STRATEGIC ACTION PLAN

Harney Basin Wetlands Collaborative

Harney Basin Wetlands Collaborative, a working group of High Desert Partnership, utilizes collaboration to integrate social, economic and ecological values in support of wetland conservation in the Harney Basin.

HARNEY BASIN Wetlands COLLABORATIVE

HIGH DESERT Partnership

January 2022

PHOTOS BY JEREMY HILL, JHILLIMAGES.COM

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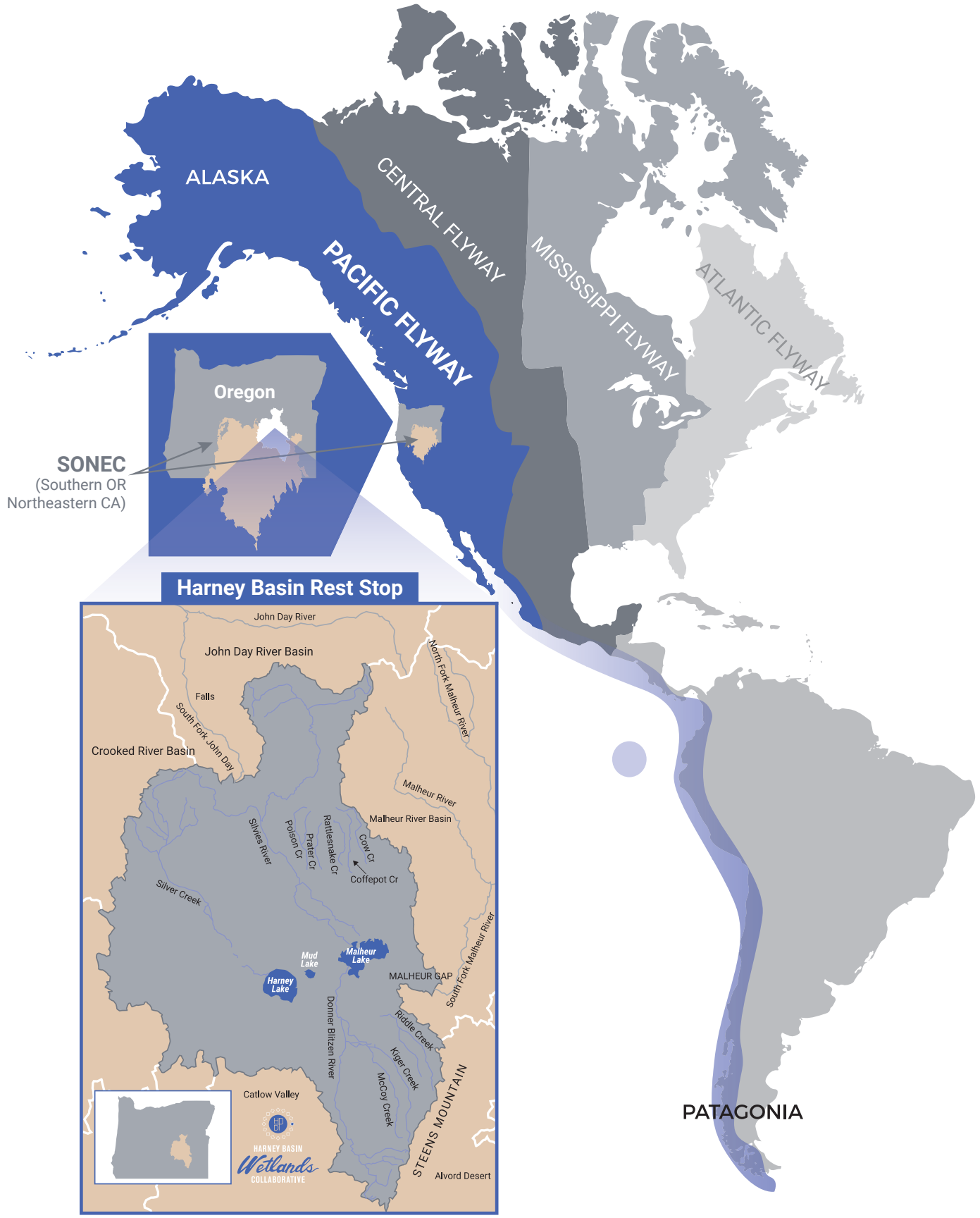
1. Executive Summary

The Harney Basin Wetlands Collaborative (HBWC) was formed in 2011, as a collaborative effort to improve the aquatic health and sustainability of Malheur Lake, and the wild flood-irrigated wet meadows across the Harney Basin. For millennia Malheur Lake was a marshland that provided waterbird habitat for migratory and resident birds by the millions. The marshland was described as having "vast quantities of submerged and emergent aquatic vegetation" (Deubbert, 1969). But after the extensive flooding in the mid 1980's and increased abundance of common carp, Malheur Lake changed dramatically. Emergent and submergent vegetation declined and Malheur Lake water became more and more turbid. The focus of the HBWC is to understand and reverse the declining quality of this critical marsh system to ensure the future bird habitat of the Harney Basin.

The receding Pleistocene Lake Malheur left an area affected by seasonal precipitation and extensive marshland that was the foundation for millions of migratory birds, providing both migratory and breeding habitat. Malheur Lake and wetlands were central to the Wadatika people. When the cattle kings came to the Harney Valley in the 1870's, they found floodplain meadows producing wild hay for winter feeding that teemed with bird life. The ranchers expanded the wet meadows by flood irrigating which added to the habitat for migratory and breeding birds. The practice of flood irrigation continues to this day, taking advantage of the spring runoff from the surrounding mountains. After a century of changes to the landscape and introduction of exotic species, Malheur Lake and the surrounding wetlands have changed. Additionally, the climate is changing, affecting runoff amounts, and timing. All these changes threaten both the ranch economy and the bird life that are dependent on these habitats. The HBWC is building an understanding of the impacts of varying water regimes on wet meadow plant communities and working with landowners to implement new irrigation infrastructure improvements and water management techniques to improve the ability to respond to changing conditions of water availability.

GREAT WONDER OF THE WEST

Every year, millions of birds use the Harney Basin as a rest stop on their migratory journeys, both spring and fall, on what is called the Pacific Flyway. An estimated 70 percent of migratory birds—including over 6 million waterbirds—annually pass through the Southern Oregon Northeast California (SONEC) region, which includes the Harney Basin wetlands. Considered one of the most significant flyways in North America, birds come to rest and refuel, using both land and water in all parts of the basin, with large concentrations converging on the Malheur National Wildlife Refuge which encompasses Malheur Lake within its boundaries.


ALASKA
CENTRAL FLYWAY
PACIFIC FLYWAY
MISSISSIPPI FLYWAY
ATLANTIC FLYWAY
Oregon
SONEC
(Southern OR
Northeastern CA)
Harney Basin Rest Stop
John Day River
John Day River Basin
Falls
South Fork John Day
Crooked River Basin
North Fork Malheur River
Malheur River
Malheur River Basin
Silvies River
Poison Cr
Prater Cr
Rattlesnake Cr
Cow Cr
Coffepot Cr
Silver Creek
Mud Lake
Malheur Lake
Harney Lake
MALHEUR GAP
South Fork Malheur River
Donner Blitzen River
Riddle Creek
Kiger Creek
McCoy Creek
STEENS MOUNTAIN
Catlow Valley
Alvord Desert
HARNEY BASIN
Wetlands
COLLABORATIVE
PATAGONIA

Outside of the Malheur National Wildlife Refuge, private flood irrigated wet meadow ranch lands provide critical habitat for this important bird migration. Traditional flood irrigation practices that spread shallow water across the Harney Basin's hay meadows every spring create conditions that mimic historical flood regimes that support migrating and breeding birds. These private working lands are one of the cornerstones of Harney County, supporting families and feeding the local economy. In the central part of the Pacific Flyway, which includes the Harney Basin, private land comprises 75% of the wetland habitat.

BUT THE BASIN IS UNDER STRESS

Malheur Lake, the largest freshwater marsh in the arid west, has been plagued with an over-abundance of invasive common carp. These non-native fish feed on and uproot the aquatic plants that once made Malheur Lake an immensely productive freshwater marsh for birds and other wildlife. Adding to the decline of aquatic vegetation, powerful persistent winds resuspend sediment making it difficult for aquatic plants to re-root or grow in Malheur Lake because the muddy water keeps sunlight from reaching them. And the problems are not just in Malheur Lake. Outdated and deteriorating irrigation infrastructure is making it increasingly difficult to sustain the traditional method of forage production using wild flood irrigation. Adding to the stress is increasing frequency of drought and increasing evapotranspiration reducing available spring flows for flood irrigation. Lessening snow accumulation patterns affect runoff amounts and timing and in turn duration and availability of water for irrigating meadows. Increased understanding of the hydrology of the basin and the management patterns and timing of water use will help to develop and implement new techniques and timelines to support the long term conservation of flood irrigated wet meadow habitats in the Harney Basin. Recent evaluations of climate change on wetlands across the arid west (Donnelly et al., 2020; Haig et al., 2019) have documented declining wetland habitats and raise the concern of loss of flyway connectivity particularly wetlands in snowmelt dominated watersheds like the Harney Basin.

YET THERE IS HOPE

The HBWC is focused on improving aquatic health and maintaining wet meadow habitats throughout the watersheds for Harney and Malheur Lakes and the streams and rivers that flow into them. The collaborative effort includes conducting research that will help guide decisions toward restoring Malheur Lake. It's also supporting landowners as they make changes in water and vegetation management, water management infrastructure upgrades and adding and/or moving fencing to support changes in when and where their livestock graze. The Harney Basin has an advantage over other majored Lakes Basin Wetland systems in the Pacific Flyway since the distribution of senior water rights to the Donner Und Blitzen River (hereinafter, Blitzen River) that feeds Malheur Lake are located either on the Malheur National Wildlife Refuge, providing some assurance that water will be provided to the Blitzen floodplain and Malheur Lake. Across the west, historic and current water policies have divided communities, and in certain watersheds, made it near impossible to address complex water centered resources challenges. The Harney Basin's challenges are not insurmountable because of the unified partnership working to address the impacts of climate change by building a more resilient Basin for all water users. The collaborative has built relationships with irrigators and there is increasing momentum behind improving irrigation infrastructure. Along with increased community engagement, the understanding of the ecological science of both the Malheur Lake and flood irrigated wetlands has increased significantly over the last few years.

HIGH DESERT PARTNERSHIP'S ROLE

High Desert Partnership (HDP) is a community-based nonprofit that brings people together to cooperatively solve local issues before those issues reach crisis. HDP supports those passionate about finding common ground solutions to issues that impact Harney County and beyond, by fostering a culture of collaboration and giving people the tools and opportunities they need to work together.

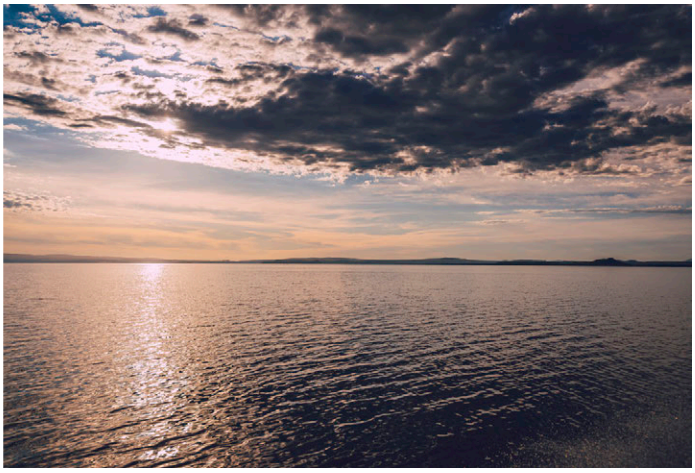
Since 2005, HDP has facilitated a unique and effective collaborative decision-making process that brings diverse stakeholders to the table. What often starts over cups of coffee, leads to well thought-out solutions developed by and for the community. HDP has learned over the years how important relationships and building trust are in helping people with diverse values and perspectives work together. Currently stewarding six collaborative groups, including HBWC, HDP is addressing the economic opportunities, environmental wellbeing, and community interests that together strengthen the Harney Basin's rural way of life—something HDP hopes to continue for many generations.

2. Introduction

Harney Basin Wetlands Collaborative's (HBWC) work focuses on critical habitat of the Closed Lakes Basin Wetlands in Harney County, supporting the needs of the local community and creating positive impacts that stretch far beyond this basin.

TWO FOCAL POINTS FOR HBWC

1. Restore the vital ecological functions and habitats of Malheur Lake to a healthy and productive clear-water state with abundant emergent vegetation restored.
2. Promote and enhance flood irrigated land use in the Harney Basin to maintain wet meadow conditions favorable to a wide-range of wildlife and maintain the agricultural value of these lands.



Photos by Jeremy Hill, jhillimages.com

Malheur Lake is part of a network of wetlands within Harney County's Closed Lakes Basin Wetlands representing a unique chain of desert oases along the Pacific Flyway that provide critical habitat and food sources for migratory and breeding birds, waterbirds, and wildlife, as well as naturally clean and filtered water. The flood-irrigated working wet meadows of the Harney Basin, in addition to providing valuable livestock forage and hay and food and habitat resources for wetland wildlife, also serve as surrogate floodplains in this hydrologically altered system. The land use ensures the continuity of floodplain functions and processes such as aquifer recharge, stream discharge, water quality filtration and flood attenuation. From the beginning of HBWC, partners agreed that the conservation of wet meadow systems on private ranch lands had to be based on the joint ability to sustain viable ranching operations and provide flooded fields for migratory and resident birds. Flood irrigated wet meadows are a critical component of many ranching operations in the Harney Basin, providing low-cost forage to landowners for supplemental feeding that is necessary to sustain livestock through the winter months.

LEARN MORE >

This plan updates the 2015-2021 Strategic Action Plan for HBWC. HBWC partners have been dedicated to addressing the complex problems of Harney Basin lakes and wetlands, a Closed Lakes Basin, since the completion of the Malheur National Wildlife Refuge Comprehensive Conservation Plan in 2013 (MNWR, 2013).

WHAT WAS ACCOMPLISHED BY PREVIOUS FIP FUNDING?

OWEB awarded $6,347,524 in funding that leveraged $2,198,891 in matching funds for HBWC. This funding made it possible for several benefits for the Harney Basin to be achieved:

- Increased knowledge and understanding of the distribution and behavior of invasive carp and methods to control them to restore Malheur Lake.
- Developed a shared science systems approach model to understand unique interactions in this important closed basin lake ecosystem that offers the collaborative a way to prioritize projects to implement and where resources can best be utilized.
- Improved the understanding of water table and plant community dynamics in flood irrigated wet meadows with new tools for land managers to adapt to changing climatic conditions.
- Added new irrigation infrastructure to enhance and increase best management of flood irrigated wet meadows to promote both wildlife and ranching.
- Building community in Harney County by engaging landowners, community groups, and partners to increase interest in and support for local conservation and a new natural resource economy.
- Coordinated monitoring approach among multiple partners to measure progress and quantify outcomes.

IMPLEMENTATION RESULTS

Metrics represent those completed or funded for biennia 2 and 3.

RESTORATION

- 4000 acres of flood irrigated wet meadow habitat enhanced through infrastructure improvements.
- 2 dilapidated in-stream irrigation infrastructures replaced with addition of 2 fish ladders installed for fish passage when the system is cleared of invasive carp.
- 1 automated flood irrigated wet meadow infrastructure installed to deliver irrigation across 300 acres of spring migratory bird habitat and hay production fields.
- 654 acres of floodplain habitat connected.
- Significantly improved understanding of ecological drivers affecting the turbid state of Malheur Lake with changed perspectives on restoration opportunities.

PLANNING

- 5 technical designs for flood irrigation infrastructure upgrades completed.

SCIENTIFIC INVESTIGATIONS

- Completed Malheur Lake restoration feasibility analyses and collaborative summit to determine best options for next restoration projects.
- Implemented mesocosm studies (bounded and partially enclosed outdoor experiment to bridge the gap between the laboratory and the real world in Malheur Lake to evaluate different restoration approaches).

- Developed state and transition model and explanation tools to communicate increased knowledge about wet meadow ecosystem change, especially the implications for management of flood irrigated wet meadow plant succession under changing climate conditions and water management.

MONITORING

- Completed aquatic health basin-wide study for several water quality metrics.
- Completed basin-wide fish distribution study to understand baseline fisheries, including eDNA sampling.
- Completed avian habitat relationships study to understand plant community and water regime response by avian species.

ENGAGEMENT

- Audiences engaged: Harney County residents, K-12 students, landowners and ranchers, Malheur National Wildlife Refuge visitors, science communities, state and regional birders. Key to HBWC engagement is meeting people where they are and practicing social equity in engagement through the use of at least 10 communications channels that includes in person and online interactions. These channels form a network of communications that can spread exponentially.
    - Tours, events, festivals, workshops, one-on-one interactions, e-newsletters, articles, social media, films, radio interviews and profiles of collaborating partners all serve to meet people where they are in their understanding of HBWC's efforts.

WHAT CAN BE EXPECTED FROM THIS UPDATED STRATEGIC ACTION PLAN?

The updated action plan remains focused on the two ecological priorities of the 2015 strategic action plan. The original 2015 strategic action plan for HBWC was built around the concept that Malheur Lake degraded conditions were controlled by invasive carp populations and the assumption that conservation easements were necessary to protect flood irrigated wet meadows. The updated action plan takes what has been learned about these systems and broadens the understanding of factors that can affect restoration opportunities.

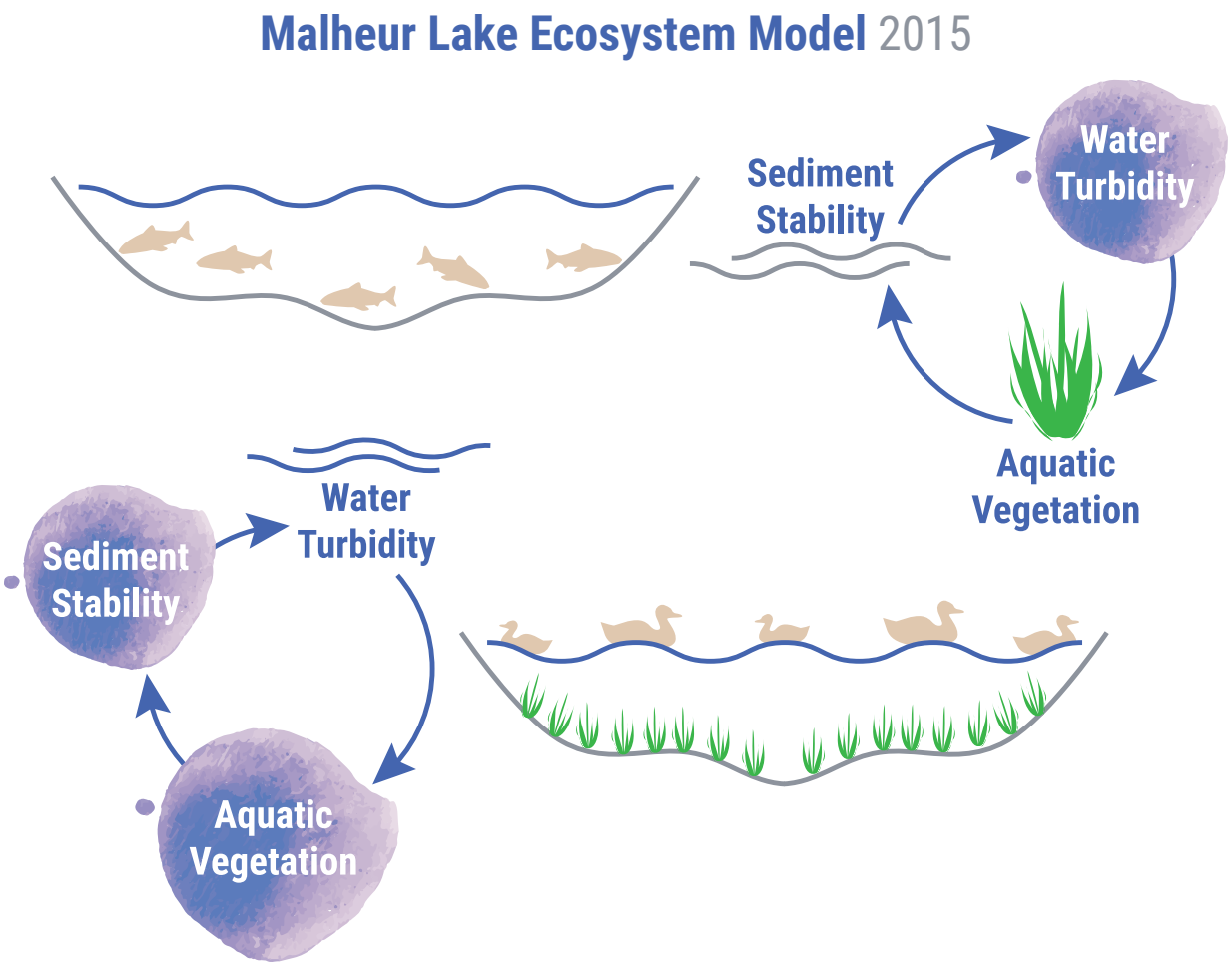


Figure 1. The original carp-focused Malheur Lake ecosystem model was relatively simple.

In 2016, HDP was awarded Oregon Watershed Enhancement Board's (OWEB) Focused Investment Partnership (FIP) funding to support proposed conservation actions of HBWC as outlined in the 2015-2021 HBWC strategic action plan. This funding has been instrumental in considerably expanding the collaborative's understanding of the complex aquatic systems in the Harney Basin lakes and wetlands. The work from the FIP effort has increased the HBWC's awareness and concern over climate driven increases in the variability of water delivery to the valley bottom floodplains and lakes. It has also been recognized that the management of water resources is central to the maintenance and restoration opportunities for both floodplain wet meadows and Malheur Lake.

Malheur Lake Ecosystem Model 2018

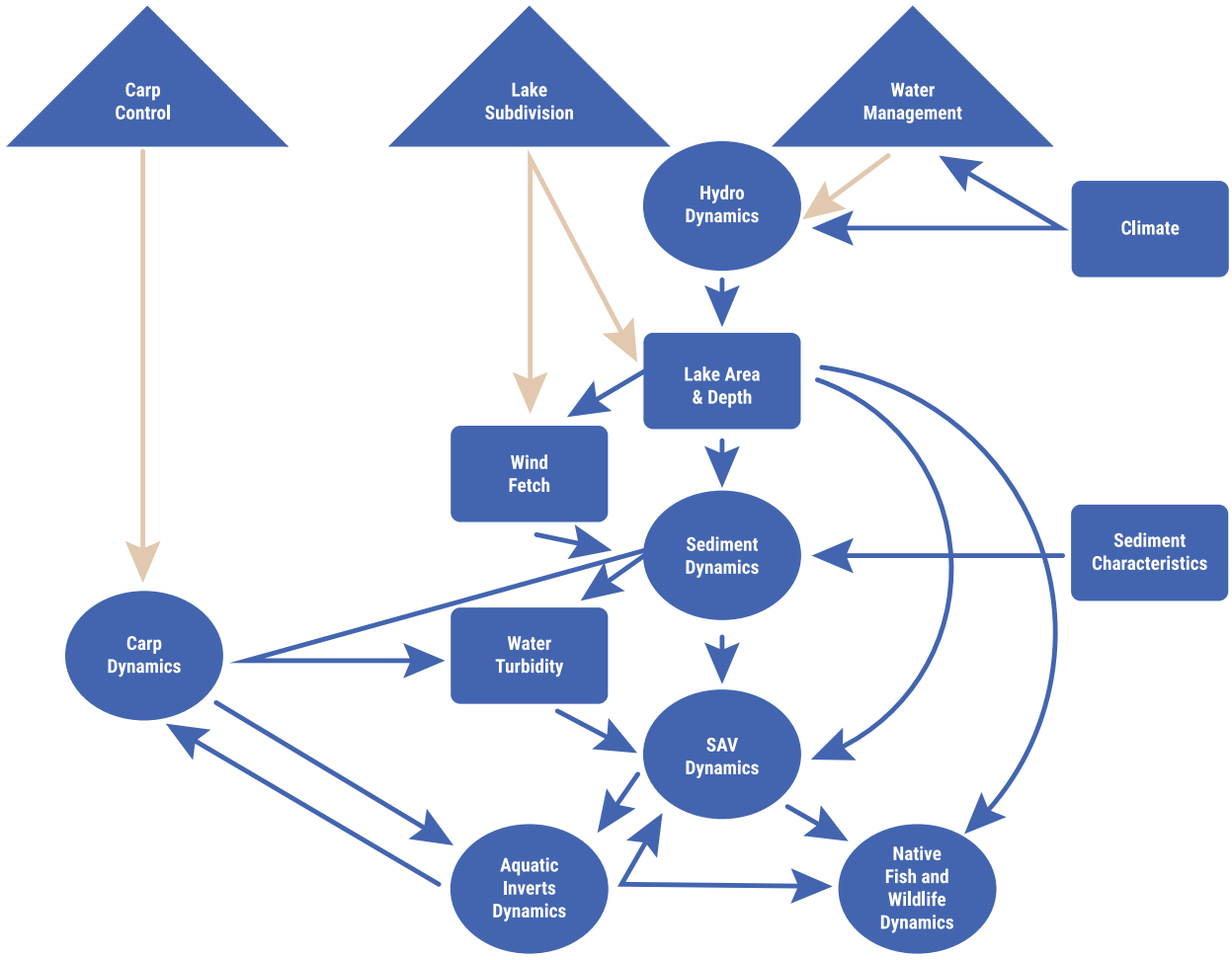


Figure 2. The 2018 Conceptual Systems Model of Malheur Lake added several additional elements in order to develop more effective lake restoration strategies.

