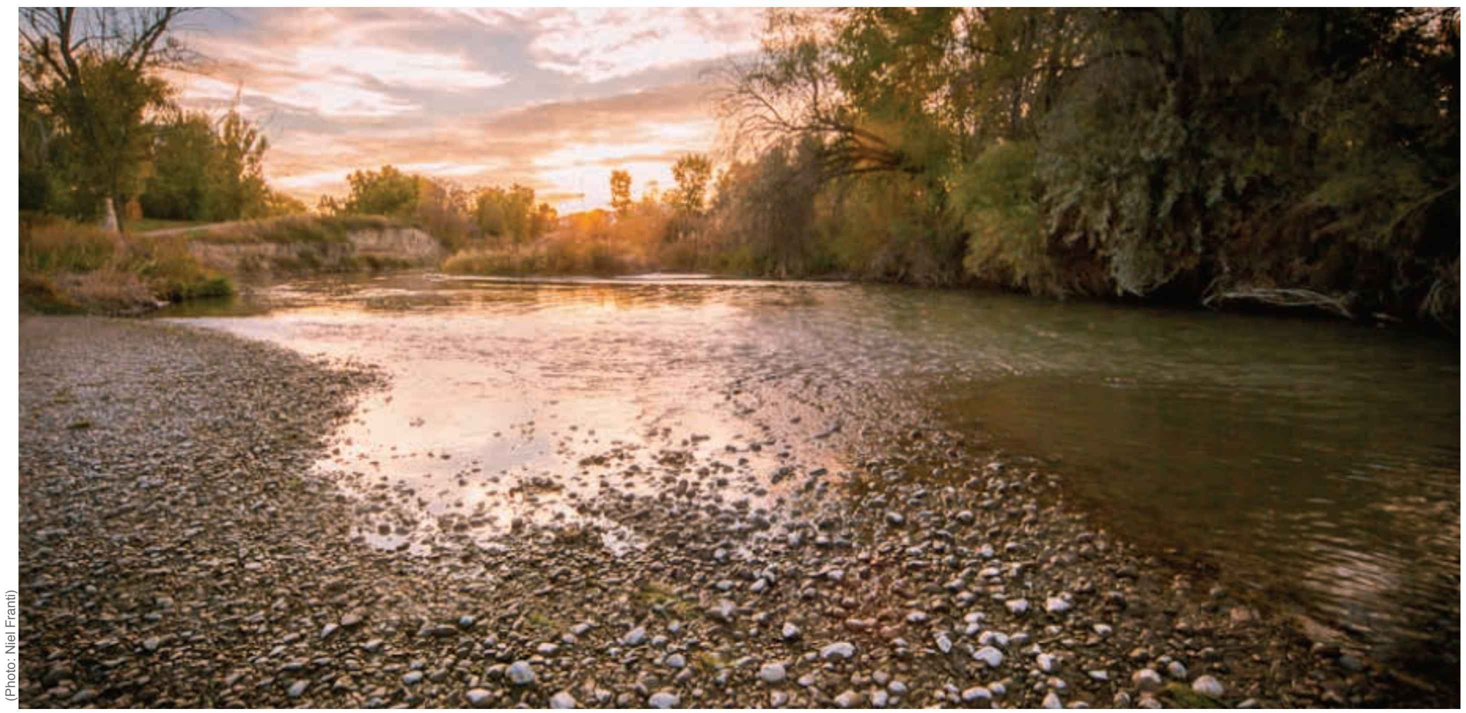
The Sandy River Basin is located adjacent to the Cascade mountain range in northwestern Oregon. The Basin has nearly 25 river miles designated as a National Wild and Scenic River and 12 miles designated as an Oregon Scenic Waterway. To restore salmon and steelhead habitat, The Freshwater Trust, a non-profit river restoration group, partnered with the Sandy River Basin Partners, a coalition of agencies, private interests and non-profit groups. Historic land use in the basin left Salmon River and Still Creek (ecologically significant tributaries of the Sandy River) straightened, disconnected from the floodplain, and without woody material instream – resulting in diminished habitat diversity and complexity. Through strong partnerships and a coordinated restoration plan, the partners are actively working to restore habitat at the basin-scale to contribute to the recovery of salmon and steelhead. Funding for this work has been provided by a diverse group of public and private entities.