MALHEUR LAKE ECOSYSTEM

The in-depth study of invasive carp populations in Malheur Lake has demonstrated that the control of carp as a sole means of lake restoration is unlikely to be effective. To achieve lake restoration, more effective carp control measures must be employed, and additional complementary restoration strategies need to be explored. HBWC is utilizing a more complex systems model of Malheur Lake to better understand mechanisms beyond carp that may be contributing to the current condition of Malheur Lake, undermining assumptions of the initial HBWC strategic action plan. As our understanding of the factors affecting the ecological conditions of Malheur Lake improves, a more complex set of relationships have been identified (Figure 3).

Malheur Lake Ecosystem Model 2020

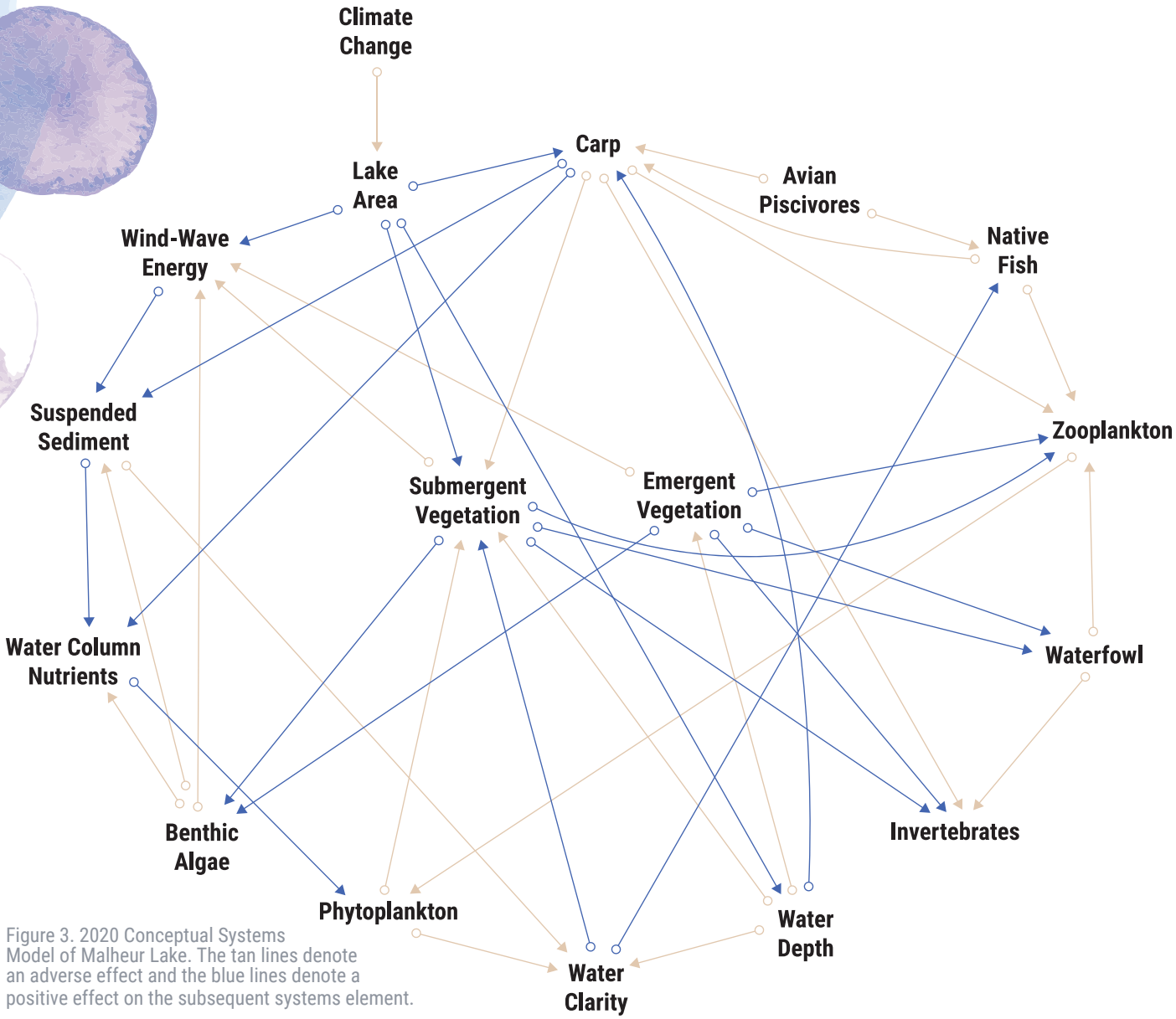


Figure 3. 2020 Conceptual Systems Model of Malheur Lake. The tan lines denote an adverse effect and the blue lines denote a positive effect on the subsequent systems element.

The more complex systems model of Malheur Lake results from targeted research to identify opportunities to improve lake conditions. The results have helped to build a better understanding of wind-wave resuspension of sediment, emergent vegetation limitations, phytoplankton growth, and the significant roles these factors play in maintaining the turbid state of Malheur Lake. These interdependent process-level relationships were unexplored when the Malheur National Wildlife Refuge Comprehensive Conservation Plan (USFWS, 2013) and the HBWC strategic action plan (HDP, 2015) were developed.

HARNEY VALLEY FLOOD IRRIGATED WETLAND ECOSYSTEM

Likewise, the view that perpetual conservation easements could significantly contribute to the maintenance of flood-irrigation land use in the Harney Basin has changed. In combination with relatively negligible development pressure, conservation easements have been relegated in priority by the broader collaborative. HBWC partners remain committed and capable of providing support to landowners that express interest. And

if circumstances develop that warrant reassessing the value of conservation easements, the collaborative remains poised to respond.

Recognition that interplays between hydrology and water management drive the abundance and distribution of wet meadow habitats in the Harney Basin has led to HBWC's interest in engaging with the community effort to develop a place-based water resource plan for the Harney Basin.

Increased knowledge of working wet meadow ecology has directed HBWC focus towards irrigation management, as dictated by seasonal hydrology. Water management decisions made by individual landowners influences meadow composition and food resource quality, for both livestock and wetland wildlife. Conversations among landowners and plant ecologists suggest a cultural shift in traditional water management is possible. Many landowners are observing the proliferation of undesired species, principally reed canarygrass. Ongoing work proposes to demonstrate a more judicious application of surface water on meadows will result in a more productive and desirable plant composition. However, judicious use of water in an agricultural landscape usually limited by water will require a solid demonstration of results to upend the cultural use of water. HBWC is working to make those demonstrations and resulting information available to landowners. Projects implemented by HBWC partners have modernized the water distribution system facilitating better management control of flood irrigation water. The Sweek Dam is one example of this.

Although HBWC has learned much about Malheur Lake and the wet meadow floodplains in the basin the original goals are still the same:

1. Return Malheur Lake to a clearwater state and improve habitat for nesting and migrating birds.
2. Maintain and enhance the existing flood irrigated wet meadows on and off Malheur National Wildlife Refuge which provides vital habitat for spring migrating water birds including cranes, waterfowl and shorebirds.

The new Sweek Dam along the Silvies River completed fall of 2019. Photo by Jeremy Hill, jhillimages.com.

3. Collaborative Partnership and Roles

HIGH DESERT PARTNERSHIP AND THE HARNEY BASIN WETLANDS COLLABORATIVE

In Harney County's remote Eastern Oregon landscape, there is a vastness only found in the high desert. This is where a local economy, healthy lands and water, and community wellbeing are inextricably linked. In the face of unique threats and challenges to Harney County's system of Closed Lakes Basin Wetlands, HDP's model of collaborative problem-solving respects this linkage and spurs further innovation to redefine what will best restore its landscapes while benefiting the community. The wetlands of the Malheur National Wildlife Refuge and the private ranch lands of the semi-arid Harney Basin are critical to migratory and resident birds of the Pacific Flyway that use the Malheur National Wildlife Refuge and adjacent private ranch lands. This gathering of wildlife attracts visitors from around the region and around the world.

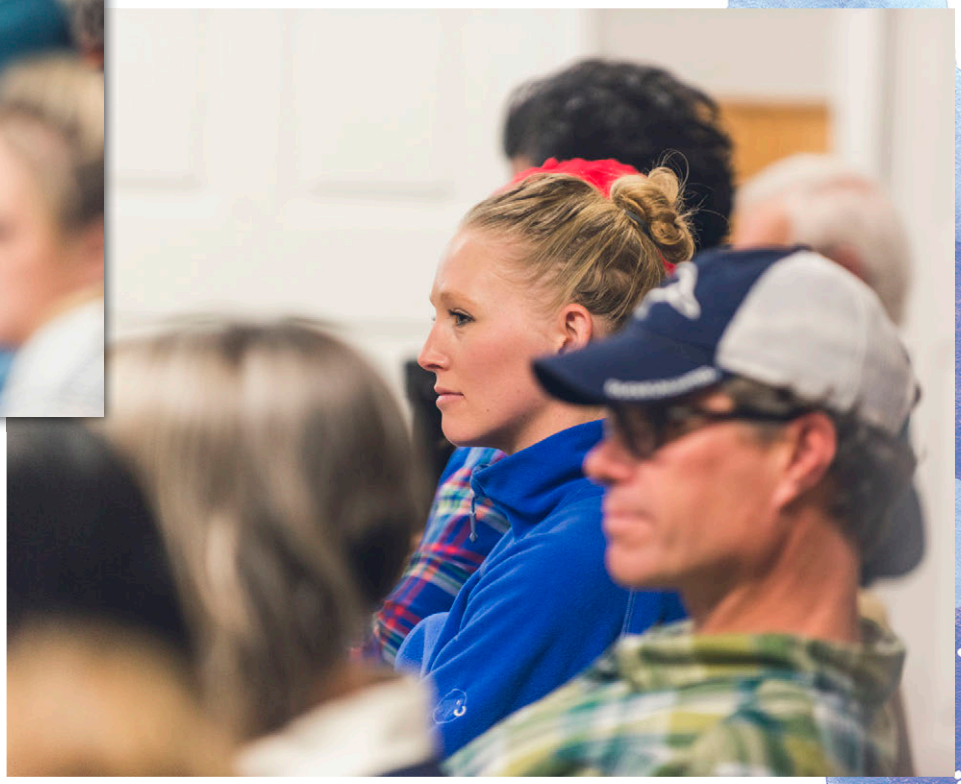
HDP is a community-based nonprofit that brings people together to cooperatively solve local issues before those issues reach crisis. HDP supports those passionate about finding common ground solutions to issues and opportunities that impact Harney County and beyond, by fostering a culture of collaboration and giving people the tools and opportunities they need to work together.

Part of downtown Burns with views of the Harney Basin beyond.

Photo by Jeremy Hill, jhillimages.com.

Since 2005, HDP has facilitated a unique and effective collaborative decision-making process that brings diverse stakeholders to the table. What often starts over cups of coffee, leads to well thought-out solutions developed by and for the community. HDP has learned over the years how important relationships and building trust are in helping people with diverse values and perspectives work together. Currently stewarding six collaborative groups, including HBWC, HDP is addressing the economic opportunities, environmental wellbeing, and community interests that together strengthen the Harney Basin's rural way of life—something HDP hopes to continue for many generations.

Formed in 2011 as HDP's third collaborative, HBWC is a coalition of ranchers, conservation organizations, the Burns Paiute Tribe, government agencies, technical experts, and others focused on improving the aquatic health and sustainability of Malheur Lake and the flood irrigated wet meadows of the Harney Basin. Its objective is to bolster the health of this wetland ecosystem, while finding solutions that also benefit the economic and social needs of the community. HBWC does this by continuing to come together through a collaborative decision-making process to address complex issues and find common ground solutions.



HBWC partners and HDP staff participating in a HBWC collaborative meeting.

Photos by Jeremy Hill, jhillimages.com.

ABOUT HARNEY BASIN WETLANDS COLLABORATIVE AND IT'S GUIDING STRUCTURE AND PRINCIPLES

Partners have a history of effective collaboration built upon shared experience, good working relationships, trust, and open communication. The following working agreements describe the commitments of partners to each other, the collaborative process used to conduct the work of HBWC, and implementation of HBWC's strategic action plan (Figure 4). With approval of the full collaborative, the working agreements may be revised as needed to meet the changing needs of HBWC and its partners.

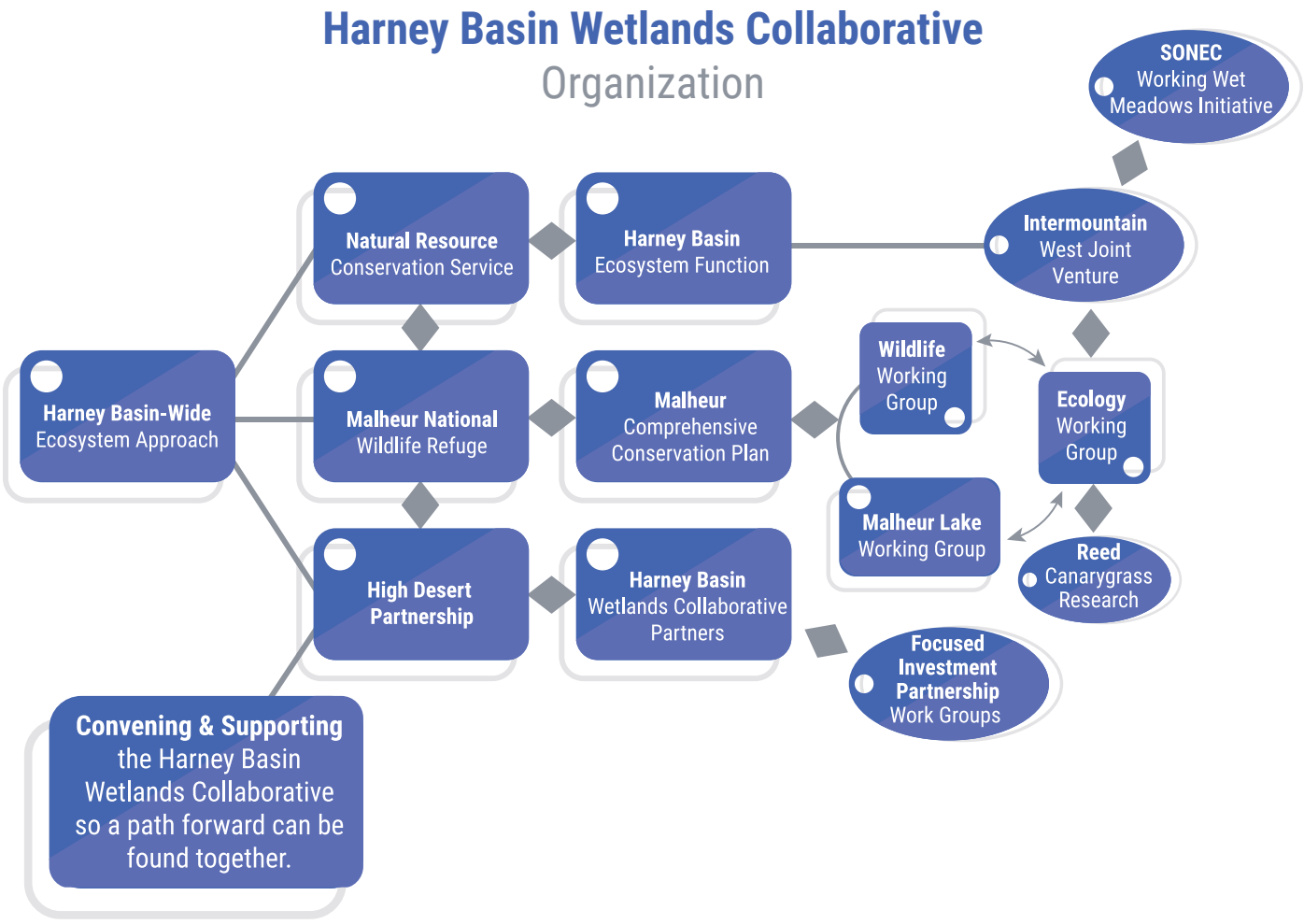


Figure 4. Diagram of how the Harney Basin Wetlands Collaborative operates as a collaborative partnership.

BACKGROUND AND PURPOSE

HBWC provides an umbrella for coordination and effective implementation of collaborative efforts to improve and maintain the ecological health of the basin's wetlands, and the social and economic values they support. A diverse set of partners works to build support for stewardship that generates long-term benefits for the human communities and native fish and wildlife of the Harney Basin. The collaborative builds upon decades of work by private landowners and the Malheur National Wildlife Refuge.

With organizational support from HDP, the collaborative brings together a broad range of public and private partners working to achieve the following:

- Wetland systems: Sustain and improve proper functioning wetland systems and water quality in the Harney Basin.
- Malheur Lake: Implement an integrated set of strategies to restore the ecological health and functions of Malheur Lake and its associated wetland systems.
- Flood-irrigation and wet meadows: Maintain and enhance traditional flood irrigation and haying and grazing practices that sustain important seasonal wetland habitats and agricultural production.
- Adaptive management: Support adaptive management strategies to meet habitat objectives under Malheur National Wildlife Refuge's Comprehensive Conservation Plan and HBWC's strategic action plan.
- Stakeholder engagement support: Build support for long-term conservation of Harney Basin wetlands among stakeholders locally and beyond the basin by demonstrating the economic and social benefits of collaborative stewardship and restoration.
- National model: Establish HBWC as a nationally recognized model for public-private partnerships for landscape-scale restoration.

THE PARTNERS

HBWC operates as a collaborative made up of stakeholders and other partners with a shared commitment to HBWC's goals and its collaborative approach to implementation of the collaboratively developed strategic action plan. HDP serves as the neutral convener for the collaborative. Stakeholders include private landowners; federal, state, and local government agencies; the Burns Paiute Tribe; conservation organizations; and other individuals with a demonstrated interest in the long-term health of the Harney Basin's wetlands. Other partners contribute time, expertise, funding, and other resources in support of the partnership's efforts.

Core partners formally commit their support to HBWC by signing on to the working agreements. Other partners participate without a formal commitment but acknowledge the terms of the agreement and agree to respect the collaborative process used to advance the work of the collaborative.

HDP serves as the fiscal agent for HBWC and provides administrative and staff support for its collective work.

THE COLLABORATIVE PROCESS

HBWC operates as a collaborative seeking to find common ground to the complex issues facing wetlands management in the basin. The group uses an independent facilitator to manage many of its meetings and strives to achieve consensus, as defined below, on all decisions.

All partners agree to:

- Honor promises and commitments;
- Bring concerns up for discussion at the earliest point in the process and be clear about what underlies concerns in an effort to find common ground among the parties;
- Keep their organizations, agencies, and constituents informed of ongoing action and of potential decisions and actions to expedite approval for any products requiring approval;
- Share all relevant information that will assist the group in achieving its goals;
- Participate in a free, open, and mutually respectful exchange of ideas, views;
- Not represent their personal or organization's views as views of the collaborative;
- Support any agreement or product that they have agreed to.

At collaborative meetings, each participant will:

- Avoid interruptions and stay on task;
- Listen well to promote mutual understanding;
- Be open, honest, straightforward;
- Be respectful and avoid what could be seen as personal attacks;
- Assume good intent and ask for clarification as needed; and
- Act in good faith in all aspects of the collaborative effort.

These principles were maintained through virtual meetings during the COVID closures.

ORGANIZATIONAL STRUCTURE

HBWC's organizational structure and formal operating procedures are limited to those necessary for the effective functioning to achieve the goals of the group. The strategic action plan provides overall guidance for the work of HBWC. Formal and informal work groups further define the plan's strategies and actions as needed, subject to the approval of the full collaborative.

Coordinating Committee

A seven-member Coordinating Committee provides guidance as needed to the facilitator and HDP staff responsible for administration and support of HBWC.

Appointments to the Coordinating Committee require approval by the full collaborative.

Membership on the Coordinating Committee is limited to representatives of core partners and is subject to approval of the full collaborative. The committee may choose a chairperson or delegate the responsibilities of the chair to staff. A committee member may be removed only by a supermajority vote (at least five members) of the committee.

Other Committees and Work Groups

A Communications Committee makes recommendations for the collaborative's communications program and assists with its implementation. Other committees or work groups may be established by the full collaborative, or the Coordinating Committee as needed.

A Malheur Lake Work Group develops recommended strategies to address aquatic health issues in Malheur Lake. A Wet Meadows Work Group develops recommended strategies to address management and infrastructure needs related to flood irrigation, haying and grazing, and the ecological functions of wet meadows in the Harney Basin.

Membership and participation in committees and work groups other than the Coordinating Committee is open to any partner.

The Coordinating Committee is responsible to review governance principles of the group annually and make any suggested updates to be reviewed and adopted by the full collaborative.

Role of High Desert Partnership

HDP is a community-based non-profit organization that convenes, supports and sustains collaborative efforts to address important and complex issues in Harney County, including HBWC. HDP serves as the neutral convener and fiscal agent for HBWC, contracts for facilitation of the collaborative process, and employs staff and contractors necessary to advance the collective work of HBWC.

Role of the Facilitator

HBWC formal meetings will generally be facilitated by an independent facilitator. The facilitator is neutral and will not take positions on the issues before HBWC. The facilitator will work to ensure that the process runs smoothly. The facilitator's role usually includes working with partners to develop draft agendas, facilitating meetings, working to resolve any impasse that may arise, and other tasks as requested by HBWC and partners. To the extent issues arise with the process, group members are encouraged to approach the facilitator or HDP staff.

STRATEGIC ACTION PLAN

The work of HBWC is guided by the collaborative's strategic action plan. The initial plan was developed in 2015 in conjunction with the partnership's successful application for funding through the OWEB's FIP program. The plan was updated in 2020 and again in 2021. HBWC will update its strategic action plan as needed but at least every six years.

Adoption of the strategic action plan and approval of any subsequent updates requires action by the full collaborative.

IMPLEMENTATION

Implementation of the strategic action plan is coordinated through the full collaborative and its committees and work groups, with specific actions undertaken by individual partners or groups of partners and aided by HDP staff.

Funding for implementation may be secured by individual partners or by HDP on behalf of the collaborative. Allocation of any programmatic funding made available to HDP to support HBWC will be determined by the full collaborative.

One or more partners will generally take the lead in securing funding for implementation of individual projects, including those related to programmatic funding commitments through OWEB's FIPs program. HDP

will generally take the lead in seeking and administering any funding used to support the collective work of the collaborative, including tasks that may be subcontracted to individual partners.

MEETINGS

All collaborative and working group meetings are open to the public. The full collaborative will meet approximately four times per year. Committees and working groups will determine their own meeting schedules as needed. Meetings may be in person or via telephone or internet-based video-conferencing.

A project calendar and other information about the planning effort will be posted to a web page:

DECISION-MAKING AND COMMITMENTS

The collaborative, working groups, and coordinating committee strive to operate by consensus. Consensus is defined as "all group members can live with the recommendation or decision." It is the responsibility of all members with a concern to describe their concerns to the group and offer alternatives for consideration which meet the vision of the collaborative. Decisions of the collaborative will be reached by consensus of those in attendance (in-person or remotely) and clearly captured in the meeting notes.

PARTICIPATION

All partners agree to act in good faith in all aspects of the collaborative effort. As such, partners will do their best to participate consistently, will consider the input and viewpoint of other participants, and conduct themselves in a manner that promotes joint problem solving and collaboration.

COMMUNICATIONS PLAN FOR HARNEY BASIN WETLANDS COLLABORATIVE

For HBWC collaborative communications is about providing a platform for information exchange and explanation of collaborative outcomes. The intent is to showcase stories and accomplishments of early-adopters, influencers and messengers that inspire and invite others to get involved in Harney County to create economic opportunity, manage, and conserve healthy lands and water and protect an enduring rural way of life. The audiences being reached and will continue to communicate and share stories with are:

- Partners within HBWC collaborative group (refer to list of Partnership Member below)
- Constituents from its partner organizations
- Harney County water users
- Harney County local community members
- Local and regional conservation groups
- Funders—individual donors and granting organizations
- Scientific community
- Harney County Court
- Government agencies
- Students
- Sovereign Nation of the Burns Paiute Tribe
- The general public-at-large—those beyond Harney County who share a love and concern for the Harney Basin

The news and stories HBWC shares with its diverse stakeholders come in a variety of forms: educational activities, newsletters, relationship building and outreach events, social media, published articles, community gatherings, videos, website content, and professional photography. The goal is to make the work of HBWC personal and relevant, fostering greater awareness and a connection to the work so stakeholders want to be part of the solution.

The High Desert Partnership and Malheur National Wildlife Refuge working together to show the community the value of Malheur Lake and surrounding wet meadows.

Photo by Jeremy Hill, jhillimages.com

Partnership Members: Experience and Roles

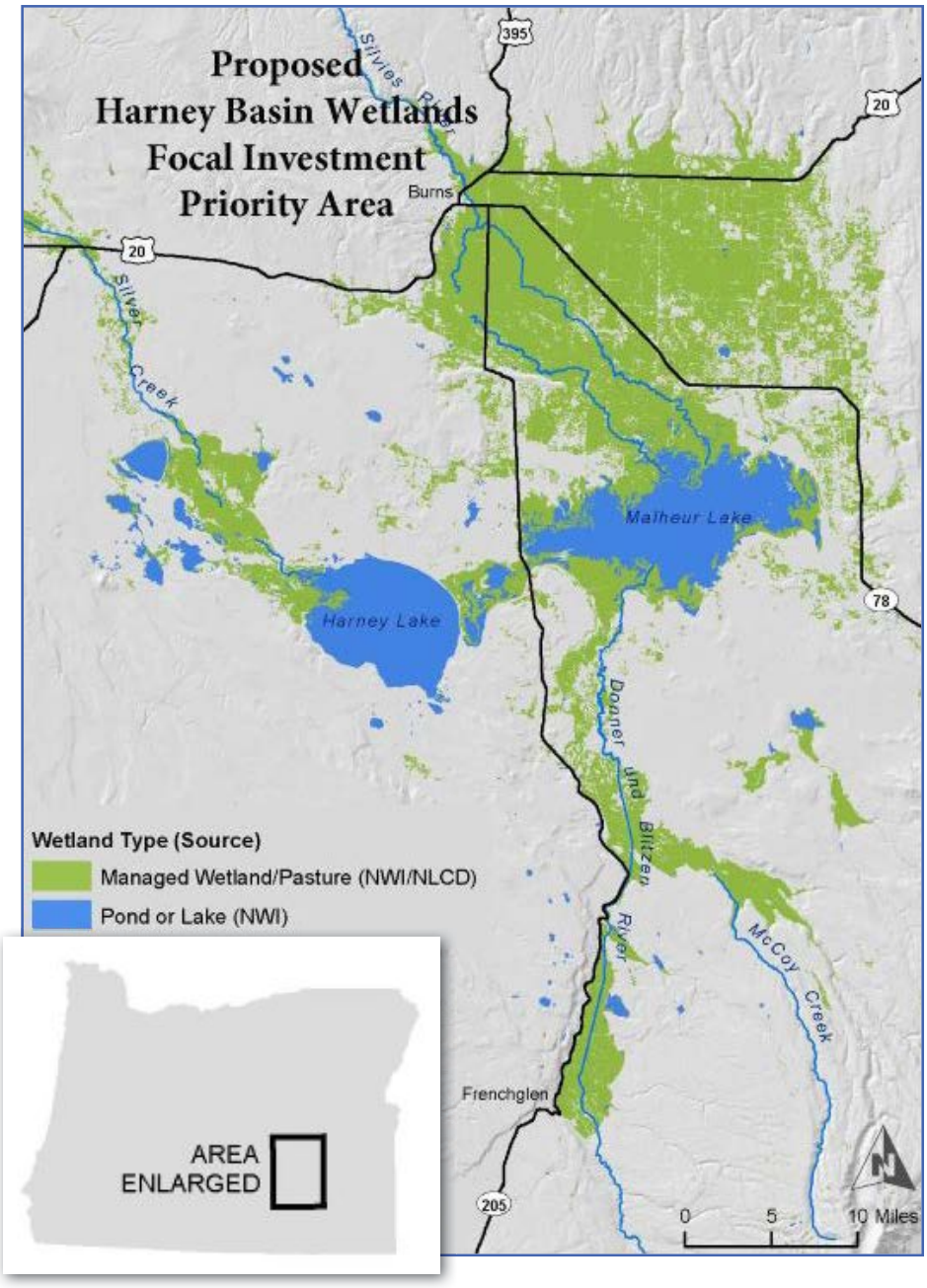
Implementation Partner	Experience	Roles
SOVEREIGN NATION		
Burns Paiute Tribe	Supporting initiatives of wetland health that promote tribal economic and cultural goals	Funding, restoration implementation, stakeholder engagement
GOVERNMENT		
Harney County Court	Project management	Supporting projects and tracking
AGENCIES: STATE AND FEDERAL		
Natural Resources Conservation Service	National leaders in private lands soil and water conservation. Experience working with many farmers and ranchers on conservation projects	Technical Assistance, landowner contacts, cost share funding, implementer of wet meadow infrastructure improvements
Oregon Department of Fish and Wildlife	Fish and wildlife stewardship experts	Technical advice, science sharing
Oregon Water Resources Department	Water resources management experts	Water regulations and best management practices
Oregon Watershed Enhancement Board	Watershed stewardship leaders statewide	Funding and support
United States Geological Survey	Technical assistance	Field research and publications
US Fish and Wildlife Service Malheur National Wildlife Refuge	More than a century of managing Malheur Lake	Focus on Malheur Lake Ecosystem model for management of waterbird production
USDA Agricultural Research Service	Expertise on State and Transition models and their uses in land management	Technical advice, developing shared science
ORGANIZATIONS: LOCAL & REGIONAL		
Audubon Society of Portland	Supporting initiatives that improve habitat for bird species	Funding, outreach, volunteer efforts
Ducks Unlimited	Private lands conservation for wetland and waterfowl habitats	Technical assistance, outreach, project design and implementation oversight
Friends of Malheur National Wildlife Refuge	Decades of supporting the mission of Malheur National Wildlife Refuge	Volunteer efforts, engaging stakeholders, educational events
Harney County Watershed Council	Providing technical expertise and funding for projects in the watershed	Landowner contact, project management, grant administration

Implementation Partner	Experience	Roles
ORGANIZATIONS: LOCAL & REGIONAL cont.		
Harney Soil & Water Conservation District	Technical assistance, project management experts	Landowner contact, project management
Intermountain West Joint Venture	Migratory bird habitat experts at Pacific Flyway scale	Science support, technical assistance, outreach
Meyer Memorial Trust	Community investment experts	Capacity funding for HDP Ecological Coordinator
The Wetlands Conservancy	Supporting initiatives to improve wetland health	Wetlands restoration efforts
Wet Meadow Partners	Supporting initiatives to improve wetland health including outreach and education	Wetlands restoration efforts
UNIVERSITIES		
Eastern Oregon Agricultural Research Center: Oregon State University Experiment Station	Expertise on latest range and plant ecological research	Technical advice, landowner contacts
Oregon State University	Research project management	Technical assistance, publications
CONSULTANTS		
Ken Bierly	Technical knowledge on wetlands and natural resources, literature and technical reviewing	Technical assistance
Robert Warren	Theory of change expert	Technical assistance
PRIVATE LANDOWNERS		
Multiple private landowners	Land management experts	Insight, knowledge and experience as land managers and water stewards while sharing their land for research and projects
SUPPORT SERVICES		
High Desert Partnership	Relationship development, consensus, partnership building, grass roots funding	Manage funds, cultivate collaboration, project assistance, leadership, coordination and communications
Oregon Consensus	Partnership planning experts	Moderate and manage meetings

4. Geographic Scope and Planning Horizon

GEOGRAPHIC SCOPE

Restoration work focuses on the flood irrigated wet meadows in the tributaries to the Malheur and Harney Lakes including Silver Creek, Silvies River, Blitzen River floodplains, and the overall health of Malheur Lake. Additional focus on riparian health of the lower Silvies and Blitzen Rivers and Silver Creek systems will also be considered. Wetlands within the Harney Basin are considered to be a high-priority habitat for migratory and resident bird populations within the Pacific Flyway, as identified in the Intermountain West Joint Venture "wetland landscapes and spring migratory priority areas" (Intermountain West Joint Venture Implementation Plan, 2013). The planning area is the Harney Basin catchment (Figure 6). Priority restoration areas within the planning area are focused on the Malheur-Harney Lakes and their associated wetlands (Figure 5).



Extent of wetlands in the Harney Basin, Oregon. Produced in the U.S. Fish and Wildlife Division of Realty and Refuge Information, Portland, OR. 9/17/2014. File 14-131-2.MXD.

Figure 5. Harney Basin Wetlands *Collaborative* focus area

PLANNING CONTEXT

The extent and distribution of flood irrigated wet meadows and the size and spatial dynamics of Malheur Lake both depend on annual precipitation. Timing and duration of runoff is affected by the snowpack accumulation and melt. While annual weather is unpredictable and always has been, there are increasingly variable patterns of precipitation related to climate change. Less snow and more rain have resulted in earlier spring freshet events and less late season runoff into Malheur Lake. Water management decisions will affect both the extent of flood irrigated wet meadows and the rate, duration, and timing of flooding of the floodplain meadows. Future water management decisions will need to be informed by expected changes to water supply and the limitations from changing conditions.

PLANNING HORIZON

The strategic action plan provides a renewed 25-year vision for the Closed Lakes Basin Wetlands systems of the Harney Basin. The primary focus is the maintenance and enhancement of flood irrigated wet meadow habitats for migratory birds, enhancement of riparian conditions for wildlife and fish, and further efforts to restore the aquatic health of Malheur Lake. Projects will be targeted for:

- **SHORT-TERM (5 YEARS)**
- **MID-TERM (10 YEARS)**
- **LONG-TERM (25+ YEARS)**

HBWC partners recognize that as improved understanding of the Malheur Lake ecosystem and the drivers and conditions of flood irrigated wet meadow systems develops, recalibration of mid-to long-term strategies may be necessary.

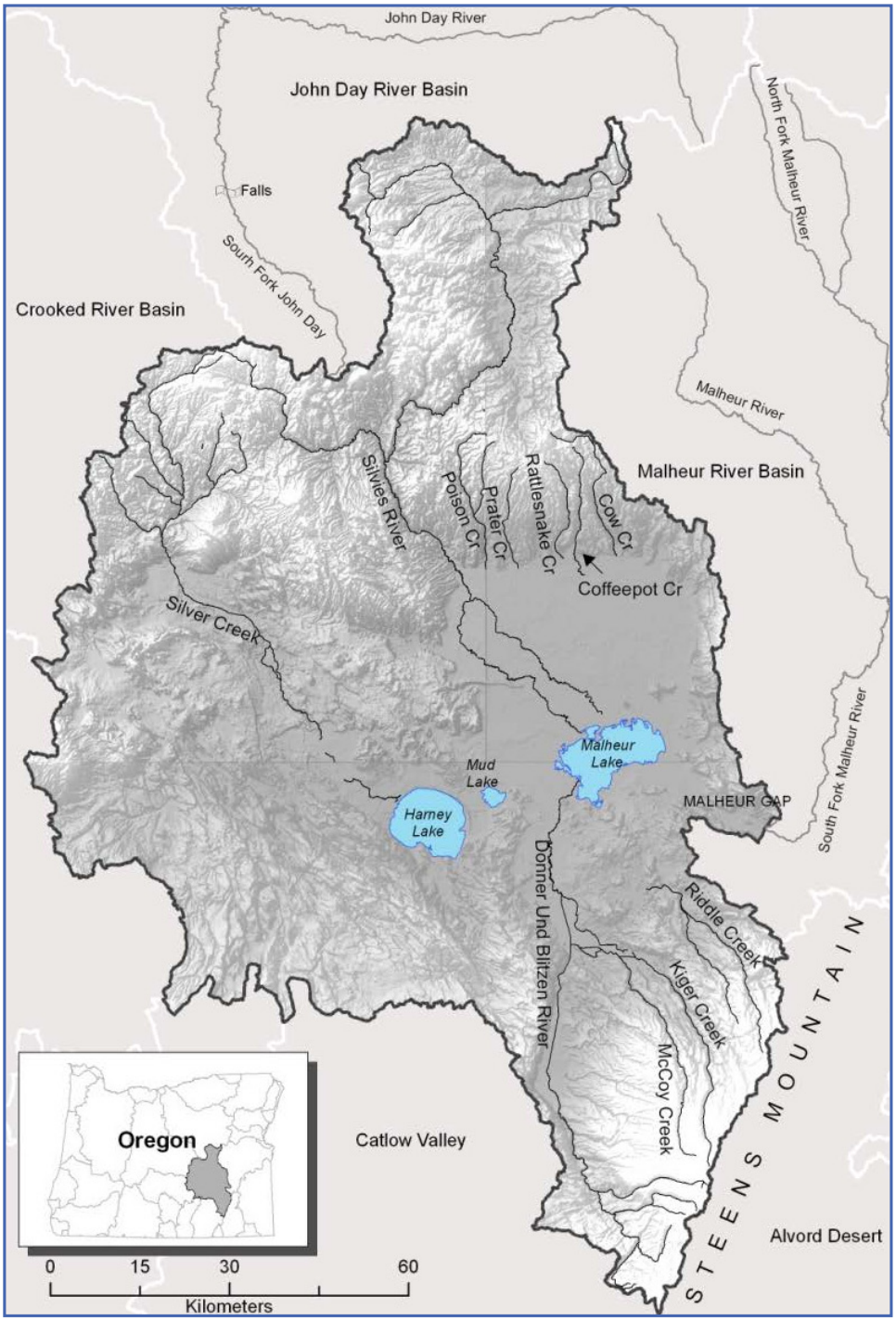


Figure 6: Harney Basin Catchment

5. Vision and Outcomes

Utilize collaboration to integrate social, economic, and ecological values in support of wetland conservation in the Harney Basin.

HBWC is working to restore and enhance healthy lands and water while nurturing an enduring rural way of life that supports and values wetland conservation in the Harney Basin. Malheur Lake and the Malheur National Wildlife Refuge have significance beyond the local area. This area has international significance for migratory birds and draws people from across the country. The following are the three outcomes HBWC is working to achieve.

OUTCOME 1.

RESTORATION OF MALHEUR LAKE: RETURN TO CLEAR-WATER STABLE STATE

Malheur Lake has lost much of the emergent and nearly all the submergent vegetation that made it such an attractive nesting and rearing area for resident waterbirds, hungry migratory birds and other wetland dependent wildlife. When Malheur Lake had abundant submergent vegetation it supported up to 150,000 breeding waterfowl and many other avian species. The current condition is turbid water with little emergent vegetation and very little submergent vegetation. Recognition of this condition and building understanding of the processes that are keeping Malheur Lake in this perpetual degraded condition has refocused restoration strategies in this action plan. Restoring and sustaining wetland conditions and clear water habitat to the extent possible is the primary goal for Malheur Lake. Managing the carp population, reintroduction of emergent vegetation, and managing substrate conditions to restore marsh conditions are objectives to move towards a clear-water lake system. The HBWC has sponsored research clarifying the potential for carp population control, to evaluate the limitations to emergent vegetation establishment, and other methods to reduce the very high turbidity of Malheur Lake. Through this improved understanding and knowledge HBWC partners are now developing strategies to reverse the degraded conditions and improve restoration success.

The current strategy is to manage carp populations by directed harvest at vulnerable locations and conditions, reestablish aquatic plants that provide both wind wave impact reduction and increase habitat resources for migratory and resident bird populations. Reestablishment of emergent vegetation has the potential to accumulate sediment and provide the topographic diversity that was characteristic of the marsh conditions of Malheur Lake in the past. Lake restoration in the area at the entrance of the Blitzen River and southwest portion of the lake, is being explored. Concepts such as levee construction to isolate the area from the rest of the lake are being considered. Isolating an area will allow better control of invasive carp populations and improve water-quality conditions. Restoration in Malheur Lake will have 6 main components:

1. Review the ecology of Malheur Lake and its watershed to integrate the new information coming from groundwater studies, carp population studies, water chemistry studies, lake physical processes, and streamflow information developed for the Blitzen River and Silvies River. This review will be used to evaluate success of potential restoration alternatives and to identify critical uncertainties associated with the management opportunities with Malheur Lake.

2. Begin altering the structure of the lakebed to recreate islands and peninsulas modeling the natural lake topography described in Duebbert (1969). Islands and peninsulas act as natural wind/wave barriers, reducing the resuspension of sediment into the water column on the leeward side, which increases water clarity and quality. The exploration will evaluate the optimal number of islands, distance between the islands, and expected water-quality changes based on modeling and pilot restoration studies.
3. Planting native emergent vegetation. Native plants such as sago pondweed and bulrush will be transplanted or cultivated in the area at the entrance of the Blitzen River and southwest portion of the lake based on research outcomes from ongoing research. It appears that there is a significant existing seedbank in the lake for emergent vegetation. Limiting factors to establishment and persistence will evaluate what management activities may affect establishment and persistence.
4. Manipulating water quality. There are opportunities to manipulate water quality by reducing the turbidity, suspended sediment concentration, and nutrient concentration, and increasing photosynthetically active radiation necessary for plant survival and expansion. The ability to obtain clear water from the Blitzen River, will be utilized. In addition to starting with water with low turbidity, the resuspension of bottom material and the concentration of suspended sediment in the water column will be considered through flocculation and sediment binding.
5. Manipulating carp biomass. Based on modeling that occurred during FIP 1, carp biomass targets for Malheur Lake have been established with the understanding that carp are now part of the Malheur Lake system and eradication is not an option. Carp populations will be controlled within the area at the entrance of the Blitzen River and southwest portion of the lake. The removal of carp from the Blitzen River and prevention of their entrance to the river will be managed by establishment of an electronic barrier. The barrier serves two primary functions; preventing carp from accessing spawning habitat in the Blitzen River when Malheur Lake is at low water levels and allowing for carp removal at congregation areas where they are attempting to return to spawning areas. Continued trapping and electro-shocking of carp will help to reduce carp biomass.
6. Monitoring and adaptive management. As the understanding of the complexity and changeable nature of Malheur Lake evolves, the new information will be collected in a model or series of models that connect the interaction between the physical and biological variables of Malheur Lake that help to demonstrate current understanding of opportunities and limitations to management. Monitoring will occur throughout the restoration projects to allow for adaptive management. Restoration actions will be adjusted depending on the water quality and plant responses and the climate model projections.

The longevity of this project, and the potential need for future action, has been considered. The islands and peninsulas that will be considered to approximate the natural topography that was present when the Malheur Lake was functional and in a clear state. It is recognized that any construction of physical features in the lake may be temporary structures.

CLICK TO LEARN MORE

Malheur Lake has lost much of its emergent vegetation and a huge majority of its submergent vegetation due to its current turbid state.
Photo by Jeremy Hill, jhillimages.com

Snow geese during early spring utilizing the hayed and grazed flood irrigated wet meadows.
This is a great example of what Outcome 2 is trying to achieve. Photo by Harney County rancher, Susan Doverspike.

OUTCOME 2.

CONSERVATION AND MAINTENANCE OF FLOOD IRRIGATED WET MEADOWS THROUGH IMPROVED INFRASTRUCTURE AND MANAGEMENT.

The goal of the 2015 strategic action plan was to protect at least 10,300 acres of privately owned flood irrigated wet meadows. This objective was derived from the Intermountain West Joint Venture 2013 Implementation Plan and based on a bioenergetic analysis of habitat requirements for spring migration of Northern Pintail as identified in the North American Waterfowl Management Plan. To date more than 4000 acres have been enhanced and conserved through irrigation infrastructure projects. Flood irrigated wet meadow conservation will ensure that there is a continued emphasis to provide flood irrigated spring migratory bird habitat through targeted conservation efforts. Management and distribution of water across the floodplain and the effects of timing, duration, and depth of water on plant communities have become crucial to providing the desired migratory bird habitats that will sustain the Pacific Flyway.

The Harney Basin (and northern Great Basin generally) is characterized by extremely high year-to-year weather variation. Vegetation managers have had to adapt to this variability. Climate change adaptation often involves projecting future climate trajectories. Rather than taking the standard approach to climate change adaptation and projecting climatic impacts on plants and animals, the first effort will be to review weather patterns over the past 30-50 years and develop “bins” for types of years. The initial focus will be on winter weather (and thus snowpack) which tends to control water availability for wet meadows, and spring weather which tends to control plant growth on uplands. Bins might include good winter and spring precipitation, poor winter and spring precipitation, good winter/poor spring and poor winter/good spring. Deciding on bins will require literature and data analysis, and discussions with vegetation managers that have years and sometimes decades of local experience and knowledge. Once specific bins are defined, past data will be used to determine the distribution of year types within each decade (1980’s, 1990’s, 2000’s and 2010’s). Looking at the past will help make some predictions about the future bin distribution and trends. For example, snowpacks have been declining since the 1950’s and are projected to continue declining well into the future.

Surveying landowners/managers how their management has changed in response to low snowpack years and what type of information or predictions they would need to make future management decisions will be completed. The importance of this information is to learn what is needed to ensure individual ranches' economic viability while maintaining and conserving their flood irrigated wet meadow ecosystems. Understanding historic hydrology paired with wildlife surveys will be a valuable tool for land managers. HBWC is bringing together field level data, local knowledge of flood irrigated wet meadow communities and continental scale science on climate and anthropogenic driven changes in wetland conditions to guide conservation delivery.

Outcome success will be based on how private land practices implemented assure the maintenance or enhancement of traditional flood-irrigation practices for the mutual benefit of forage production and migratory and resident bird habitat. This outcome will be measured using current social science metrics. Additional outcomes include enhanced resiliency for wildlife habitat and irrigated flood meadow agricultural practices to climate change by improving infrastructure and restoring floodplain function.

At the LY Ranch on the edge of Burns, OR wild flood irrigation infrastructure improvements were made, like the addition of this new headgate, to better manage water flow and irrigate fields that previously were not able to be irrigated.

Photo by Jeremy Hill, jhillimages.com

OUTCOME 3.

AWARENESS, ATTENTION, AND TRUST FROM MULTIPLE AUDIENCES.

Engaging the community with HBWC restoration and management efforts, both locally and beyond Harney County, will build greater awareness, garner attention, and deepen trust as audiences engage in this conservation journey. Growth in awareness, attention, and trust will also generate greater public support and social license for actions to revive Malheur Lake as management decisions are explored, tested, and implemented. HBWC partners work with private landowners to provide tools and improved infrastructure to effectively manage flood irrigation for the benefit of their businesses as well as bird and wildlife habitat. HBWC partners are addressing a complex socio-ecological system where there are many and occasionally conflicting demands on water resources. As climate change affects water supply and availability, ensuring better understanding of the complex interactions of water supply, timing and effects of that on human uses as well as ecological processes is critical in the development of management approaches that can optimize values for the community.

The Harney Basin Wetlands Collaborative works hard to engage members of the community and build trust.

Photo by Jeremy Hill, jhillimages.com

6. Ecological Priorities and Goals

WHY IS MALHEUR LAKE AND THE CLOSED LAKES BASIN WETLAND OF THE HARNEY BASIN IMPORTANT?

The Closed Lakes Basin Wetlands exist within the Southern Oregon Northeast California (SONEC) region, which is a portion of the Closed Lakes network within the northern Great Basin (Figure 7). South central and southeast Oregon have a series of wetland systems that are important for migratory birds. The Klamath, Warner Lakes, Summer Lake and Malheur Lake all have extensive wetland systems managed for migratory and resident birds. Each area is recognized by some form of wildlife habitat protection area (Klamath Basin National Wildlife Refuges, Warner Lakes Area of Critical Environmental Concern, Summer Lake State Wildlife Area, and Malheur National Wildlife Refuge). The Harney Basin is one of the largest Closed Lake Basins. Closed Lakes Basin flood irrigated wet meadows are ecologically unique high desert wetlands that provide critical habitat for numerous migratory and resident bird species, as well as other wildlife. This region is recognized internationally for its important migratory bird habitat. Oregon's Closed Lakes Basin Wetlands are a significant portion of the greater SONEC complex of wetlands that are critical to the millions of birds traveling along the Pacific Flyway each year. The SONEC region's geography and habitat has been defined by the Intermountain West Joint Venture (IWJV) and in the federal North American Waterfowl Management Plan. The IWJV recognizes the SONEC region as one of two top priority areas in the Intermountain West for wetland-dependent birds and it is one of the IWJV's highest priority landscapes for conservation for several reasons. It is a rich mosaic of wetlands, wet meadows, and irrigated pasturelands that provide critical migration and breeding habitat for a myriad of North American bird species. These wetland complexes are an important part of the intercontinental Pacific Flyway. Within the SONEC region, 75% of wetland habitat is located on private lands, most of which is managed as flood irrigated hay and pastureland.

Closed Lake Basin Wetlands represent a unique chain of desert oases that, as an integrated network, provide a critical corridor of habitat and food for waterbirds throughout the seasons. Closed Lake Basin Wetland habitats include shallow lakes and marshes, wet meadows, and irrigated pasturelands. A recent analysis shows Malheur Lake as being affected by climate and human water use (Donnelly et al., 2020). Malheur National Wildlife Refuge and other sites within the Harney Basin are critical for seasonal recreation which also feeds Harney County's economy each year. The U.S. Fish and Wildlife Service has documented over 65,000 annual visitors to the Malheur National Wildlife Refuge alone—a renowned destination for avid birders and outdoor recreationists.

Many of the managed wetlands and pastures in the floodplain of tributaries and lakes of the Harney Basin are also part of the vitally important ranching community that supports the rural economy of Harney County. Many ranching businesses are reliant on the ecological health of flood irrigated wet meadows as a critical part of their operation for the forage that they provide. Finally, the unfolding impacts of climate change may lead to a reduction in overall water availability. This is of grave concern as it is yet unknown how water scarcity will further alter the natural hydrologic regime across these sensitive habitats. This concern, in tandem with water resource issues in other important areas of the SONEC wetland complex, lend added urgency to the importance of conservation efforts concerning this unique habitat and its relationship with the area's water resources.