Case Study 4: Jordan River Watershed, Utah

The Jordan River is located in northern Utah, flowing from Utah Lake through 15 cities and 3 counties into the Great Salt Lake wetlands. In 2010, the Jordan River Commission was formed to facilitate the implementation of Blueprint Jordan River, a comprehensive effort and vision to transform a neglected river corridor into a defining regional amenity. The visioning process involved over 3,000 residents from multiple stakeholder groups, technical experts, planners, state legislators, county commissioners, and leaders from private, non-profit and governmental organizations. The purpose of the Commission is to help various local governments and state agencies implement the projects identified in the Blueprint, raise public awareness, and help promote coordination and communication among stakeholders. The Commission is a governmental entity but all projects and efforts undertaken are funded by either grants or private donations. To date, the Jordan River Commission has leveraged over $13 million dollars to implement projects, including the support of a 45-mile trail along the Jordan River corridor. The inclusive stakeholder process has resulted in a widely embraced plan throughout the affected communities and state-wide.


(Photo: the Freshwater Trust)

Creation of log jam in Still Creek, Oregon.


(Photo: Niel Franti)

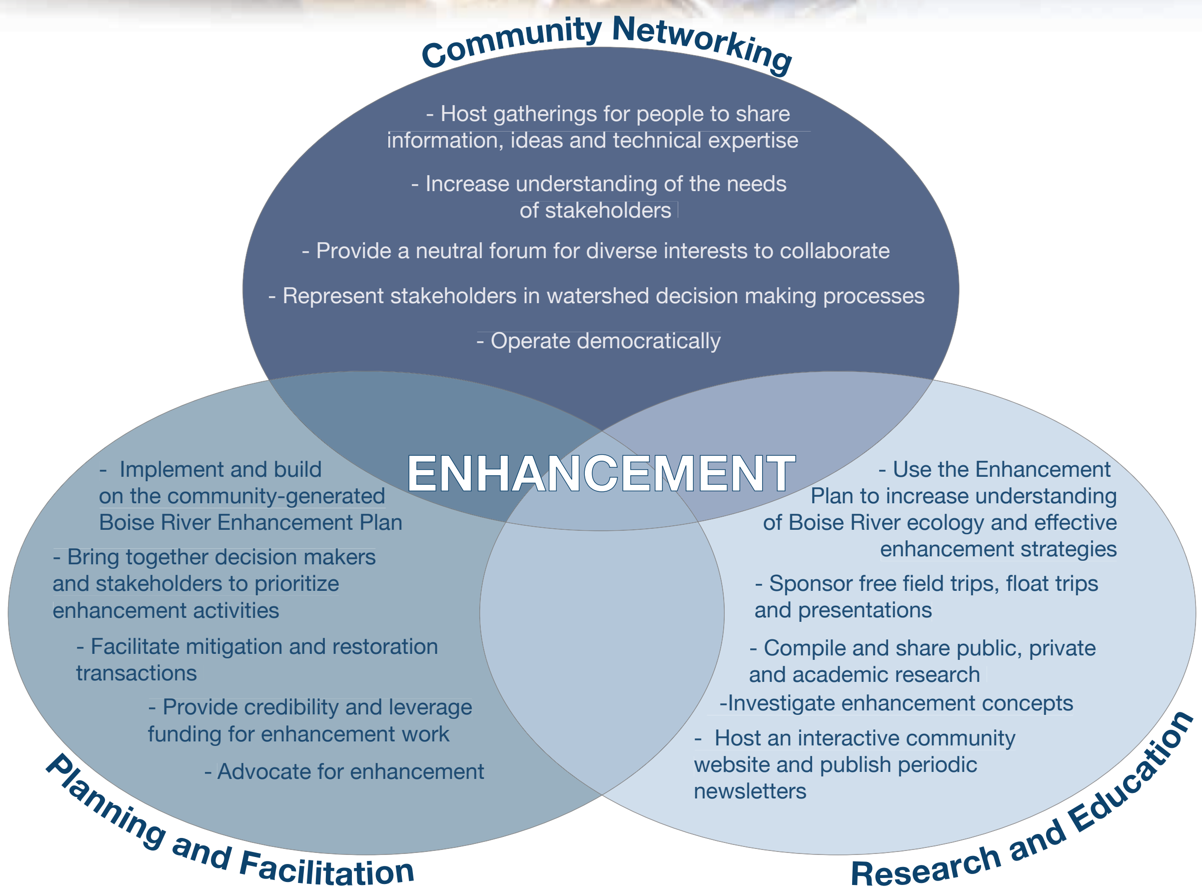
Jordan River, Utah

BREN's Collaborative Approach

The Boise River Enhancement Network (BREN) provides a forum for stakeholders to share information, ideas and technical expertise regarding the health of the Boise River. The Coordinating Team, elected by BREN members, represents a diverse group of stakeholders including agriculture, development, irrigation, recreation, advocacy and environmental consulting, among others. Stakeholder participation and support is vital to the creation and implementation of this Enhancement Plan and the sustainability of the Network. Through the use of this Plan, BREN will work to leverage funds and bring together decision makers and stakeholders to implement enhancement activities. An aggregator such as BREN can leverage partnerships created during the development of this Plan to continue the momentum towards a highly functioning Boise River.