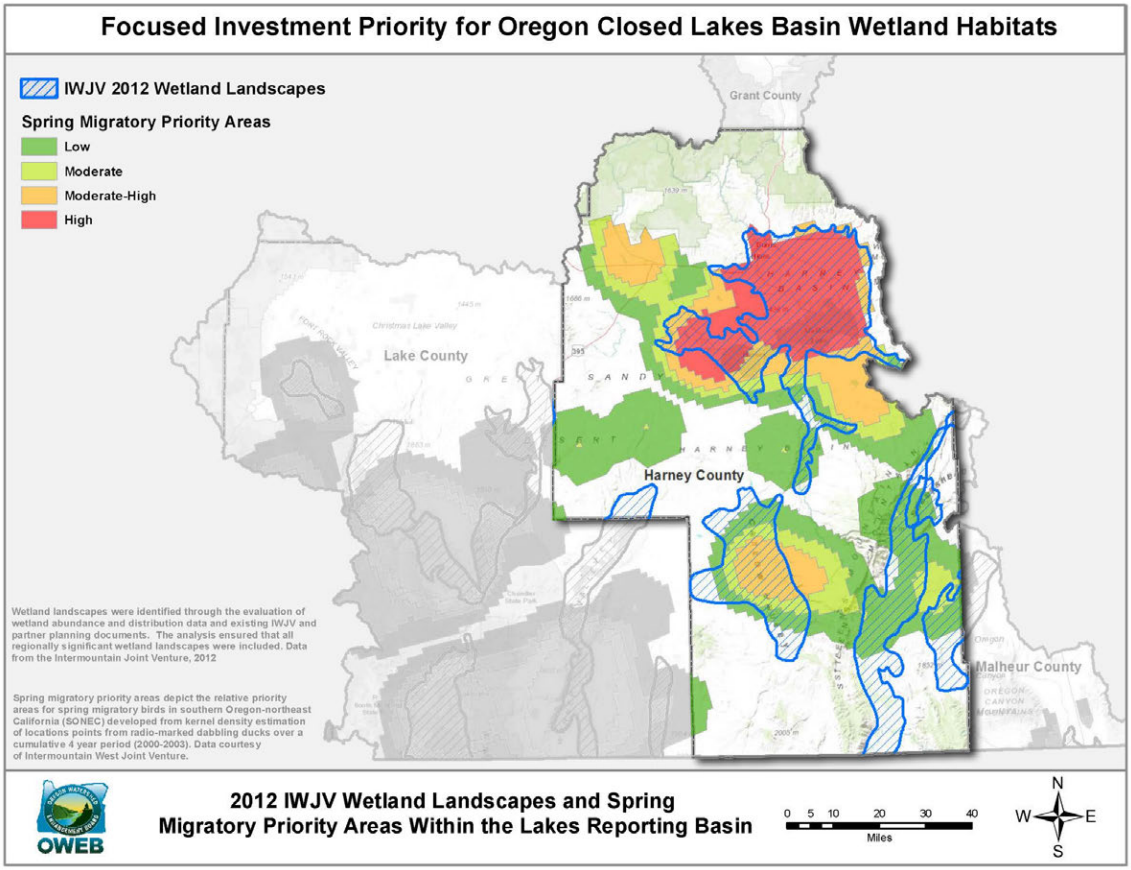


Figure 7. Spring migration wetland priority areas within the Closed Lakes Basin.

SPECIES OF INTEREST SUPPORTED BY CLOSED LAKES BASIN WETLANDS HABITATS

An estimated 70 percent of migratory birds—including over 6 million waterbirds—annually pass through the SONEC region, which includes the Harney Basin wetlands.

Species include:

1. Most of North America's Snowy Plovers breed in the region (the interior population is not federally listed under the Endangered Species Act but the coastal population is);
2. Most of North America's eared grebes, long-billed dowitchers, and all of the world's Wilson's Phalaropes use the region during migration with phalaropes and grebes nesting in the Blitzen floodplain and Malheur Lake;
3. Most of the world's American Avocets (a keystone species) use the region for an extended post-breeding period, and over 50% of this species breeds in the Great Basin;
4. Most of the world's White-faced Ibis breed in the Great Basin;
5. 80% of nesting greater Sandhill Cranes in Oregon are found in the closed lakes basins;
6. Migratory and resident bird species alike rely on this habitat;
7. The Harney Basin supports the largest population of breeding Bobolinks in Oregon.

Of particular importance is habitat for shorebird species and migratory birds on the spring and fall migration paths along the Pacific Flyway. This region provides a diversity of food production at different water regimes throughout the year; thus, seasonal water conditions drive habitat function and productivity. Additionally, the Harney Basin wetlands support native fish species such as tui chub and redband trout. Irrigation infrastructure is being upgraded with provisions for fish passage for migratory redband trout use.

The wetlands of the Malheur National Wildlife Refuge are important to many species of wildlife.

Priority Habitats

MALHEUR NATIONAL WILDLIFE REFUGE

Malheur Lake and its adjacent wetlands are critical habitat for a wide variety of waterbirds that pass through the area via the Pacific Flyway. The lake provides habitat for fish-eating birds, nesting habitat for ducks, and feeding habitat for a variety of shorebirds. The Audubon Society of Portland describes the importance of the Malheur National Wildlife Refuge as:

- Malheur is important to the watch-listed Western Snowy Plover, Long-billed Curlew, and Franklin's Gull which use the lake.
- The Malheur National Wildlife Refuge supports up to 20% of the world's population of White-faced Ibis and significant breeding populations of American White Pelican, Cinnamon Teal, Redhead and Greater Sandhill Crane (the latter being 20% of Oregon's breeding population).
- A large portion of the entire population of Ross's Geese use the Malheur Lake as a roosting site and surrounding private lands during migration.

- A significant proportion of the total populations of Green-winged Teal, American Wigeon, Northern Shoveler, Northern Pintail, Canvasback, and Ruddy Duck use the area as an important migratory stopover.

- During migration, on good water years Malheur Lake regularly supports hundreds of thousands of waterfowl. This includes estimates of up to 100,000 Snow Geese, 15,000 Green-winged Teal, 15,000 Mallards, 250,000 Northern Pintail, 250,000 Northern Shovelers, 4,000 Canvasbacks, 2,000 Ring-necked Ducks, 5,000 Lesser Scaup, and 50,000 Ruddy Ducks.

- Breeding populations include up to 150 pairs of Green-winged Teal, 400 pairs of Northern Pintail, 200 pairs of Blue-winged Teal, 700 pairs of Northern Shoveler, 2,000 pairs of Gadwall, 400 pairs of American Wigeon, 800 pairs of Canvasback, 3,000 pairs of Redhead, 80 pairs of Lesser Scaup, and 2,500 pairs of Ruddy Ducks.

- Malheur Lake supports an intermittent breeding population of California and Ring-billed Gulls, the largest concentrations of these species occurring in August.

- Up to 25,000 Ring-billed Gulls have been recorded on Malheur Lake and surrounding areas.

- Up to 1,300 pairs of Franklin's Gulls have nested at Malheur Lake and surrounding wetlands.

- Forster's Terns breed on the Malheur National Wildlife Refuge, and up to 350 pairs of
Caspian Terns have nested in Malheur Lake when water levels are ideal.

- Up to 6,000 Black Terns regularly nest at Malheur Lake.

- Harney and Malheur Lakes support significant shorebird populations, especially during migration in spring and fall. Migration concentrations of up to 25,000 Western Sandpipers, 350 Pectoral Sandpipers, 35,000 Long-billed Dowitchers, 15,000 Wilson's Phalaropes, 15,000 American Avocets, and 200 Black-necked Stilts have been recorded.

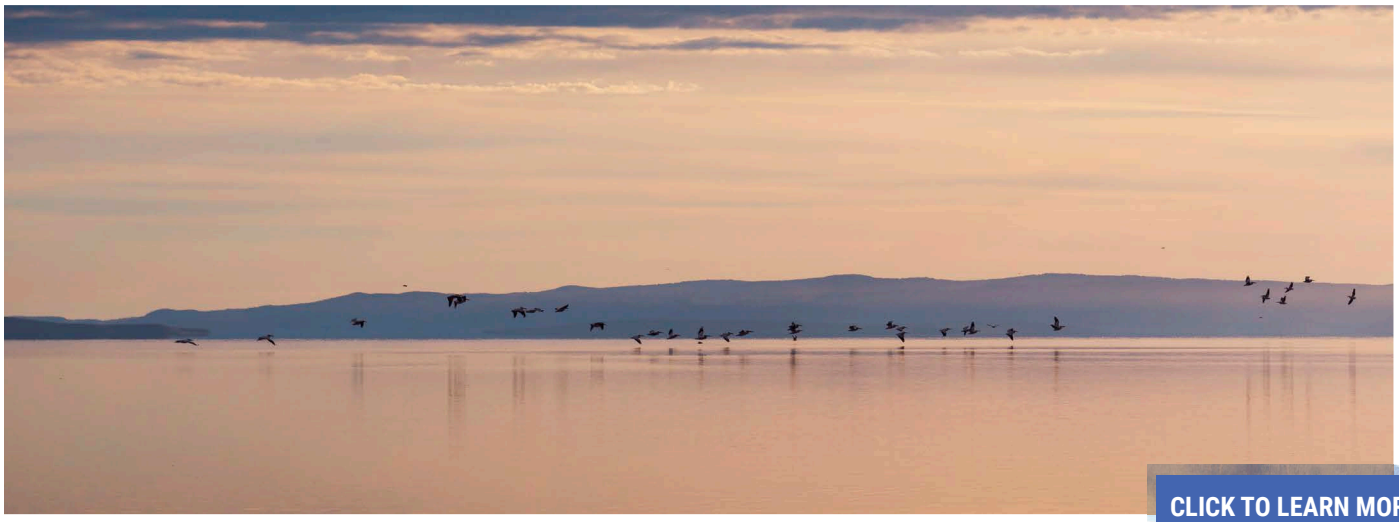
- The Western Snowy Plover is the most common breeding shorebird at Harney Lake, and up to 400 individuals have been seen there during the nesting season. During low water years these birds use Malheur Lake.

- From 100 to 600 pairs of Great Blue Herons and similar numbers of breed and nest on Malheur National Wildlife Refuge every year in scattered colonies, though mostly around Malheur Lake. Over 200 pairs of Snowy Egrets have nested around Malheur Lake.

- Over 200 pairs of Snowy Egrets have nested around Malheur Lake.

- The first Oregon breeding record of Cattle Egret also came from Malheur Lake in the mid-1980s, when 1-2 pairs nested for about 3 years.
- Numbers of Black-crowned Night-Herons vary widely year to year, but generally a few hundred pairs nest on the Malheur National Wildlife Refuge, the majority of them at Malheur Lake.
- American White Pelicans are sporadic breeders depending on water levels in Malheur Lake, and up to 1,500 pairs have nested there.
- Malheur Lake is a concentration point in winter for raptors of many species. Over 100 Rough-legged Hawks, 40 Red-tailed Hawks, 60 Northern Harriers, 10 American Kestrels, and 15 Bald Eagles have been recorded on Christmas Bird Counts.
- Malheur Lake and wetlands provide habitat for the largest breeding colony of Bobolinks in Oregon.

Malheur Lake is clearly an outstanding migration site providing a natural Malheur National Wildlife Refuge for a diverse concentration of birds. Thousands of birders from around the world come to Harney County each year to visit Malheur National Wildlife Refuge and take part in the migratory spectacle. According to eBird, Malheur National Wildlife Refuge Headquarters has the highest bird count in Oregon, with Malheur National Wildlife Refuge (general) in second. The Malheur Lake area has 3 of the top 20 highest all-time bird lists on eBird.



CLICK TO LEARN MORE

Even with its current water quality issues Malheur Lake is still a very important natural wetland habitat for birds. Photo by Jeremy Hill, jhillimages.com

FLOOD IRRIGATED WET MEADOWS

The wet meadow system in the Silvies River floodplain is also an Audubon Important Bird Area. As described by the Audubon Society of Portland: "The Silvies River Floodplain is an area of flood irrigated meadows and hay lands between Burns, Oregon and Malheur Lake. The Silvies River area was historically a shallow, slow moving river system of sloughs and swales interspersed with meadows. In wet years, the flooding banks of the Silvies River creates an extensive wetland system in the valley."

Forested and shrub dominated riparian areas thread through the wet meadows creating structural diversity and providing significant habitat for swallows and other summer residents, winter residents, or migrant birds. Species of continental importance in the Partners in Flight North American Landbird Conservation Plan include the Willow Flycatcher, Calliope Hummingbird, Red-naped Sapsucker, Lewis's Woodpecker, Willow Flycatcher, Brewer's Sparrow, and Green-tailed Towhee.

Key habitat threats to the Harney Basin

- Loss and degradation of wetland habitats due to dilapidated infrastructure and inability to efficiently flood irrigate.
- Loss and degradation of wetland habitats due to conversion from flood irrigation to sprinkler irrigation or other land uses including but not limited to residences, solar farms, etc.
- Reduced seasonal water availability because of altered natural hydrologic functioning resulting from climate change.
- Proliferation of invasive common carp, wind resuspension of sediments in the water column, and altered nutrient dynamics have altered the ecological conditions of Malheur Lake resulting in the persistence of a turbid state that significantly reduces vegetation otherwise available as habitat and food for birds and other wildlife.
- Invasive plant and macroinvertebrate species, which can reduce food production for native bird species.

Sandhill cranes and waterfowl utilizing the flood irrigated wet meadows of the Silvies River Floodplain near Burns, OR. Photo by Jeremy Hill, jhillimages.com

7. Profile of the Focus Area

BIOPHYSICAL

The Harney Basin is the northern extension of the Northern Basin and Range ecoregion, bounded on the north by the Blue Mountains and to the south by Steens Mountain. The Harney Basin is a Closed Lakes Basin that has no external surface drainage. The lowest point of the basin is Harney Lake, a terminal lake that loses water through evaporation.

- **Geological Setting.** The Harney Basin is a depositional basin composed of alluvial deposits from the Silvies, Silver Creek, and Blitzen River systems. Also, lacustrine deposits from Pleistocene Lake Malheur. All the rocks in and near the Harney Lake and Malheur Lakes are of Pliocene or younger age and include ashfall and ash flow tuffs and tuffaceous sedimentary rocks, interstratified basalt flows, local accumulations of basaltic eruptive material, and broad expanses of several different kinds of Pleistocene and Recent surficial sediments (groundwater study Advisory Committee presentation March 19, 2019).

- **Groundwater Over-Appropriation.** In the five years since the development of HBWC's strategic action plan, Harney County has learned of significant over- appropriation of groundwater in the basin. Recent hydrogeological studies are in preparation that will identify aquifers, groundwater conditions and the groundwater budget (OWRD-USGS, 2021). The preliminary information presented to the groundwater study advisory committee indicates the basin is out of balance for groundwater by about 120,000 -130,000-acre feet/ year (presentation of December 12, 2019). A community-based integrated water plan is being developed and is led by a HBWC partner: the Harney County Watershed Council in cooperation with Harney County Court. The significant over appropriation of groundwater has been recognized as a key area of concern and strategies are being developed with local solutions to address the use of the area's limited groundwater resources. The water plan will also address surface water resources and representatives of HBWC are actively participating to ensure lake and wetland conservation investments to date are recognized during plan development. The allocation and distribution of surface water could have a significant effect on flood irrigated wet meadow systems and the size and fluctuation of Malheur Lake.

- **Ecoregional Context.** Malheur Lake and the Silvies Floodplain are in the High Desert Wetlands portion of the Northern Basin and Range ecoregion. The High Desert Wetlands are described as: "The nearly level High Desert Wetlands ecoregion consists of high desert lakes and surrounding wetlands that provide critical habitat for nesting and migratory birds and associated upland birds and mammals. Elevation varies from 4,000 to 5,200 feet (1,219 to 1,646 m). The fine-textured soils are poorly drained, and basins collect water seasonally. Although water levels fluctuate from year to year, lakes and wetlands in this region hold water more consistently than on the course, better drained soils of the Pluvial Lake Basins. Sedges, rushes, black greasewood, tufted hairgrass, mat muhly, meadow barley, creeping wildrye, and Nevada bluegrass occur in wetter areas. Drier areas support basin big sagebrush, Wyoming big sagebrush, silver sagebrush, bluebunch wheatgrass, basin wildrye, Idaho fescue, Thurber's needlegrass, and cheatgrass (an invasive species). The region covers 1,651 square miles (4,276 km2) in Oregon, including the Malheur National Wildlife Refuge and land surrounding Malheur Lake, as well as several other wetland systems."

- **Terrestrial and Aquatic Ecosystems and Supported Species.** As described in Ecological Priorities and Goals within this document, the wetlands of the Harney Basin are a critical resource for a multitude of migratory and resident avian species. Along with the waterbirds, the wetlands complex is important to small mammals, amphibians and reptiles and the streams are important for cold water fish (primarily redband trout). Groundwater-dependent ecosystems include a number of invertebrates unique to the springs and other groundwater dependent habitats in the basin.

HISTORICAL

For more than ten thousand years, people have inhabited the Harney Basin and lived off its wetlands. The Wadatika people (Wada eaters) have used Malheur Lake and surrounding areas for food, medicine, shelter, and spiritual centering for their people. The Burns Paiute Tribal Council recognized "the spiritual and cultural importance of Malheur Lake and its current and historic shoreline to the Burns Paiute Tribe, and that these locations hold invaluable, irreplaceable, and endangered aspects of our cultural heritage" in Resolution 2016-01. The Burns Paiute Tribal Council also recognizes Malheur Lake and its current and historic shoreline, watershed, and viewshed as traditional cultural properties each with numerous sacred loci including historic and contemporary spiritual quest sites, sacred sites, and other important cultural sites. Figure 8 shows the traditional territory of the Burns Paiute tribe in the Harney Basin area.

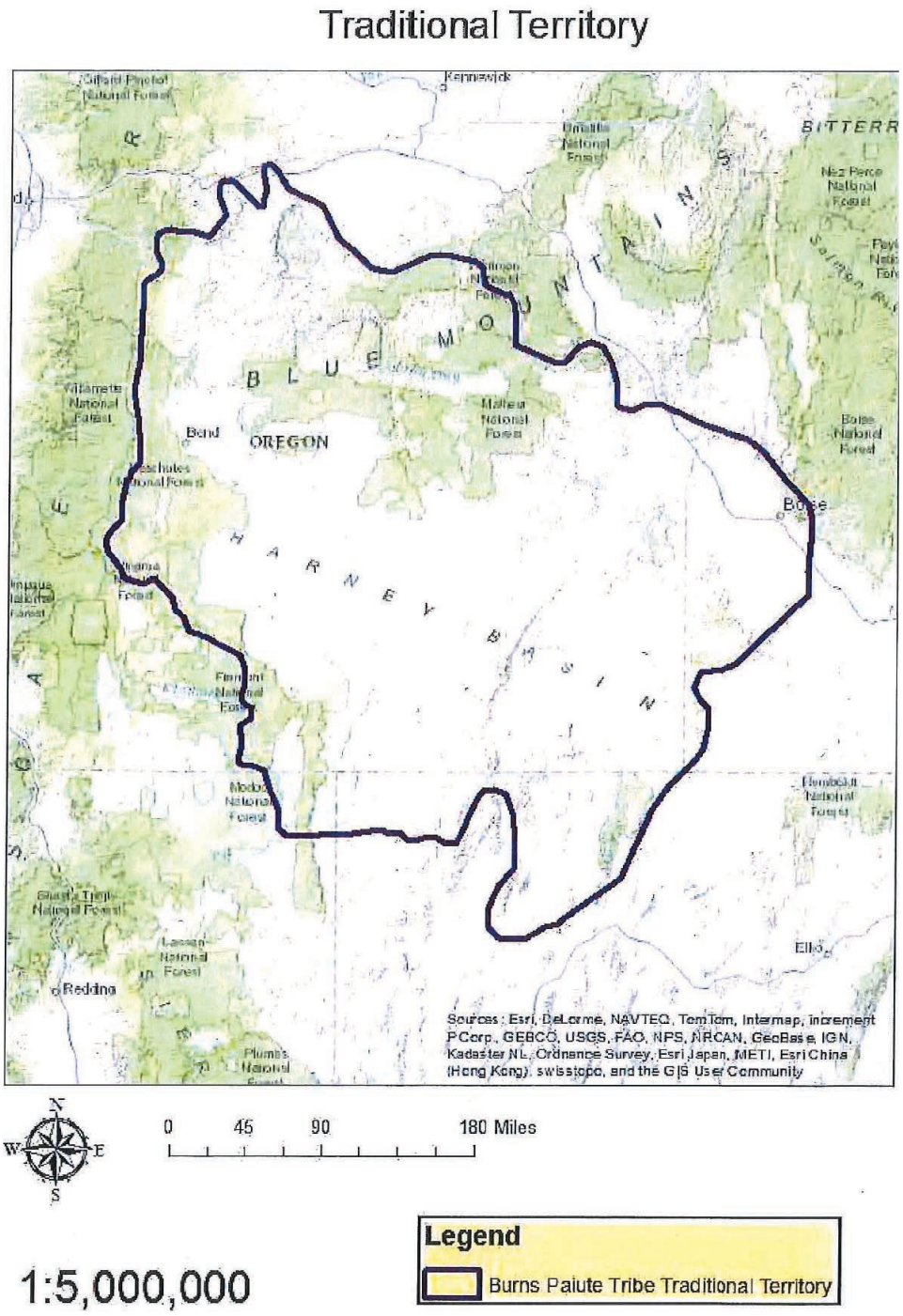


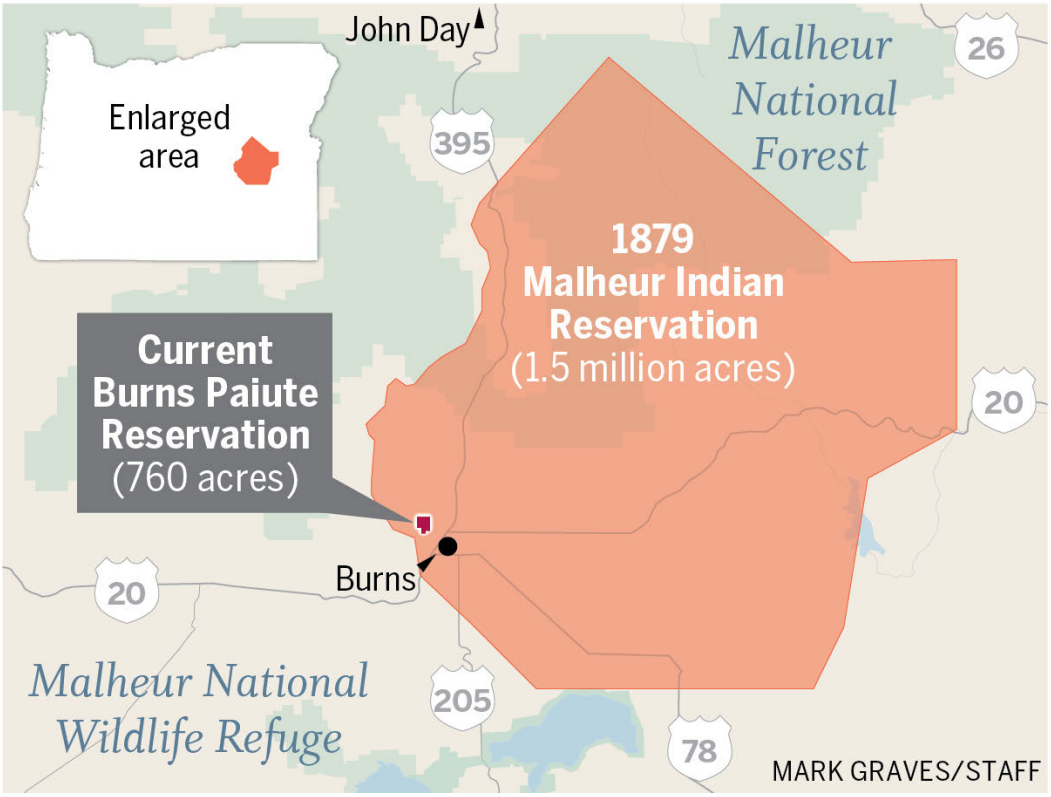
Figure 8. Burns Paiute traditional area Map for the Harney basin region.

In 1872, President Ulysses S. Grant created the Malheur Indian Reservation by executive order. Over time the reservation was reduced and eliminated in 1879. Some 11,000 acres of allotted land are owned by individual tribal members and the Burns Paiute Tribe purchased a 760-acre site near Burns in 1935. The Tribe was identified as a federally recognized tribe by executive order in 1972 and the lands purchased earlier were recognized as reservation lands.

Malheur Indian Reservation: Then and now

The Malheur Indian Reservation once covered nearly 1.5 million acres of land in Harney, Grant and Malheur counties. Today, the Burns Paiute Tribe's reservation consists of just 760 acres on the outskirts of Burns.

Sources: Bureau of Indian Affairs; U.S. Interior Department.



Fur trappers came through the Harney Basin in the 1820s, taking beaver from the Silvies River and other streams in the basin. Beavers were mostly trapped out of these areas by the 1830's. Settlers passed through the area headed to the Willamette Valley in the 1840s-1860s. Army exploration of the area in the 1860s led to the establishment of army outposts (forts) in the area, and along with settlers, led to the provocation of hostilities with the native people. Large ranch interests from California came north to use the summer ranges found in the Harney Basin. Ranches were established where wet meadows from spring flooding provided abundant forage. Early water management included spreading the spring water to as much land as possible (Langston, 2003).

Homesteaders began moving into the basin in the 1870s. The Malheur National Wildlife Refuge was established in 1908 and incrementally added to its present size of 187,757 acres around Malheur and Harney Lakes. (Figure 9).

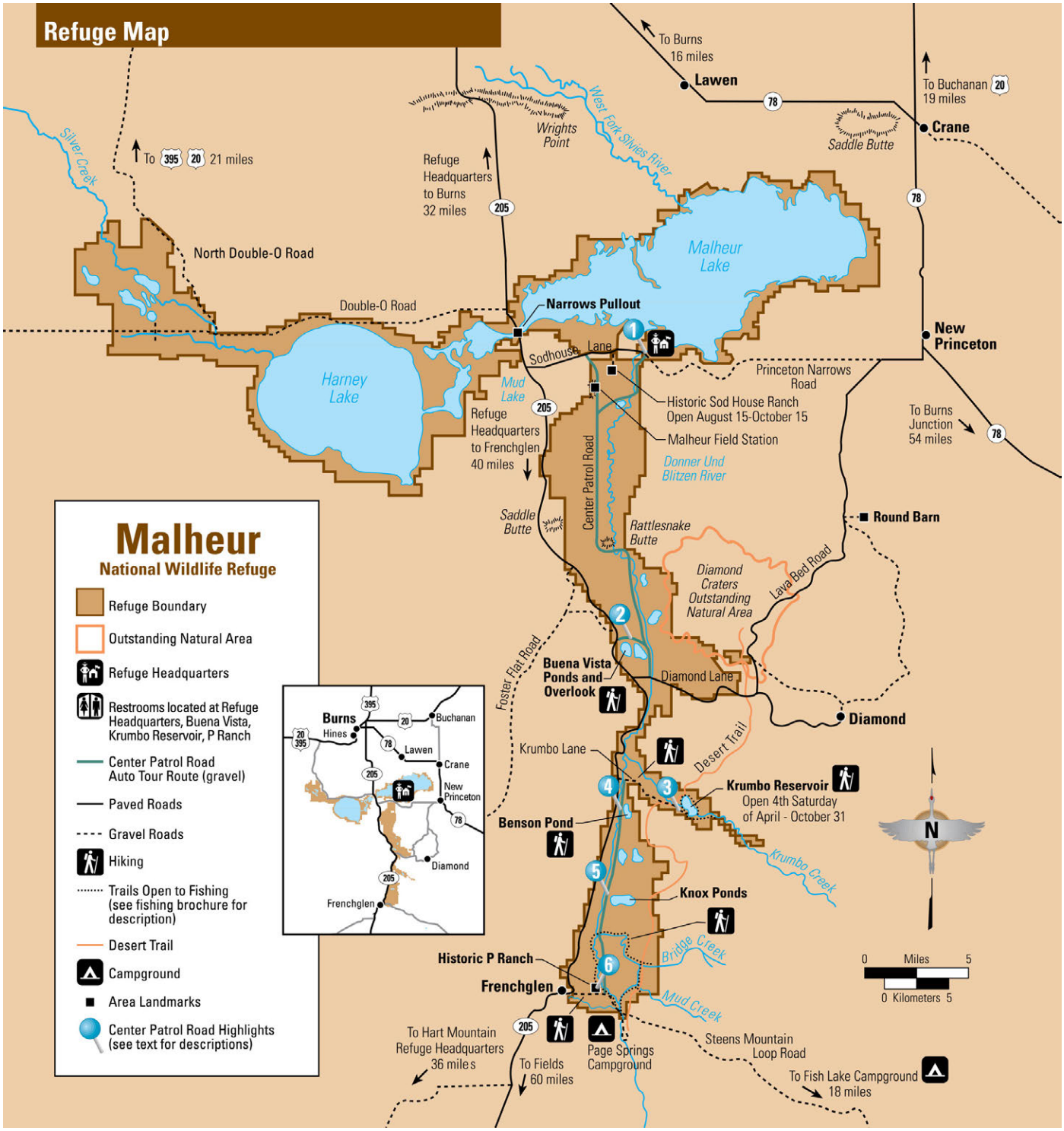


Figure 9. Malheur National Wildlife Refuge boundary map.

CULTURAL

Harney County has a population of around 7,300 people with the median age of 46. It is a predominantly white Caucasian population (87% white and about 3% American Indian). Home ownership in the area is around 70% and the median property value is about $112,000.
(source: https://www.homefacts.com/demographics/Oregon/Harney-County.html)

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Harney County is the tenth largest county in the U.S. in terms of land mass, at 10,226 square miles with just 7,300 people. This vast landscape is made up of 75% public lands managed by various government agencies.

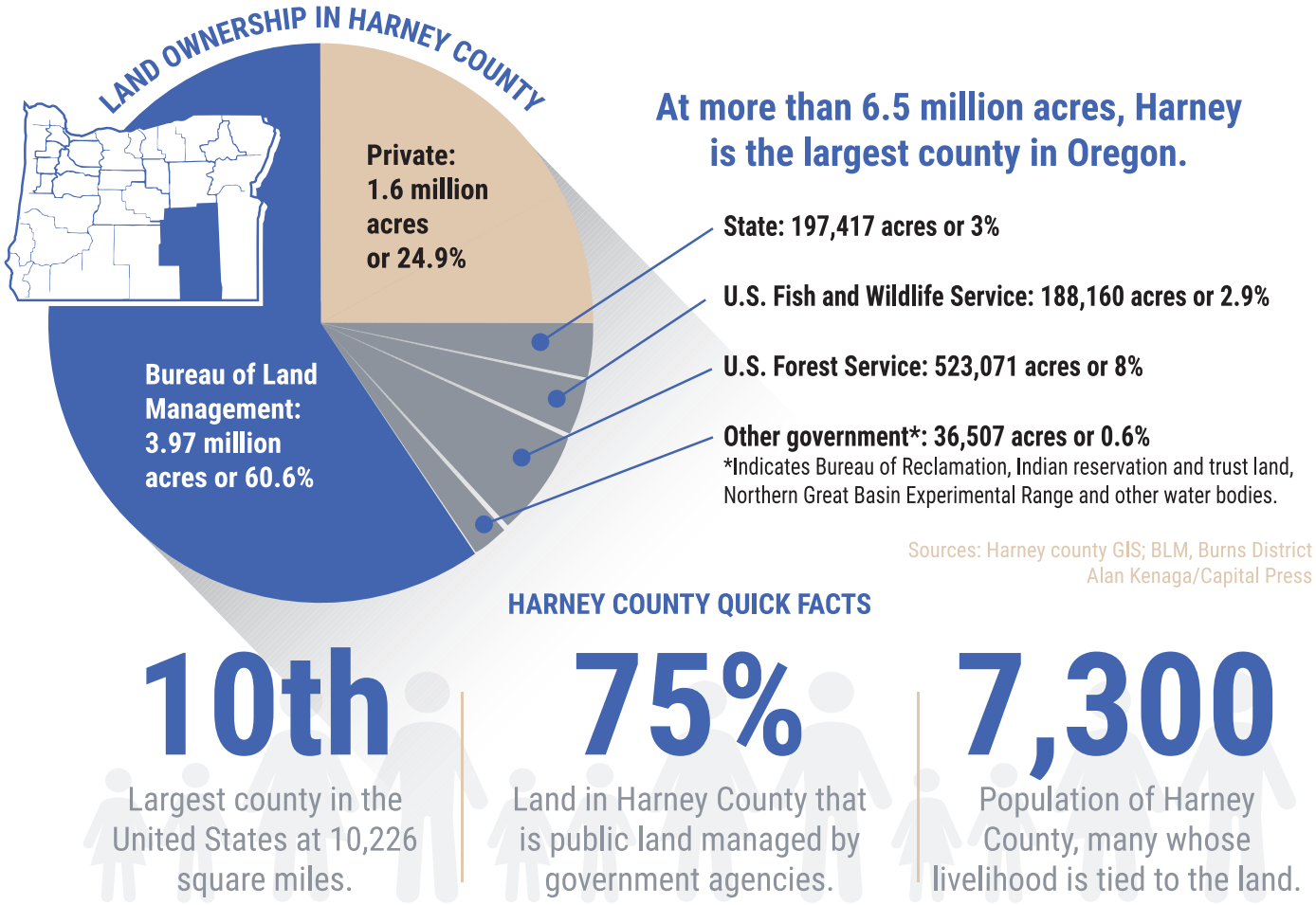

Figure 10. Land ownership for Harney County

In HDP's view the culture of rural Harney County is one of self-reliance, determination, resilience, volunteerism, and taking care of each other. It is also a culture where a local landowner might say: "Oh, I've only been here 40 years or so", which is a sign of the respect given to those who come from families who have resided in the area for generations working on and caring for the land. There is a common sentiment among locals that "we can do this together" despite differences and fiercely held independence. As a community that has weathered hard times in the past, there is a resilient spirit deeply embedded in Harney County's rural culture that brings determination and optimism to new challenges.

It is also a place where landowners who manage their own lands understand the choices and decisions they make have an impact on the community as a whole. It is this rural culture that has made working together such an effective tool for solving problems in Harney County. As Peter Walker shares in his book Sagebrush Collaboration, "In a nation staggering to find its center of gravity, Harney County proved the power of a community that knows how to work together."

ECONOMIC

Among Oregon's most sparsely populated rural counties, Harney County faces common economic challenges because it is a community strongly tethered to its ranching, logging, and mining past. Developing new economic opportunities that maintain the natural balance and integrity of the landscape continues to be a major challenge. Agriculture and ranching have been a steady backbone of the local economy for generations. The expansion of groundwater irrigated agriculture has contributed to accelerated groundwater depletion that limits future growth and development. There is also a shift in generational interests where young farmers and ranchers are no longer guaranteed to take over their family business because they seek other career paths or leave the area for opportunities elsewhere.

Like so many rural Oregon communities, Harney County was once home to a booming timber industry. But rising costs, increasing regulation, and a range of other factors have completely eroded this industry over the years. The final closure of the Louisiana Pacific lumber mill in 2007 led to employment and income shortfalls for which no large-scale or single-source replacement has been found. These factors and others have led to the classification of Harney County as one of Oregon's "Top Five Distressed Counties" by Business Oregon. While the number of jobs in Oregon has grown more than 74% in the last 40 years, they have fallen significantly in Harney County, where there are 10% fewer living-wage jobs in the region now versus in 1976 (Oregon Office of Economic Analysis, 1976-2016). Harney County's unemployment rate at 13.1% is almost double the state rate of 6.8%. At the current time agriculture amounts to nearly 25-30% of the employment in the County. The Agricultural Census of 2017 shows cattle and hay production as the dominant agricultural producers in the area. The public sector is a primary employer accounting for some 39% of the jobs in Harney County. Bird viewing in the basin accounts for some 79 jobs and some $9,200,000 annually to the County (Bair et al., 2021).

OPPORTUNITY

NEW NATURAL RESOURCE ECONOMY

Over the last 20 or more years, there have been outstanding advances in Harney County toward implementing environmentally-sound, ecologically based ecosystem management throughout the region using a collaborative model. There also has been a shift in Harney County to embrace grassroots economic development strategies and BizHarney Opportunity Collaborative, an economic collaborative convened by HDP, is building on this interest by intentionally developing pathways for entrepreneurs and small businesses within the natural resources restoration and conservation sector. Opportunities are ripe as Harney County is uniquely located to capitalize on the area's land-based economy and multiple collaborative efforts are coming together to solve these complex issues.

8. Conservation Needs and Opportunities

Conservation Need

The Harney Basin wetlands and Malheur Lake constitute a continentally significant resource for migratory birds. This area is a critical part of the Pacific Flyway as documented in the North American Waterfowl Plan and identified as one of the areas of greatest continental significance to North American ducks, geese, and swans (U.S. Fish and Wildlife Service, 2012). The Harney Basin wetlands are part of SONEC that is an extremely important spring staging area for waterfowl and waterbirds. Through alteration of flooding patterns, the Donner und Blitzen and Silvies River floodplains had vast flooded wetlands used by migratory birds. The Malheur, Mud, and Harney Lakes complex were globally important bird areas. The water clarity of Malheur Lake has declined significantly over the past thirty years resulting in Malheur having extremely turbid water. Consequently, emergent and submergent vegetation has been reduced or eliminated. Bird habitat and bird use of Malheur Lake has diminished significantly with approximately 90% loss of resident waterfowl.

There are several factors impacting floodplain wetland habitats and the water clarity of Malheur Lake. Changes in riparian health, increased invasive species, field leveling and conversion to pivot irrigation has affected the flood irrigated wet meadows. In this semi-arid environment, one of the largest conservation concerns is the demand for irrigation water. Increasing irrigation demand in the face of increasing frequency and intensity of drought has put severe limitations on water resources in the basin. Outdated and failing irrigation infrastructure that do not allow for effective surface water management are being addressed by HBWC partners.

Malheur Lake

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Malheur Lake, once one of the largest freshwater marshes in North America and an important breeding area for numerous shorebird species, is now in a turbid state. The water is murky, vegetation is limited and nonnative common carp thrive.

Photo by Jeremy Hill, jhillimages.com

Malheur Lake is a large (≈ 19,600 ha), shallow (avg. depth ≈ 0.76 m; max depth ≈ 1.52 m), polymictic, terminal lake (endorheic basin), wetland-lake system with two major freshwater inputs, the Silvies and Blitzen Rivers (Miller, 2012; Williams et al., 2014). Malheur Lake is located within the Malheur National Wildlife Refuge, which is managed by the U.S. Fish and Wildlife Service. Malheur Lake was once one of the largest freshwater marshes in North America, serving as an important transitional area for migratory duck and geese species, breeding area for numerous shorebird species, and habitat for resident species (Duebbert, 1969; Cornely, 1982; MNWR, 2012). Currently, the aquatic ecosystem of Malheur Lake is highly turbid, with a lack of submergent and emergent vegetation, high levels of nutrients and suspended sediments in the water column, and diminished fish assemblage dominated by the non-native benthivorous common carp (*Cyprinus carpio*).

A major focus in the ecology of shallow lakes is on processes that determine whether a shallow lake such as Malheur Lake exists in one of two alternative stable states: clear or turbid. Clear states are characterized by an abundance of aquatic macrophytes, diverse aquatic biota, low water column nutrients and phytoplankton biomass, whereas the turbid state is characterized by the opposite (Scheffer et al., 1993; Scheffer & Carpenter, 2003; Janssen et al., 2014). A shift from a clear to a turbid state can be induced by several physical or ecological factors, and interactions among them, including climatic drivers, nutrient fluxes, hydrologic variability, biotic invaders, and losses of native species). These factors can also increase the system's resistance to a shift between states via reinforcing feedback loops (Hargeby et al., 2004). Identifying the mechanisms that maintain the turbid state and determining how to effectively change conditions to eventually shift the shallow lake back towards the clear state. Therefore, over the last six years HBWC has utilized a combination of historical literature review, systems modeling, and field research to provide a greater understanding of the drivers of turbidity in Malheur Lake and demonstrated the efficacy of multiple restoration alternatives targeted at shifting the aquatic ecosystem from a turbid to a clear state.

First HBWC utilized systems modeling to investigate the non-native carp population. The results demonstrated that restoration actions in the form of carp control solely targeting the adult life stage (commercial harvest) will likely be insufficient at suppressing and maintaining the carp population below the desired 50 kg/ha (hypothesized to be the threshold at which waterfowl productivity would increase via the recovery of lake clarity and aquatic vegetation; Vilizzi et al. 2015). The difficulty in changing the lake conditions by carp harvest alone is due to the carp population exhibiting compensatory density dependence, in which demographic rates shift in response to population densities (Pearson 2020, Pearson et al. 2019, Weber et al., 2016; Rose et al., 2001). This means that as carp are harvested, their reproduction increases making population control difficult by harvest alone. These simulations demonstrated that management actions directed at suppressing the carp populations should target multiple life-stages to overcome these compensatory responses. Furthermore, modeling also demonstrated that the highly variable environment of Malheur Lake (lake level fluctuations) is likely a significant factor affecting the carp population with lower lake levels reducing the population and higher levels resulting in higher carp populations. This affects the ability for managers to impose mortality rates via removal efforts.

The results of the Malheur Lake system modeling suggest that lake fluctuations driven by environmental variability drive the carp population in Malheur Lake, with lake level fluctuations responsible for the carp biomass naturally falling below the critical threshold (50 kg/ha ≈ 17% of the years). However, Malheur Lake has maintained the turbid state during these years, and further modeling efforts more broadly focused have demonstrated that wind-wave resuspension (Figure 11) would likely maintain the turbid state (Figure 12) in the absence of carp. For instance, the modeling demonstrated that wind-wave resuspension is driven by both physical and environmental factors (i.e., water depth, wind fetch, and wind speed; Figure 13), and therefore, restoration treatments such as wave reduction barriers could be used to decrease the overall suspended

sediment concentration and increase light in the water column. Collectively these results reinforce the notion that future restoration actions in Malheur Lake must be more broadly focused (i.e., systems perspective). It is recognized that there are alternative stable states for shallow lakes and understanding the conditions that move conditions towards clear water or turbid water will improve management decisions (Scheffer et al., 1993; Janssen et al., 2014; Williams, 2005).

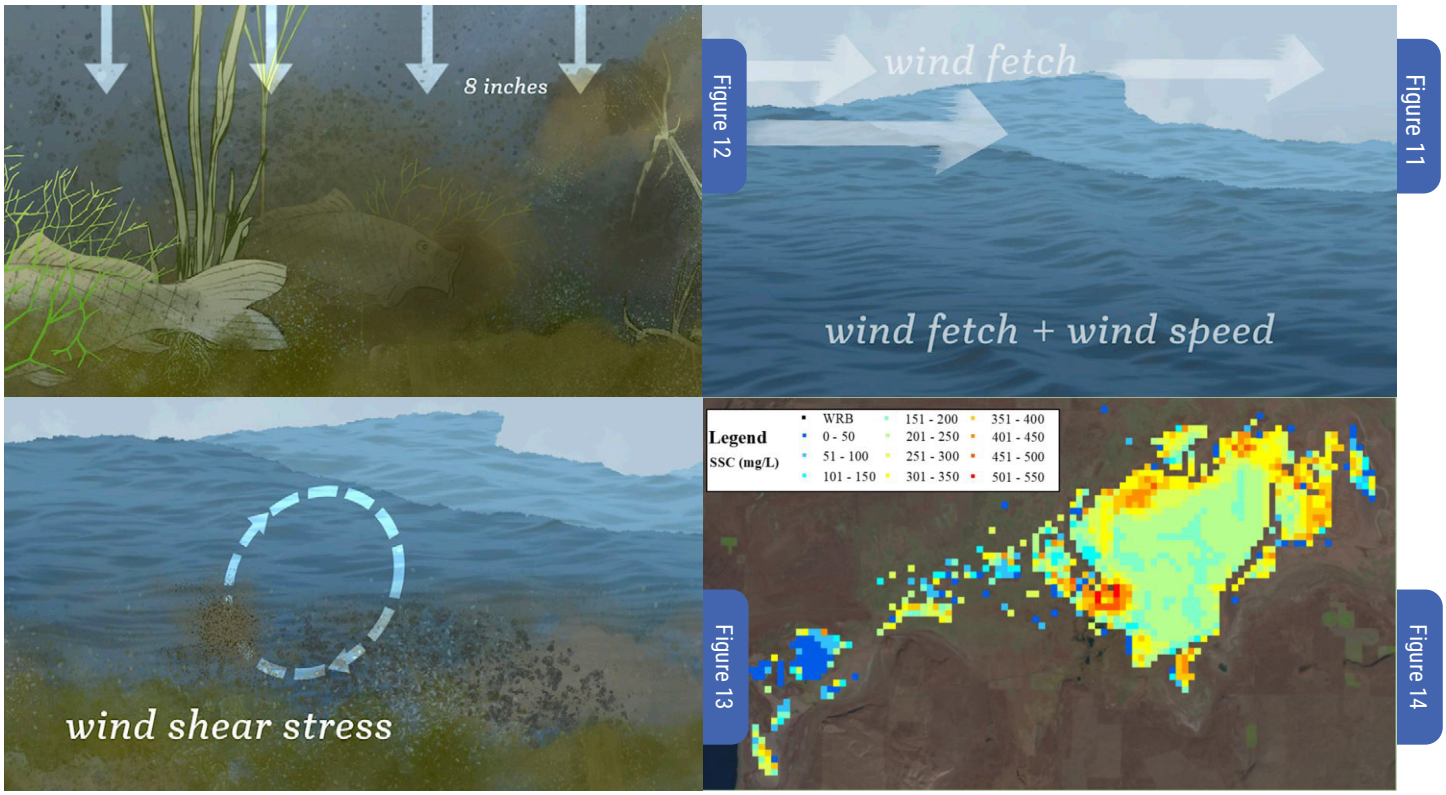


Figure 11: A visual demonstration of wind fetch and wind speed.
Figure 12: A visual demonstration of a turbid water column, in which suspended sediment resuspended by the activity and mode of feeding by the carp and the wind-wave resuspension. This image also shows how the photosynthetic active radiation is extinguished within 8 inches (20 cm) of the water column.
Figure 13: A visual demonstration of wind shear stress. Wind shear stress is the energy exerted at the sediment water interface. As the wind shear stress increases, more sediment is suspended into the water column.
Figure 14: A wind-wave resuspension model output demonstrating the average suspended sediment concentration (SSC; mg/L) for each cell throughout Malheur Lake.

Recognizing that there are alternative stable conditions of clear water or turbid water, the presence and or absence of aquatic macrophytes (emergent and submergent vegetation; Figure 15) is the main driver that stabilizes either of the states (clear/turbid) in perpetuity. For instance, aquatic macrophytes reduce wind driven sediment resuspension (Figure 13) via shortening the effective wind fetch (Figure 11) and settling the sediment which subsequently reduces internal phosphorus loading and promotes the establishment of benthic algae (Horppila et al., 2013; Zhang et al., 2013). The establishment of benthic algae further removes nutrients from the water column and decreases the susceptibility of sediment to wind resuspension (Zhang et al., 2013). Furthermore, aquatic macrophytes provide structural habitat for zooplankton (Figure 17), increasing their negative effect (predation) on the phytoplankton biomass (Figure 13), which further increases water clarity (Timms & Moss, 1984). Lastly, aquatic macrophytes take up nutrients available in the water column, release allelopathic chemicals, and oxidize sediment, all of which decrease the amount of phosphorous available to phytoplankton, further reducing phytoplankton biomass and increasing water clarity (Wium-Andersenet al., 1982; Carpenter et al., 1983; Ozimek et al., 1993; Williams, 2005). In the context of Malheur Lake restoration, aquatic macrophytes, while generally described for their benefit as habitat to residential and migratory bird

species (i.e., material, food, shelter, etc.), also act as a system stabilizing mechanism that is crucial for the establishment and maintenance of the clear state.

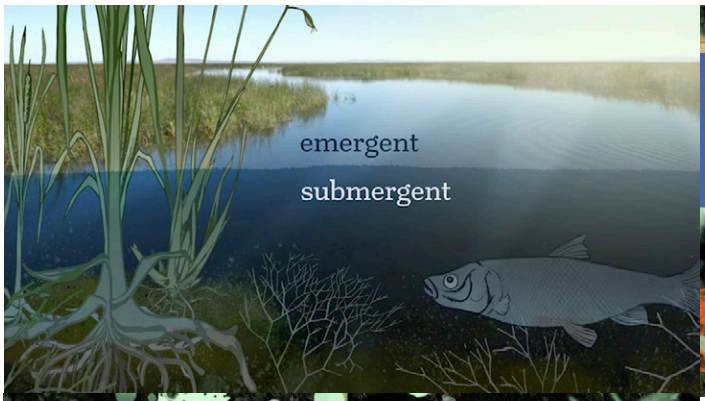


Figure 15

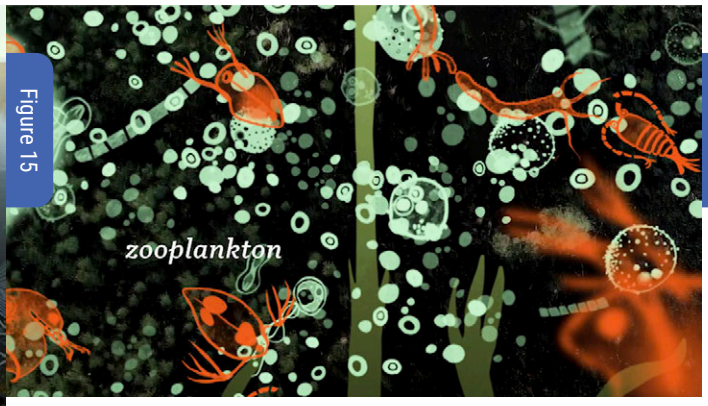


Figure 16

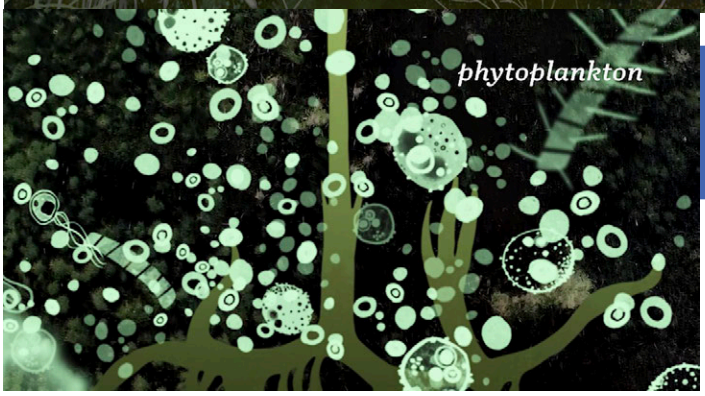


Figure 17

Figure 15: A visual demonstration of emergent and submergent vegetation.
Figure 16: A visual demonstration of zooplankton.
Figure 17: A visual demonstration of phytoplankton.