(Photos: Liz Paul / BREN)

BREN hosts float trips and field trips along all reaches of the Boise River that serve to increase our understanding of the River's ecology and constraints to the system.



(Photos: Liz Paul / BREN)

Acknowledgments

Bureau of Reclamation WaterSMART Grant Team

Land Trust of the Treasure Valley

Role: Fiscal Agent, Outreach/Stakeholder Involvement

The LTTV is a 501(c)(3) non-profit organization that works to conserve natural, scenic, recreational and farm lands of the lower Boise River watershed. The LTTV owns land and easements along the Boise River and has conducted community based conservation planning for communities in the lower Boise Watershed.

Idaho Rivers United

Role: Structure, Internal Process, Sustainability, Outreach/ Stakeholder Involvement

IRU is a 501(c)(3) non-profit organization located in Boise, Idaho whose members' use and enjoyment of the Boise River is significantly impacted by water quality and quantity. IRU is capable of promoting sustainable use of water resources through their established education, outreach and citizen advocacy programs.

The South Boise Water Company

Role: Outreach/ Stakeholder Involvement

The SBWC is an irrigation ditch company with water delivery authority incorporated in the state of Idaho in 1917 that diverts water from the lower Boise River for multiple uses. Company shareholders affect, and are affected by, the quality and quantity of the Boise River, and the Company promotes the sustainable use of water resources.

The Ted Trueblood Chapter of Trout Unlimited, Inc.

Role: Data acquisition, Enhancement Concept Identification

The Ted Trueblood Chapter of Trout Unlimited, Inc. is a subsidiary of TU, a national conservation organization, a recognized 501(c)(3) non-profit organization. The 800 members of this Chapter conserve, protect and restore trout and salmon fisheries and their watersheds through habitat restoration projects and education programs in southwest Idaho.

Ecosystem Sciences Foundation

Role: Data acquisition, Enhancement Concept Identification, Literature Review, Enhancement Plan Development, Design, Layout, Graphics and Production.

ESF is a 501(c)(3) international environmental science and design organization dedicated to bridging the gap between scientific disciplines and resource management strategies. The Foundation advocates the wise application of science and design to protect the environment and uses a collaborative and multi-disciplinary approach to solving watershed management challenges.

Contractor

Mountain Visions

Role: Development of BREN website and newsletter

Mountain Visions specializes in creating immersive, interactive, 360 degree photographic and multi-media "virtual explorations" of outdoor landscapes for collaborative partnership groups.

Partner

Idaho Water Resources Research Institute

Role: Outreach/ Stakeholder Involvement

IWRRI was established in 1963 by the University of Idaho Board of Regents. They support and direct water research for the State of Idaho and the region.

Expert Reviewers

Thank you to all of the expert reviewers who gave of their time and insight for each of the following sections:

Geomorphology

Fisheries and Aquatic Habitat

Wetlands and Riparian Habitat

Water Quality

Coordinating Team

Chair: Tamsen Binggeli, Ecologist,
Ecosystem Sciences Foundation

Vice-chair: Doug Fowler, Project Manager, Harris Ranch

Secretary/Treasurer: Tim Breuer, Executive Director,
Land Trust of the Treasure Valley

Members:

Alan Winkle, Board member, Boise City Canal Company

Alex Johnson, Senior Freshwater Solutions Director,
The Freshwater Trust

Derek Risso, Watershed Ecologist,
Ecosystem Sciences Foundation

Gary Grimm, Multimedia communication and
environmental networking, Mountain Visions

Julie Scanlin, Education and Outreach,
Idaho Water Resources Research Institute

LeeAnn Garton, Board member,
South Boise Water Company

Liz Paul, Campaign Coordinator, Idaho Rivers United

Michael McConnell, Environmental Scientist,
Idaho Habitat Works

Mike Somerville, Farm owner, Canyon County

Tom "Chel" Chelstrom, Boise River recreation

Special Thanks to:

Rob Richardson and Jimmy Guilinger for their efforts on the Geomorphic Assessment, feedback and expert input throughout the process.

Boise River
Enhancement Plan

Boise River Enhancement Network