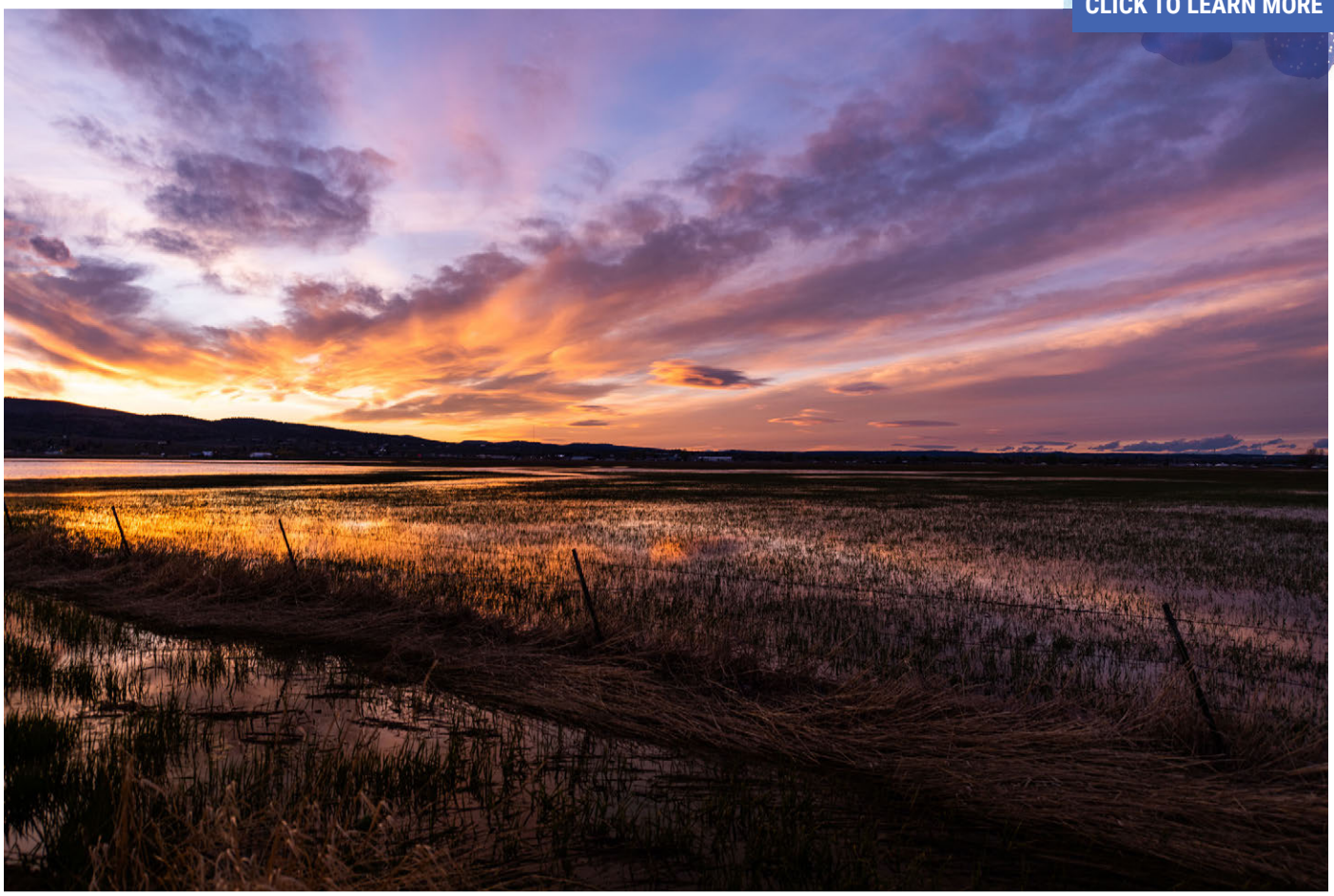
Aquatic macrophytes have generally been identified as an important system stabilizer, emergent vegetation may have specific importance to Malheur Lake. For instance, emergent vegetation (e.g., bulrush, cattail, etc.) can act to dissipate wave energy in shallow lakes, decreasing the winds forces and limiting resuspension of bottom sediments. The rigid stems of emergent vegetation dissipates the effective turbulence, and lower the frequency of resuspension events (Horppila et al., 2013). Emergent vegetation has also been shown to have a large effect on reducing internal phosphorus loading, with emergent vegetation decreasing loading by 26 mg/m2/d (Horppila & Nurminen, 2005). Carp have not been demonstrated to have a deleterious effect on emergent vegetation. Many studies have demonstrated the negative effect carp have on submergent vegetation both directly and indirectly (Crivelli, 1983; Lougheed et al., 1998; Miller & Crowl, 2006; Matsuzaki et al., 2007; Weber & Brown, 2009). Unlike submergent vegetation that is adversely affected by carp, emergent vegetation should be able to persist even in the presence of carp and dissipate wind energy and potentially promote favorable growing conditions for submergent vegetation during years coupled with carp management treatments.

These findings led us to conduct a historical review of the Malheur National Wildlife Refuge literature, demonstrating that emergent vegetation once occupied 40% to 53.9% of the surface area in the two main units of Malheur Lake (west and central units respectively; Deubbert, 1969; Spencer, 1994). During the 1980's Malheur Lake increased to a lake area of ≈ 51,500 ha (average lake area = 19,200 ha) with a max depth of ≈ 4.4 m (avg max depth = 1.26 m), exceeding all previously instrumented recordings (Hostetler & Bartlein, 1990). These floods inundated the previously robust emergent vegetation stands for an extended period under depths at which they were not able to survive. Once the flooding subsided, Malheur Lake was devoid of emergent vegetation except for a narrow area around Malheur Lake. It has been hypothesized that the loss of emergent vegetation, specifically the rooted structures that act to secure the sediment is why Malheur Lake is now highly susceptible to wind resuspension (Hamilton et al., 1986; Spencer, 1994; MNWR, 2012).

While our modeling has identified the output variables to be addressed for the management of the carp population and wind-wave resuspension in Malheur Lake, we now recognize that to overcome the momentum of the reinforcing feedback loops pulling Malheur Lake towards the turbid state, a large-scale transformative effort is necessary, incorporating a combination of carp suppression, wind-wave suppression, and restoration of emergent vegetation, to not only flip the current state, but also maintain the clear state in perpetuity (Williams, 2005; Kates et al., 2012, Pearson 2020, Pearson et al., 2021).

Flood Irrigated Wet Meadows

CLICK TO LEARN MORE



Flood irrigated wet meadows in the Harney Basin provide habitat for resident and migratory birds as well as hay for local cattle ranches. Photo by Jeremy Hill, jhillimages.com

In the original 2015-2021 strategic action plan for HBWC conservation targets for spring migratory bird habitat were established on the basis of North American Waterfowl Management Plan population targets for northern pintail in the SONEC region and U.S. Geological Survey bioenergetics modeling to calculate habitat acres needed to support the target population. It was estimated through these modeling efforts and field studies that evaluated the foraging value of flood irrigated habitats to the principal waterfowl using them, that a minimum of 10,300 acres of flood irrigated wet meadow habitat is necessary to support target populations for this species and currently the minimum acreage is met but maintaining and enhancing acres a high priority.

During spring migration, the Silvies River floodplain supports high numbers of migrant waterfowl. A study conducted by the USFWS in the late 1970s and early 1980s found that 56 percent of the waterfowl use in the Harney Basin occurred on the private lands of the floodplain during the spring. Scientists from the U.S. Geological Survey have documented the importance of such flood irrigated areas in southeastern Oregon and northeastern California; these areas support about 80 percent of the Pacific Flyway pintails during spring migration (Miller et al. 2010).More recently, the dependence of spring migrating dabbling ducks moving through the Oregon SONEC was further reinforced by tracking migration stopovers of Cinnamon Teal (Mackell et al., 2021).

Northern Pintails, as well as most other waterfowl, saw a sharp decline in numbers in the late 1970's and early 1980's. Urbanization and changes in agricultural practices throughout the continent created a habitat deficit. This deficit in conjunction with continent wide drought conditions in the 1970's and 1980's led to the sudden decline of these migratory birds. While there has been a recovery of numbers, the threats remain with changing climate and irrigation conversion. Emerging research is demonstrating a strong correlation between Northern Great Basin snowpack and breeding success in the northern prairies, presumably a function of snowmelt and resources made available on seasonal wet meadows.

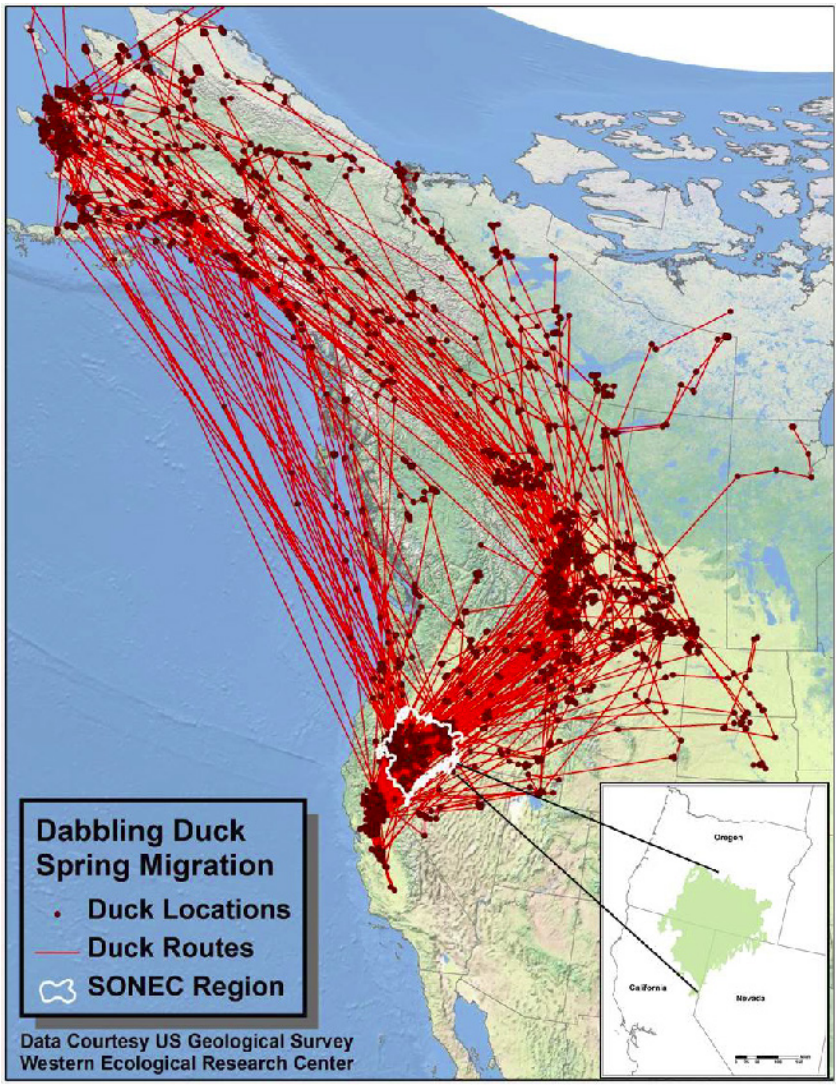


Figure 18: Spring migration routes by strategy category of adult female Northern Pintails PTT-tagged in the northern Central Valley of California during December-January and tracked annually through August each year 2000-2003 (Michael R. Miller, 2005).

Within the Pacific Flyway management region, there are 14 areas of concern named in the NAWMP. The intermountain west contains six of these regions (NAWMP, 2018). IWJV named the Great Salt Lake and the SONEC regions as their two top priorities in their 2013 plan. It is estimated that about 50% of the Northern Pintail's continental population uses the Pacific Flyway. Of those birds, approximately 70% (1/3 of the continental population) pass through the SONEC region before heading north either following the Rockies or west of the Cascades (Fleskes and Gregory 2010; Figure 6). It is the food resources in the flood irrigated pasture and hay land that keeps these birds returning annually (Beatty et al. 2014).

More recent evaluations of wetland change in the southern Oregon, Nevada, eastern California areas have further documented the importance of privately managed wetlands (Donnelly et al. 2019). The authors conclude: "Patterns indicate privately owned flood-irrigated hay meadows, first settled in the late 1800s for their persistent water resources (Sauder 1989), remain a major driver of habitat abundance seasonally. Hay meadow sites were unique in that they were confined to riparian floodplains and lowlands." Today, 61% of snowpack driven wetlands occur on privately owned agricultural lands, and of all irrigated lands only 7% provide this critical wetland value (Donnelly et al. 2020). The flood irrigated wet meadows of the Harney Basin are part of this 7% irrigated agriculture footprint. The large percentage of that footprint that falls under private ownership is part of what makes conservation efforts of wet meadow habitats so complex from a socioeconomic standpoint.

The evaluation of wetland hydrology using Landsat imagery has developed a tool to evaluate the hydroperiod of wetlands at a scale useful for connecting plot data with basin scale patterns. Past HBWC efforts to document the plant communities that exist in flood irrigated wet meadows, and the bird populations that utilize them, can now be evaluated through the lens of seasonal water persistence on the landscape to link surface water presence, plant communities, and wildlife use.

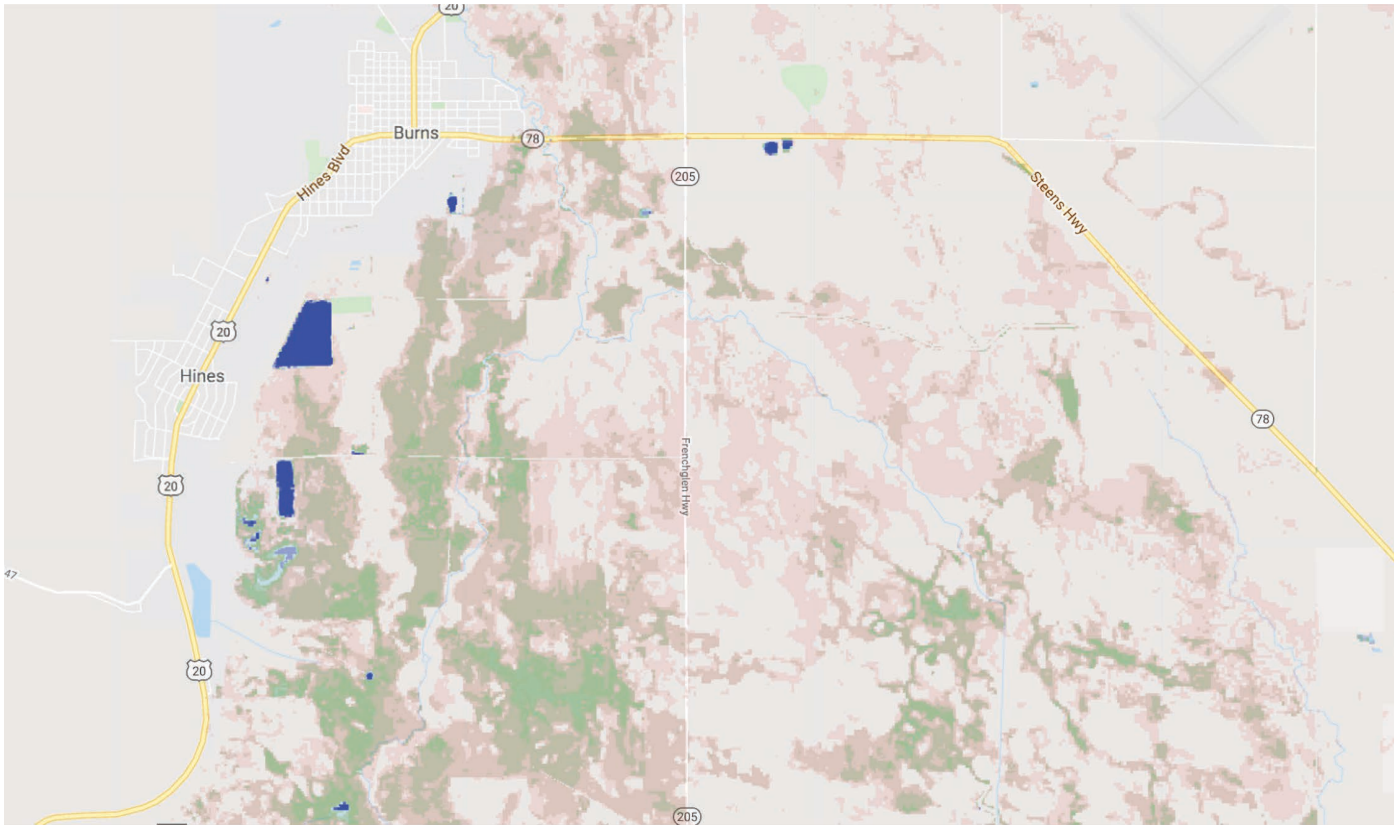


Figure 19 & 20. Hydroperiod data is being used to help with land management. This is one example of some data showing the hydroperiods on the Silvies River floodplain. Mean 2015-2019. Pink-temporary (flood=<2months); green-seasonal (flood>2 and =<7months); blue-semi-perm wetlands(flooded>7months). Provided by Patrick Donnelly 2020.

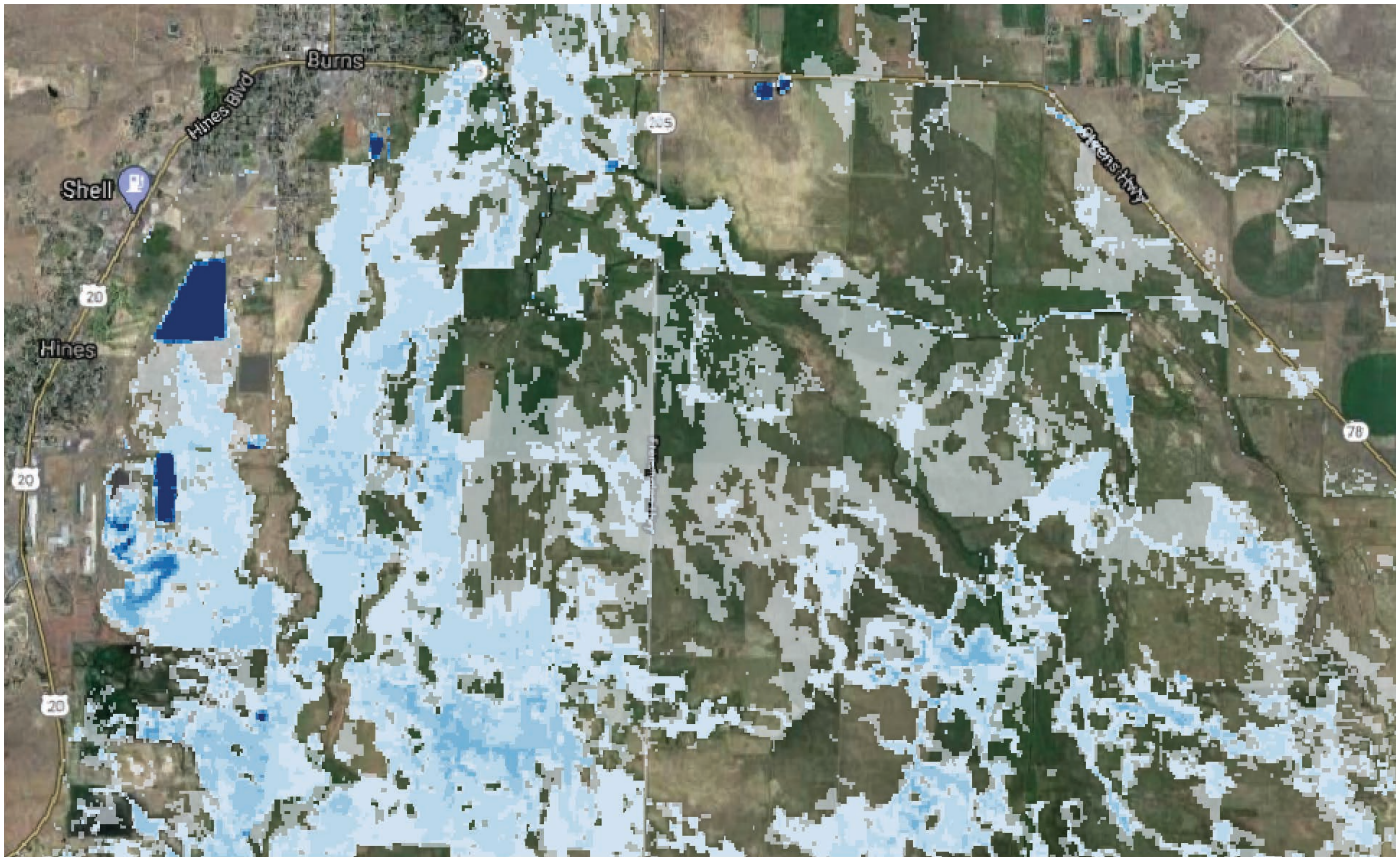


Figure 20

Donnelly et al. (2019) concluded that to maintain migratory pathways land managers must maintain dynamic wetland systems. “Our findings emphasize the joint role of public–private wetland resources in supporting migratory waterbirds. While the focus of this work is placed on waterfowl, outcomes are applicable to conservation of all migratory waterbird species. In arid landscapes, predictions of increased climate variability are likely to intensify resource bottlenecks (e.g., fall migration) triggering temporal mismatches in wetland flooding and energetically demanding migration events (e.g., Maron et al. 2015). To bolster landscape resiliency, we encourage development of conservation strategies that maintain wetland function aligned with migratory waterbird needs and timing.”

The emphasis on managing water use for a variety of outcomes such as plant community composition, surface water persistence and timing and maximum productivity has become a significant driver of strategies for further conservation of wet meadow systems. The work of the last few years has focused on building understanding of vegetation-hydrology relationships through the construction of state and transition models where the driving factor is hydrology. Restoration work has primarily focused on improving water management infrastructure to provide a win-win scenario where private landowners gain greater management flexibility of water distribution, reducing the threats of conversion to alternative land uses. The work has led to a more holistic view of the human development activities that has changed water distribution across the Silvies River floodplain (Figure 21).

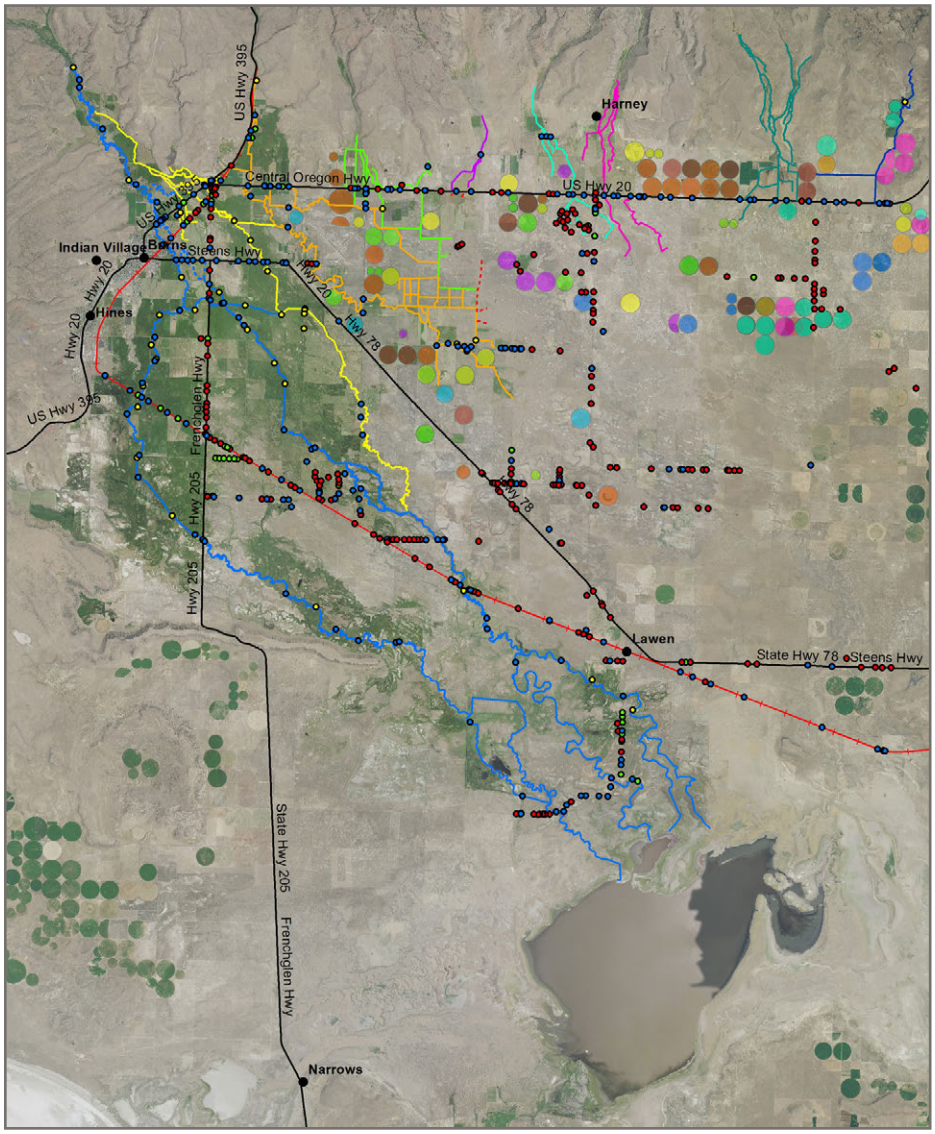


Figure 21: Silvies River Floodplain Alterations (2016 NAIP imagery)

Blue dots: surface conveyance infrastructure.

Red dots: surface conveyance obstructions; could be roads, levees, etc.

Green dots: unknown whether there is infrastructure (culvert) or not.

Yellow dots: dam or diversion infrastructure.

Blue dotted lines: historical channels that are no longer active.

Red lines: suspected drain ditches.

Solid lines: respective stream systems, based on interpretation, separated by color.

Pivots: as they emerge on Google Earth imagery across a timescale from pre 1994 through post 2016, starting in yellow and transitioning through aqua, green, yellow, orange, red, grey, and white as time goes by, with white being only a few years old.

HBWC is working to gain a more comprehensive understanding of the complexity of water flow across the altered floodplain through several avenues. This work will help identify restoration opportunities and limitations. For example there is no map of all the current infrastructure in the basin. Many roads have undersized culverts flowing under them that are changing the way water flows across the landscape. Nearly all of the floodplain area of interest is on private lands; it will require considerable effort and partnerships to improve and restore natural hydrology where feasible. (Figure 21)

HOW WILL CLIMATE CHANGE AFFECT THE HARNEY BASIN?

It is highly possible that the impacts of climate change will affect the efficacy of restoration strategies and/or require future adaptations as conditions evolve. Fortunately, there has been significant evaluation of the potential effects of climate change on wet meadow systems (Donnelly et al., 2020; Haig et al., 2019) and Malheur Lake carp management (Pearson et al., 2020). In a review of the effects of climate change on waterbirds Haig et al (2019) state: “Regional water management strategies will need to consider the mosaic of water needs throughout the annual cycle in order to forestall loss of critical breeding grounds and a hemispheric migratory pathway.” The refined understanding of the Harney Basin ecology and hydrology of

these critical ecosystems built over the last few years will enable the development of restoration strategies that can be readily adopted by water users to build resilience into the changing wetland systems.

Malheur Lake and Climate Change

Malheur Lake is a large terminal lake, which exhibits large annual lake fluctuations. For instance, in the past Malheur Lake fluctuated from ≈ 51,500 ha in 1986 to ≈ 550 ha in 1992 (Figure 22). The fluctuations in lake area are primarily driven by precipitation runoff and evapotranspiration (Hubbard, 1975; Hamilton et al. 1986). Precipitation falls primarily as snow and accumulates in the Steens and Blue Mountains and melts in the spring and early summer. Runoff enters Malheur Lake via the Silvies and Blitzen Rivers, which drain a total area of ≈ 7,770 km2 (Hamilton et al. 1986). Malheur Lake is located within the Great Basin region of the United States where climate change projections predict a decrease in the annual snow water equivalent (≈30% decrease in SWE by mid-century in Pacific Northwest; Naz et al., 2016), and more frequent drought conditions (low spring snowpack; Lute et al. 2015), which in turn, will likely reduce the size of Malheur Lake (Dalton et al. 2018; Mote et al., 2018; Snyder et al., 2019).

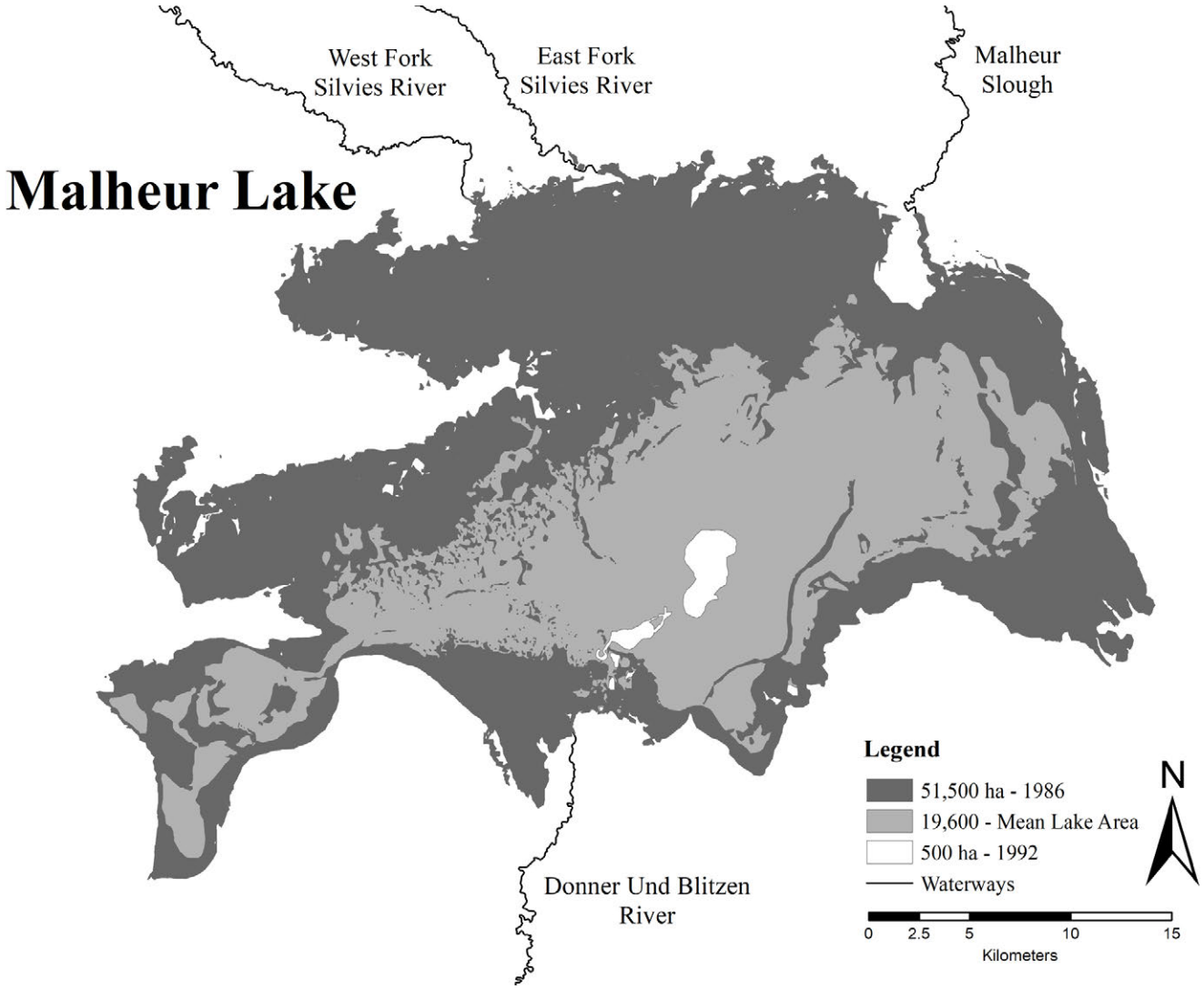


Figure 22. Map of Malheur Lake, located within the Malheur National Wildlife Refuge in Southeastern Oregon. The dark gray region depicts the maximum lake area extent in 1986 (≈ 51,500 ha), the gray region depicts the average fall lake area (≈ 19,600 ha), and the light gray region depicts the lowest lake area extent in 1992 (≈ 550 ha).

A recent study on the effects of climate change on SONEC wetlands over the past 35 years (Donnelly et al., 2020) finds a significant loss of wetlands peripheral to Malheur Lake (-81%) and loss of lake area (-59%). Although these figures are especially high as a result of a record flooding and precipitation during the first year of this study (1984), the decline of wetlands over the last 35 years in the Harney Basin, mirrors wetland trends in other snowpack driven closed basins in the Northern Great Basin. These changes are correlated with significantly increased evapotranspiration, a modest decrease in snowmelt equivalent and precipitation over the 1983-2018 period. All this recent information highlights the need for better local information on specific impediments to wetland conservation, such as the correlation between snowpack and surface water availability and timing and helps to direct HBWC work to build wetland ecosystem resilience through restoration and improved water management tools to influence hydrology and associated habitat characteristics.

As decreased snowpack and snowmelt occurs due to climate change, Malheur Lake will likely have less surface area over time. Concerns of the impacts of climate change throughout the Great Basin on terminal lakes include the potential of traditional freshwater lakes shifting towards saline lakes, and existing saline lakes becoming hypersaline lakes (Haig et al., 2019).

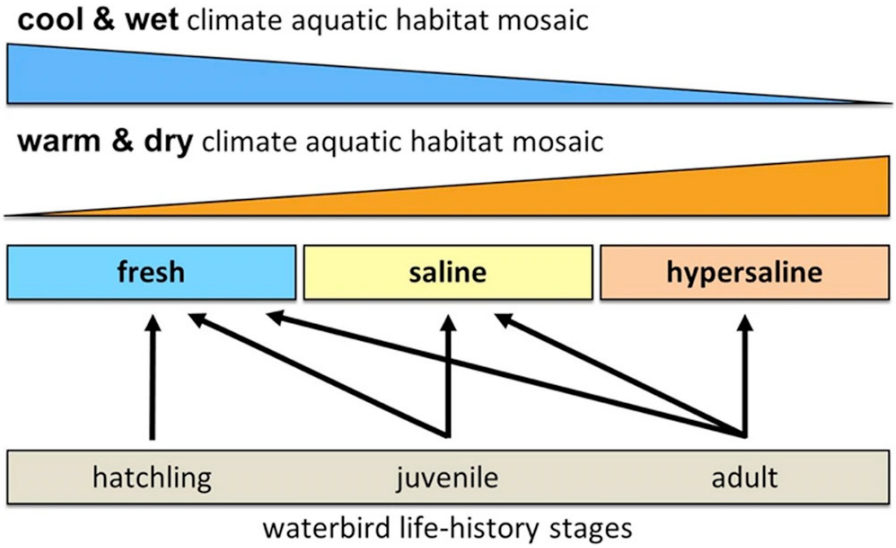


Figure 23: Hydro-climatic relationships in dry systems. Associations of climate variability with wetland water type (fresh, saline and hypersaline) and the connection to specific migratory waterbird life-history stages. The relationship between wetland type and climate illustrates the contraction of variability in wetland type during wet (blue wedge) and dry (orange wedge) years. As shifts continue toward a warmer, drier climate, the diversity of wetland types will transform. (Taken from Haig et al, 2019.)

The generally drier conditions expected in the future may decrease carp biomass which will make carp populations easier to control; however, this may not compensate for other negative impacts of climate change on the aquatic ecosystem (Pearson et al. 2020). Drier conditions may result in desiccation of what little emergent vegetation presently exists in Malheur Lake. This could further exacerbate the already significant wind fetch problem that significantly contributes to poor water quality (Pearson et al. 2020).

Flood Irrigated Wet Meadows and Climate Change

White-faced Ibis are commonly seen foraging in the wild flooded wet meadows of the Harney Basin. A ring- billed gull searches for food from the air.

Photo by Jeremy Hill, jhillimages.com

Snowpack driven wetland systems appear to be more vulnerable to climate change than monsoonal wetlands in the southern end of the Central and Pacific Flyway (Donnelly et al. 2020). Snowpack driven wetlands are facing functional reductions and losses as a result of climate change. As previously noted, privately owned wet meadows comprise the majority of wetland acres in closed basins. Investments on private lands will be critical for the future of wetland ecosystems. To address changing climate conditions, the partnership will expand communications with private landowners to use information developed from the state and transition models of wet meadow systems in managing irrigation water. The ongoing Harney County community-based water planning effort will be an opportunity to adjust allocation of surface water using the information on the appropriate timing, depth and duration of flooding that optimizes bird use and pasture production. Additionally, tools for private landowners to understand the effects of water use on plant communities and improved water management infrastructure can assist in the management of surface flood waters. To counter the effects of significantly increased evapotranspiration, modest decreases in snowmelt equivalent, and precipitation in the catchments tributary to Malheur and Harney Lakes will require careful consideration of water distribution during the spring freshets. Flood irrigation in the Harney basin is conducted on an ownership basis. Each landowner maintains and manages their own irrigation system, thus adjustments to the built infrastructure are individual decisions. However, multiple projects will be required to allow for effective water management. New tools and models will inform strategies that can identify where projects can be developed and implemented to assure flooding of core

areas critical for both hay production and bird nesting and feeding. The selection of irrigation infrastructure upgrades and other projects to improve flooded habitats will focus on retaining resiliency of these critical seasonal wetland habitats.

Since the flood irrigated wet meadows are managed by private ranchers, the focus of our efforts is to provide information in a way that can influence their decision making (Sketch et al., 2020). HBWC expects that through improved economic viability of wet meadow-dependent ranches, and improved decision-making for wetland habitat managers who do not have forage production as a primary objective change in irrigation management will provide improved benefits to both ranchers and migratory birds. The overall goal is to maintain productivity and improve biodiversity of plants and animals in the face of changing climate.

From a bigger picture standpoint, this effort will also test an approach that, to the knowledge of HBWC's partners, has not been attempted within the climate adaptation community. The nature of water availability is clearly going to change in the future, and managers need a way to approach that change. The information generated by this effort will be shared with water planning efforts in the area, since those efforts may impact irrigation of flood irrigated wet meadows.

9. Theory of Change

The following results chain (Figure 24) is a graphical representation of HBWC partner's theory of change. Please note the assumed or predicted relationships between strategies, implementation results (outputs), near- and long-term ecological results (outcomes), as well as the connections to economic and social priorities that represent HBWC/HDP broader goals.

Numbered results are those HBWC desires to integrate into a progress monitoring framework that facilitates its ability to measure progress toward both near- and long-term objectives. Each numbered result in the results chain corresponds to the same results in Tables 1 and 2 where objectives are defined and metrics or indicators are shown.

STRATEGIES

HBWC strategies fall into six general categories:

1. Malheur Lake Restoration
2. Flood Irrigated Wet Meadow Management
3. Infrastructure Improvement
4. Tributary Restoration
5. Building Knowledge to Share
6. Community Engagement

Together, these strategies are designed to advance two overarching goals:

1. Malheur Lake: restore ecosystem structure and processes necessary to return Malheur Lake to a clear water stable state supporting healthy plant and animal communities.
2. Flood Irrigated Wet Meadows: manage floodplain wet meadows in the Harney Basin to support healthy bird populations and floodplain function.

E-4

Notations like these are referring to specific boxes in the Results Chain (Fig. 24)

Malheur Lake Restoration Strategies

STRATEGY 1: REDUCE WIND FETCH

Theory of Change

Restoration of lake bottom microtopography creating wind barriers [1-2] and planting of emergent vegetation are intended to reduce the area of open water and therefore the reduction of wind fetch. These outcomes will contribute to a reduction of suspended sediment and an increase in water clarity [E-3] directly or through a reduction in nutrients [E-4] that are available for phytoplankton production. Improved water clarity [E-3] will increase photosynthetic radiation necessary for emergent and submerged aquatic vegetation germination, maturation, and proliferation [E-12]. As emergent and submergent vegetation increases, food abundance and availability for birds and fish increases respectively. These outcomes are predicted to produce an overall increase and shift toward bird populations and use [E-11] for species that depend on these types of aquatic habitats in Malheur Lake.

STRATEGY 2: REDUCE PHYTOPLANKTON AND CYANOBACTERIA

Theory of Change

Sediment stabilization by addition of aluminum sulfate or other measures[2-1] (alum) into the lake water column is expected to reduce nutrient concentrations[E-4] and suspended sediment by promoting the formation of a floc (when alum binds to phosphates) that then settles to the lake bottom where it is unavailable for phytoplankton production. The resulting reduction in phytoplankton will improve water clarity[E-3]. Reduced suspended sediment contributes to an increase in submerged aquatic vegetation[E-12], habitat for birds[E-1] and aquatic invertebrates that are an important food resource for birds and fish.

STRATEGY 3: REDUCE CARP

CLICK TO LEARN MORE

Nonnative common carp flourish and are a detriment to native aquatic life in Malheur Lake and the Harney Basin rivers and streams. An annual carp 'roundup' where thousands of carp are caught helps to reduce the population.

Theory of Change

Implementation of carp control measures including actions to limit carp reproduction[3-1], constructing barriers to prevent carp access into targeted areas[3-2], and the active removal or harvesting of carp[3-3] will result in a reduction in the spatial distribution and overall biomass of carp[E-3]. Fewer carp across a smaller spatial extent will contribute to an overall increase in water clarity[E-5] by reducing suspended sediment.

Improved water clarity[E-3] will increase photosynthetic radiation and increase the abundance and spatial extent of aquatic vegetation[E-12]. As emergent and submergent vegetation increases, food abundance and availability for birds and fish (in the form of aquatic invertebrates) increases. These outcomes will produce an overall increase and positive shift in the relative abundance of bird populations and use[E-11] for species that depend

on these types of aquatic habitats in Malheur Lake and an increase in growth and productivity of native fish species. In addition, an increase in invertebrates that consume phytoplankton will also contribute to an increase in water clarity[E-3].

STRATEGY 4: FORMULATE NEW STRATEGIES

MALHEUR LAKE MANAGEMENT

HBWC and the Malheur National Wildlife Refuge will continue to learn from all restoration efforts, current research on emergent vegetation establishment, carp research, and water quality data. Planned and ongoing mesocosm study will show which strategies are working and which need improvement. Malheur Lake is a very dynamic system that presents difficulties in predicting outcomes of management efforts.

Future water management strategies that could be investigated:

- Lake subdivision using temporary levees.
- Diverting water in the Blitzen River from Dunn Dam into the Butte Ditch channel to send water into the western part of Malheur Lake during certain conditions to promote aquatic vegetation.
- Create a drain system through the narrows to Mud Lake.
- Create an access road to get equipment to Malheur Lake for restoration activities.
- Create “living” bulrush wind barriers.

Flood Irrigated Wet Meadow Management

CLICK TO LEARN MORE

HBWC partners will continue efforts to maintain flood irrigated land use and respective wet meadow habitat and processes on private lands and on lands managed by the Malheur National Wildlife Refuge. Flood irrigated wet meadows on private lands support spring migration habitat water birds, breeding habitat for some birds. Managed wet meadows on Malheur National Wildlife Refuge lands are intended to provide breeding and migrating habitat for both water and land birds. Actions on both private and Malheur National Wildlife Refuge lands may also include improvements for fish passage in conjunction with irrigation infrastructure upgrades where needed and possible.

STRATEGY 5: MAKE STRUCTURAL IMPROVEMENTS

This strategy focuses on improving flood irrigation infrastructure so that it is safe to operate, efficient, and allows for optimal water management and improved fish passage[5-1].

A new concrete diversion structure to more effectively move water to the head gate in the distance. The head gate can be opened as needed to flood the meadow with water that lies beyond the gate. Photo by Jeremy Hill, jhillimages.com.

Theory of Change

Upgrading flood irrigation infrastructure will improve operator safety and efficiency with which water can be effectively managed for multiple uses [5-2] including the maintenance (or expansion) of shallow water wet meadows[E-6]. Effective water management and maintenance of wet meadows will reduce the drivers of wet meadow habitat loss on private lands in part because these will improve or maintain the profitability of forage production, reducing the incentive to convert flood irrigated meadows to other land uses. Maintenance or expansion of shallow water wet meadows through improved water management will result in the habitat of sufficient quantity and quality to support current or increasing use and abundance of target migratory waterbirds on both Malheur National Wildlife Refuge and private lands across the Harney Basin[E-10]. Increased operational flexibility of irrigation systems will also allow water to be managed in a way that inhibits invasive plant species and promotes desirable vegetation. A reduction of the extent of invasive plants[E-7] promotes the abundance and diversity of native and desirable non-native plant associations[E-8] and the maintenance or expansion of areas of wet meadow with short stature vegetation in the spring[E-9] needed to provide habitat for target migratory waterbirds.

Fish passage improvements [5-1] will also be integrated into irrigation infrastructure upgrades to contribute to an increase in the resilience of native fish populations. For example, the state sensitive Great Basin redband trout use ephemeral and perennial streams to migrate and spawn as well as seek thermal Malheur National Wildlife Refuge during times of drought.

STRATEGY 6: FORMULATE AND IMPLEMENT TARGETED MANAGEMENT STRATEGIES

This strategy constitutes actions defined by a management tool or guide [6-2], the state and transition model. Actions include weed treatment [6-1] or water management approaches that inhibit invasives and promote desirable vegetation and agricultural management practices in wet meadows associated with hay production or grazing that contribute to improved meadow conditions as it relates to bird habitat and forage quality.

Other actions (to be defined) [6-3, 6-4] will be implemented to reduce drivers of wet meadow habitat loss on private and Malheur National Wildlife Refuge lands.

Theory of Change

The development of a management tool or guide based on a state and transition model will inform weed treatments and water management actions to reduce the extent or expansion of invasive species[E-7] and therefore maintain or increase the abundance and diversity of native and desirable non-native species[E-8]. A reduction in invasive species [E-7] also promotes the acreage of wet meadows with short stature in the spring[E-9]. These are outcomes needed to increase wet meadow habitat of sufficient quality and quantity to support an increase in the abundance and use of target bird species on private and Malheur National Wildlife Refuge lands[E-10].

Tributary Restoration Strategies

STRATEGY 7: RIPARIAN AND CHANNEL ENHANCEMENT

Theory of Change

Actions to enhance riparian areas along tributaries to Malheur Lake[5-1] increase the extent of riparian vegetation[E-1] which stabilizes streambanks and reduces erosion and subsequent sediment inputs into the stream and ultimately improving Malheur Lake water clarity[E-3]. Riparian enhancement also contributes to a reduction in nutrient inputs and concentrations in Malheur Lake[E-4] and associated phytoplankton and cyanobacteria production in Malheur Lake. A reduction of sediment inputs and nutrients therefore contributes to an increase in Malheur Lake's water clarity[E-3].

Stream channel enhancements designed to raise the bed elevation will consequently raise the water table[E-2]. An elevated water table contributes to the maintenance and increase in the area of wet meadows. This outcome contributes to improving the profitability of forage production on private lands and the development of habitat quality necessary for migrating waterbirds on private and Malheur National Wildlife Refuge lands and therefore contributing to the increased use and abundance of target birds of wet meadows across the Harney Basin[E-10].

An elevated water table[E-2] also increases the duration and discharge of water in stream systems that support habitat necessary for sustaining native fish populations and increased resiliency in the face of climate change (Silverman et al., 2019).

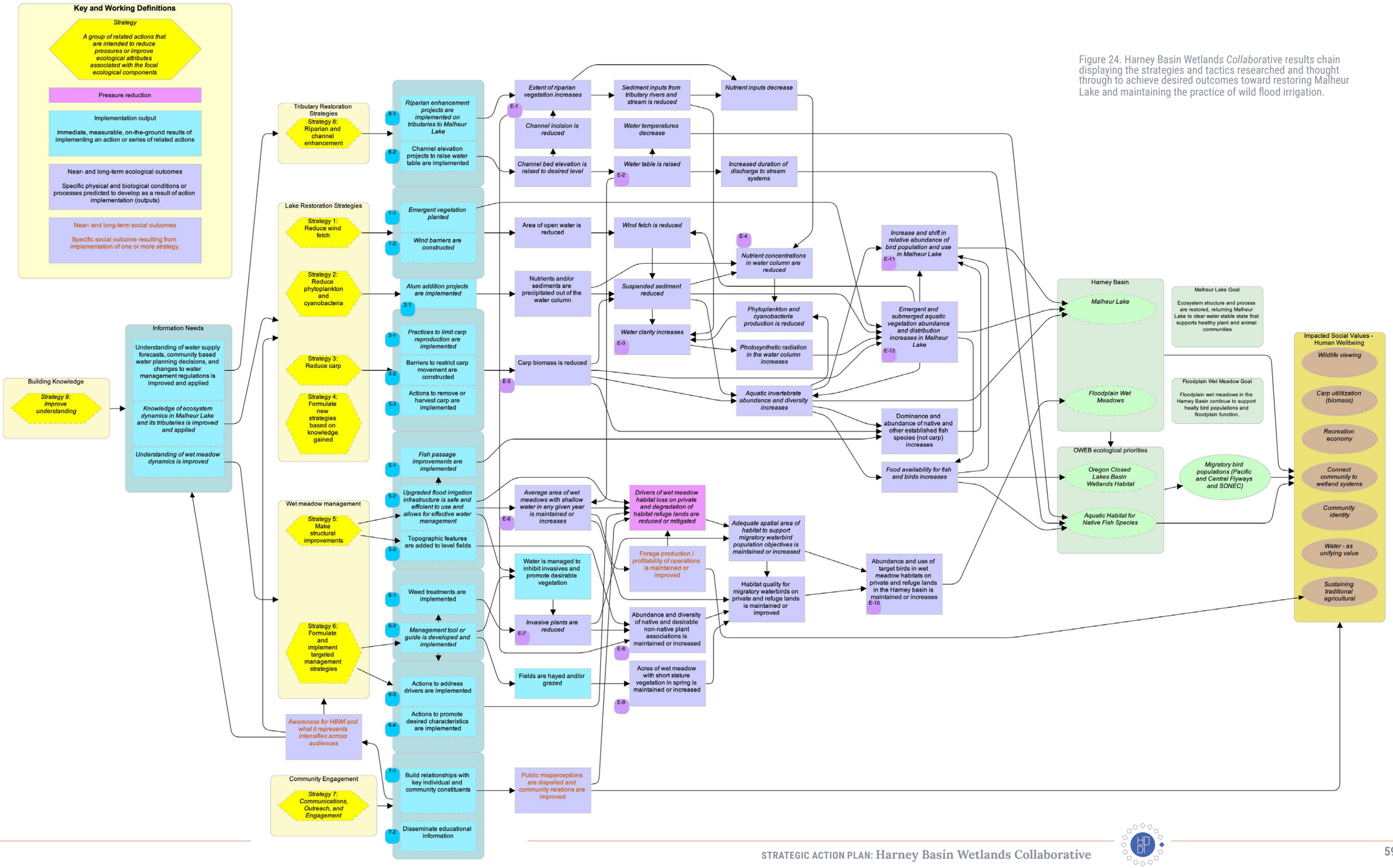


Figure 24. Harney Basin Wetlands *Collabora*tive results chain displaying the strategies and tactics researched and thought through to achieve desired outcomes toward restoring Malheur Lake and maintaining the practice of wild flood irrigation.

Building Knowledge To Share Strategies

STRATEGY 8: IMPROVE UNDERSTANDING

This strategy is designed to maximize the likelihood of successful implementation of all restoration strategies by ensuring that critical information gaps are filled, and actions are designed based on the most current understanding. Specific areas of knowledge needed to inform action include:

- Understanding of water supply forecasts, community-based water planning decisions, and changes to water management regulations
- Knowledge of ecosystem dynamics in Malheur Lake and its tributaries
    - Carp dynamics, wind, emergent vegetation loss, nutrient inputs
- Improved understanding of seasonal snowpack and snowmelt relationships
    - Water timing and duration
- Learning appropriate agriculture and ranching practices that reduce water consumption and increase production
- Understanding of how ecological improvements are linked to economic and social outcomes
- Knowledge of climate change impacts and mitigation strategies

Community Engagement Strategies

STRATEGY 9: COMMUNICATIONS AND ENGAGEMENT

High Desert Partnership, Harney Basin Wetlands Collaborative, The Malheur National Wildlife Refuge and The Wetlands Conservancy partnered to serve carp delicacies at the 2019 Wetlands Conservancy Wetlands & Wellies annual fundraising event. Enticing people's palettes proved beneficial toward sharing with Western Oregonians the importance of Malheur Lake and the challenges HBWC is tackling to stage its restoration.

Theory of Change

Community support and engagement is necessary to advance all of these strategies. Community stakeholders will be engaged through a series of ongoing educational and awareness activities, direct communications, landowner outreach, and community events[7-2]. Through this engagement the aim is to broaden public awareness of HBWC's purpose, goals, and activities in order to build greater trust and expand community support for the long-term stewardship of Harney County's ecosystems and local economy. Relationships built through outreach activities[7-1] will help keep people informed, dispel misperceptions, deepen understanding of conservation challenges, and bolster community engagement needed to mitigate the drivers of wet meadow habitat loss on private and Malheur National Wildlife Refuge lands. Examples of a communication effort aimed at building community buy-in can be found in this story about infrastructure improvements at LY Ranch and this story about Sweek and Tyler dam replacements. Published in the local newspaper, shared through social media and HDP's website, these stories showcase the win-win scenarios that infrastructure improvement projects can provide for flood irrigators and wetland conservation.

Greater community awareness, attention, and trust will lead to improved wetland conditions for migratory and resident birds because the buy-in, support, and social license will exist to move forward with the conservation strategies identified in this Theory of Change, as well as bolster Harney County's ranching community directly by maintaining the practice of flood meadow irrigation through investment in flood irrigation infrastructure. Furthermore, participation of private landowners will increase from existing partnerships. The groundswell of public interest and support for reviving Malheur Lake to a healthier state will positively influence management decisions as they are explored, tested, and implemented.

Influencing communications efforts will also be participation with local workgroups, like the Harney County Watershed Council and the Burns Paiute Tribe's Ad Hoc Water Committee. Partnerships with these groups will add to the core knowledge of HBWC and impact communication strategies and tactics. For example the Harney County Watershed Council's community-based water planning collaborative has an ecological working group that is helping bring awareness to groundwater-dependent springs in the basin.

As relationships with key individuals and community constituents are strengthened, increased support from stakeholders, partners, and the general public will increase as more people see themselves playing a role in advancing HBWC, and how this work fits into the larger HDP framework of working together. This result supports successful implementation of all restoration strategies and improves the likelihood of achieving desired long-term and sustainable outcomes.

10. Progress Monitoring Framework

IMPLEMENTATION PROGRESS MONITORING

Table 2. Implementation results objectives and metrics. The result numbers correspond to results shown in the results chain (Figure 24) and theories of change.

Implementation Results (Output)	**Objective**	**Metric**
5-1: Riparian enhancement projects are implemented on tributaries to Malheur Lake Malheur	Nutrient input to Malheur Lake is reduced	Nutrient discharge to Malheur Lake (kg/day)
5-2: Channel elevation projects to raise water table are implemented	Flood irrigated wet meadow habitat is improved or enhanced (i.e. management capabilities and efficiencies, improved seasonal duration, species composition, etc.)	Channel miles restored
1-1: Emergent vegetation planted	Objective I1.1: 3000 hectares of emergent vegetation is planted by 2028	Hectares of emergent vegetation established
I-2: Wind barriers are constructed	Objective I2.1: 10 wind fetch reduction projects are completed by 2026	Projects completed
2-1: Alum addition projects are implemented	Reduce phosphorus levels in Malheur Lake by 25% by 2028	Volume Alum added
3-1: Practices to limit carp reproduction & recruitment are implemented	Practices to limit carp reproduction & recruitment are implemented by 2024*	Practices implemented
3-2: Barriers to restrict carp movement are constructed	Barriers to restrict carp movement are implemented by 2022*	Barriers constructed
3-3: Actions to remove or harvest carp are implemented	Actions to remove or harvest carp are implemented by 2022*	Actions implemented

Implementation Results (Output)	Objective	Metric
5-1: Fish passage improvements are implemented	Objective I6.1: 5 fish passage improvement projects associated with irrigation upgrades are implemented	Passage projects completed
5-2: Upgraded flood irrigation infrastructure is safe and efficient to use and allows for effective water management	Ensure adequate acres of quality habitat for migrating and breeding birds	Infrastructure projects completed
5-3: Topographic features are added to level fields	10 features added by 2025	Projects completed
6-1: Weed treatments are implemented	Management actions to reduce non-native undesirable vegetation are developed, tested, and implemented by 2025	Hectares treated
6-2: Management tool or guide is developed and implemented	State and Transition Model is developed and available for testing by 2021 (implementation will involve workshops with land managers to explain guide)	Number of workshops held
6-3: Actions to address drivers are implemented	Three actions completed by 2024	Number of actions implemented
6-4: Actions to promote desired characteristics are implemented	Water management actions to promote desired vegetation are developed, tested, and implemented by 2026	Hectares of flood irrigated wet meadows enhanced
7-1: Build relationship with key individual and community constituents	Ten new community constituents and individuals are engaged by 2026	Number of new partners
7-2: Disseminate educational information	Educational information regarding the benefits of flood irrigation are developed and disseminated by 2022	Number of educational pieces developed

*The decision to implement strategies to reduce carp biomass in Malheur Lake will be based on current environmental conditions and carp population levels, taking advantage of annual variability in order to maximize effectiveness and efficiency.

Ecological Progress Monitoring

Table 3. Ecological results and metrics for effectiveness monitoring. The result numbers correspond to results shown in the results chain (Figure 24) and theories of change. Given the ecosystem complexity, continued assessment and planning will be required to support development of specific, measurable objectives for the desired ecological outcomes.

Limiting Factor Reduction or Intermediate Ecological Outcome	Working Objective	Potential Metric
E-1: Spatial extent of emergent vegetation increases	Objective E1.1: Spatial extent of emergent vegetation is expanded by 3000 hectares	Area (acres/hectares) of expansion
E-2: Water table is raised	Water table improved by six inches	Depth to water table (m)
E-3: Water clarity increases	Objective E5.1: Turbidity (NFU) of Malheur Lake decreased by 50% by 2028	Continuous monitoring of SSC – mg/L
E-4: Nutrient concentrations in water column are reduced	Objective E8.1: Phosphorus concentrations in Lake Malheur are reduced 25% by 2028 Objective E8.2: Nitrogen concentrations in Lake Malheur are reduced 25% by 2028	µg/L of Phosphorus (Total P)
E-5: Carp biomass is reduced	Objective E12.1: Biomass of carp is reduced to 50kg per hectare by 2030	Density (Kg / Hectare)
E-6: Average area of wet meadows with shallow water in any given year is maintained or increases	Objective E7.1a: Wet meadow habitat attributes on private lands Objective E7.1b: Wet meadow habitat attributes on Malheur National Wildlife Refuge lands	Average acres of wet meadows with shallow water (1-18 inches) in a year Average acres of wet meadows with shallow water (1-18 inches) in February
E-7: Invasive plants are reduced	Objective E6.1: Spatial extent of invasive species is reduced by 20% by 2026	Remote sensing—spatial extent as measured by hectare
E-8: Abundance and diversity of native and desirable non-native plant associations is maintained or increased	Management actions to promote desirable plant associations are implemented.	Number of increased desirable plants

Limiting Factor Reduction or Intermediate Ecological Outcome	Working Objective	Potential Metric
E-9: Acres of wet meadow with short stature vegetation in spring is maintained or increased	Adequate acres of hayed or grazed working wet meadows are maintained in the basin to support migratory water birds	Average hectares of wet meadows with shallow water (1-18 inches) in a year
E-10: Abundance of wet meadow habitats on private and Malheur National Wildlife Refuge lands in the Harney Basin is maintained or increases and target bird populations are monitored.	Objective E4.1: Migratory bird use and abundance in wet meadow habitat is monitored in correlation with habitat characteristics to improve understanding of bird habitat requirements / preference	Bird use by species Bird abundance
E-11: Increase and shift in relative abundance of bird population and use in Malheur Lake	Objective 10.1: Relative abundance of bird populations	Bird use by species
E-12: Emergent and submerged aquatic vegetation abundance and distribution increases in Malheur Lake	Objective 11.1: Spatial distribution of emergent vegetation increases to 3000 hectares by 2028 Objective 11.2: Spatial distribution of submerged aquatic vegetation increases to 500 hectares by 2028	Hectares of emergent vegetation expansion

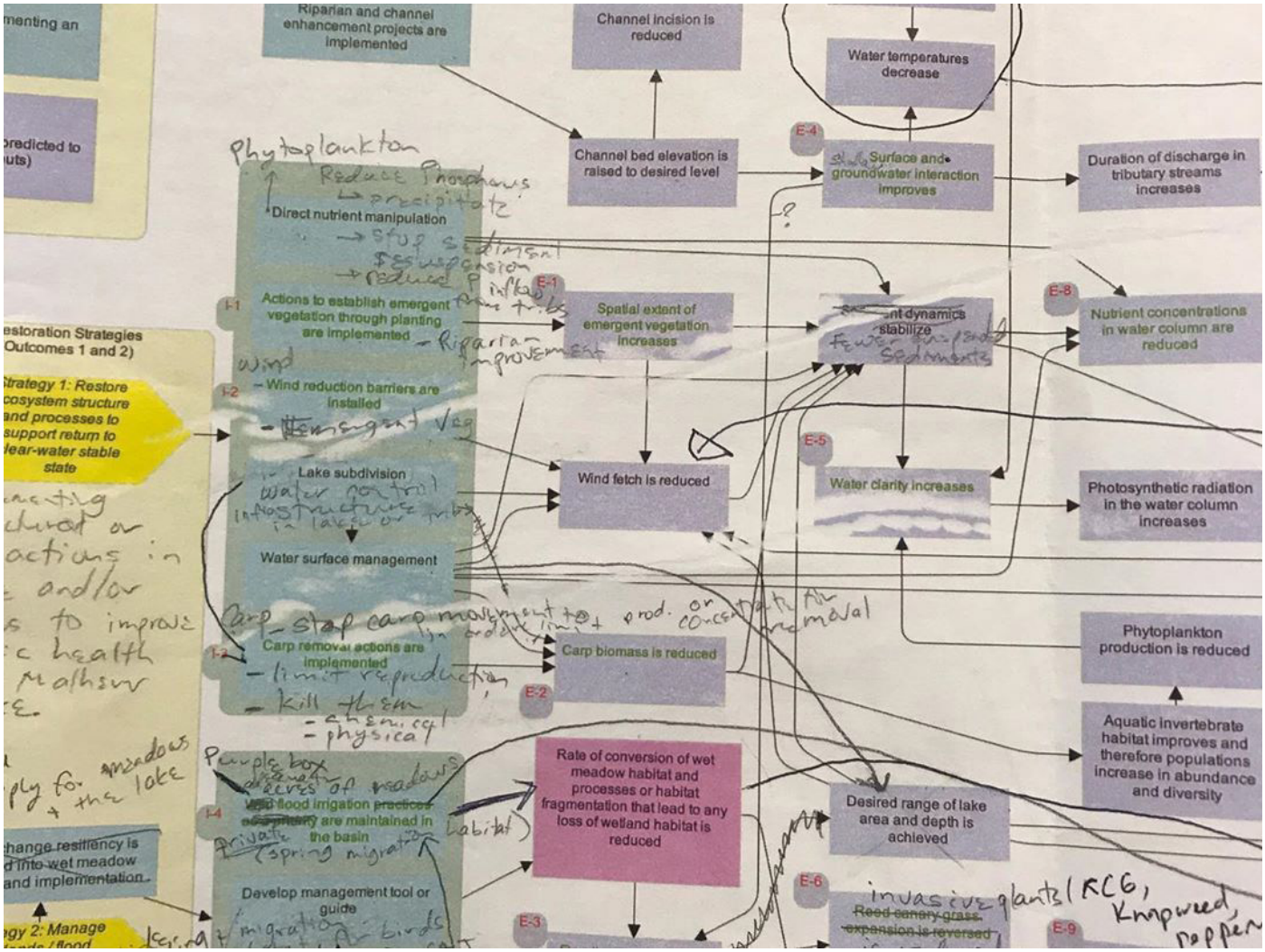
11. Adaptive Management

CLICK TO LEARN MORE

Developing a results chain is difficult, time consuming work that requires many brain trusts working together. Here many pieces of information are being reconciled as strategies and tactics evolve.

Strategies change all the time—that is adaptive management. Practicing adaptive management is the process of using monitoring to improve management decisions over time to examine different management alternatives (Reever-Morghan et al. 2006). The process incorporates management objectives, monitoring, analysis of data, and decision-making to determine the best course of action as management progresses. In the years 2015-2020, HBWC partners have been on the frontline of learning-by-doing to adaptively manage Harney Basin wetlands as a collaborative group. Quarterly meetings are held with data reviews and latest research findings shared. HBWC meeting participation is consistently strong leading to valuable discussions that guide the adaptive management process with shared science.

Adaptive management promotes flexible, informed decision-making, allowing for necessary adjustments to be made as outcomes from management actions and other events are better understood. In addition, adaptively managing across ecological, economic, and social factors has added a layer of complexity for how decisions are ultimately made and adjusted as new information comes to the collaborative.



Adaptive management is about the willingness to adapt, respond and be flexible as approaches evolve.

In HBWC's original strategic action plan, carp control was the primary strategy to improve water quality and aquatic health in Malheur Lake. With new information, partners now realize that additional factors (e.g., wind stress, turbidity, phytoplankton) contribute to Malheur Lake's highly turbid and degraded conditions. Partners have since proposed, come to consensus on, and implemented projects that will help inform a more comprehensive systems model, enabling partners to test alternative restoration strategies for Malheur Lake (e.g., wind breaks, lake subdivision, water management) with the OWEB's FIP 1 investment. HBWC partners have also modified some of its original timelines due to project implementation issues or new scientific findings.

ECOLOGICAL LESSONS LEARNED

In OWEB's FIP 1, HBWC used a mechanistic system modeling approach to provide a greater understanding of the drivers of turbidity in Malheur Lake and demonstrated the efficacy of multiple restoration alternatives targeted at shifting the aquatic ecosystem from a turbid to a clear state. The initial focus was on controlling the harmful effects of carp via removal efforts aimed at suppressing the carp biomass below the 50 kg/ha threshold. Simulations demonstrated that the carp population in Malheur Lake is more affected by the interactions within the population brought on by environmental fluctuations than imposed mortality rates via removal efforts. Ultimately these results demonstrated that focusing all resources on carp control as a sole mechanism for lake restoration is likely to be ineffective, and investigations of other mechanisms adding to the turbid state were necessary. The second focus was on sediment resuspension via wind. We determined that there is a strong relationship between the wind speed and the amount of re-suspended sediment, and it may be possible to manage the resuspension of sediment effects of the wind energy via wind reduction barriers targeted at decreasing the wind's energy and ultimately increasing the water clarity.

HBWC currently has three lake projects proposed that focus on changing Malheur Lake to a clear state. These projects are carp tracking via radio telemetry, mesocosm pilot restoration project, and a small pilot project focused on the efficacy of transplanting emergent vegetation throughout Malheur Lake.

CARP TRACKING VIA RADIO TELEMETRY

In order to increase efficiency of removing carp on Malheur Lake HBWC has proposed a study in which Malheur National Wildlife Refuge staff will surgically implant carp with radio tags and track the tagged fish via an unmanned aircraft. The carp location data will be analyzed to identify aggregation behaviors, habitat preferences, and differences in these behaviors that can be explained by life stage (sub-adult, young adult, and adult). Upon completion of the project, HBWC will better understand the temporal and spatial movements, habitat usage, and aggregating behaviors of carp, enabling HBWC to increase removal efficiencies and prolonged suppression of the carp population in the future.

MESOCOSM PILOT RESTORATION PROJECT

The pilot mesocosms restoration project will determine which factor, or combination of factors, can be manipulated or controlled to substantially reduce the turbidity in the water column, and determine how far the suspended sediment concentration has to be reduced to allow emergent and/or submergent vegetation to survive.

EMERGENT VEGETATION REESTABLISHMENT

The absence of submergent vegetation and minimal emergent vegetation in Malheur Lake is partially a result of the lack of available light to support development of aquatic vegetation in the system. The turbidity that limits light transmission through the water column is a result of wind fetch/wave action, phytoplankton abundance, and carp activity, among other factors.

Together the completed and ongoing projects funded by OWEB in FIP 1 have led us to determine that the path forward to restoring Malheur Lake will be achieved by managing the system as a whole and considering the reinforcing feedback cycles that are continuously working towards one of the two states: clear or turbid. Based on these results, HBWC has demonstrated that restoration efforts in Malheur Lake should no longer take a singular approach focused only on removing carp and instead take a broader view of restoration, focusing on the multiple drivers of the turbid state, using a combination of actions targeted

at carp suppression, emergent vegetation reestablishment, and improving water clarity via decreased wind resuspension of lake sediments. The goal is to shift the aquatic ecosystem of Malheur Lake from the currently turbid state to a clear state, which will support an abundance of birds and wildlife.

Today, understanding of aquatic resources in the Harney Basin has continued to evolve and expand. Additional work on water availability, ranging from groundwater and spring systems to evaluation of streamflow regimes and habitat availability in the basin's terminal lakes (Harney, Mud, and Malheur Lakes), has placed a central focus on water. Ongoing work in the headwaters of the Blitzen River is seeking to better understand sources of water during increasingly frequent drought conditions (J. Dunham, U.S. Geological Survey, unpublished data). New work downstream in both the Silvies and Blitzen Rivers, as well as the lakes themselves seeks to understand multiple components of water quality, including temperature, turbidity, and nutrient dynamics (C. Smith, U.S. Geological Survey, unpublished data). Collectively these data provide a foundation for understanding a much broader range of ecosystem processes and system dynamics for addressing not only the lake, but the streams, groundwater, and wetland ecosystems that collectively comprise the diverse hydro system that sustains agriculture and ecosystem services in the Harney Basin.

ECONOMIC LESSONS LEARNED

Through both experience with commercial fishing and modeling of the carp population it has become clear that commercial fishing is insufficient to affect the carp population. Alternative strategies built around lake levels (area) to harvest carp have been identified. David Kling, an Applied Economics Assistant Professor at Oregon State University has developed a report about the bioeconomics of Malheur Lake and harvesting carp. The insights provided within this report are anticipated to provide some valuable information to help determine strategies for harvesting carp.

The management of wet meadow systems is crucial for ranchers in the basin. Developing tools for effective water management that results in improved vegetation patterns for both cattle and birds is an opportunity to both conserve water and optimize habitat benefits. The control of reed canarygrass in wet meadow systems and management of water to reduce the spread is an important outcome from the wet meadow work. Reed canary grass is a non-native species that can be very aggressive at creating a monotypic stand that is not very valuable as forage for livestock. Ongoing studies are being conducted to determine the use of these communities by birds.

SOCIAL LESSONS LEARNED

One of the early assumptions was that conservation easements would be an effective tool for wet meadow conservation. Work with ranch owners and managers has shown that the importance of using their experience in managing water and applying information on the effects of water management may have a greater conservation benefit. The experience has also shown limitations to easement use with the lack of a locally trusted easement holder. The primary lesson learned is that there is significant interest in improving the understanding of the effects of flood irrigation water timing and duration on pasture quality. Working with the landowner's interests can advance conservation outcomes as better information on the ecological and forage consequences of different water management approaches are demonstrated.

MILITIA OCCUPATION OF MALHEUR NATIONAL WILDLIFE REFUGE

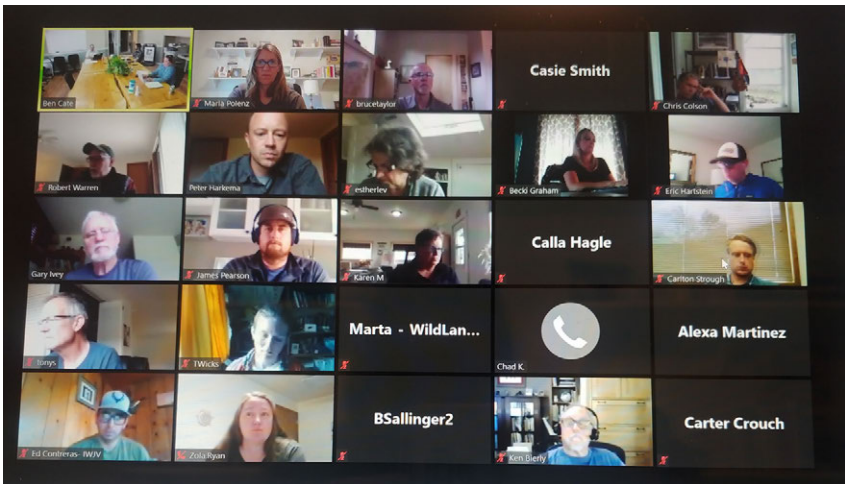
One of the difficult situations that influenced OWEB FIP 1 progress was access to the Malheur National Wildlife Refuge was impossible during the occupation January-February 2016 and has changed how partners access the Malheur National Wildlife Refuge post-occupation. This situation slowed some of the initial monitoring and research and put work behind schedule for future restoration planning. But, HDP kept meetings and planning moving forward despite what was happening at Malheur National Wildlife Refuge headquarters.

COVID 19 IMPACTS

COVID-19 tentacles reach far and wide. Social distancing restrictions have affected access to private lands and the Malheur National Wildlife Refuge and like everywhere, has canceled events in Harney County. One such event is the premier Harney County Migratory Bird Festival. An important event for the community and HBWC that typically benefits the economy and aids with HBWC engagement and communication efforts. With this event not happening HBWC and partners put in place a social media campaign, Harney@Home, to keep people connected to the Harney Basin during this challenging time.

But, in uncertain times like these there is certainty in collaboration. Due to social distancing restrictions in-person meetings were put on pause and HBWC partners took to Zoom. Discussions continued and progress was made that enabled this strategic action plan to be created using a collaborative effort. Numerous HBWC partners contributed to this document and it was finalized through consensus by partners.

As to research and restoration projects several wet meadow irrigation diversion projects were put on hold while projects at Malheur Lake were able to move forward. Additionally, material costs have increased as much as 50% and contractor availability has become very limited. Both resulted in both schedule and budget creep of planned projects. This includes a summer 2020 nutrient project; pilot projects for the future mesocosm project; and an emergent vegetation restoration project. HBWC partners and HDP staff have been an important asset stepping in to help with projects as U.S. Fish and Wildlife and U.S. Geological Survey staff were unable to work or travel during some of this time.



25+ individuals participating in a HBWC collaborative VIRTUAL meeting held Wednesday, April 29, 2020.

12. Sustainability

Management of Malheur Lake is a primary responsibility of the Malheur National Wildlife Refuge; however, the Malheur National Wildlife Refuge is affected by upstream uses of water that eventually enter the lake. Historic changes to Malheur Lake's ecosystem and the consequences of those changes are a significant challenge. By building a stronger shared science understanding of lake ecosystem dynamics in FIP 1, management options are being both reduced (e.g. carp cannot be controlled by harvest alone) and expanded (e.g. better understanding of the role of wind/wave effects and nutrient/phytoplankton dynamics). The long-term management of the Malheur Lake system will continue to be implemented by Malheur National Wildlife Refuge but will need to be done in close cooperation with the local community, so management activities are communicated, understood, and supported.

From the beginning of HBWC, partners agreed that the conservation of flood irrigated wet meadow systems had to be based on the joint ability to sustain viable ranching operations and provide flooded fields for migratory and resident birds. Building greater understanding of the interconnection between water management and its impact on bird use and wet meadow plant ecology in a relatable and usable manner by private landowners has been essential for long-term sustainability of the flood irrigated wet meadow systems. If ranchers better understand the relationships between water management, bird use, and hay production they can manage to optimize opportunities into the future.

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