Partnering on multispecies aquatic assessments to inform efficient conservation delivery

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Partnering on Multispecies Aquatic Assessments to Inform Efficient Conservation Delivery

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Abstract.—Efficient conservation can require making strategic decisions across large landscapes. For example, two fish habitat partnerships—the Desert Fish Habitat Partnership and the Western Native Trout Initiative (WNTI)—fund conservation and restoration projects across the western United States. The Desert Fish Habitat Partnership alone serves 11 states and nearly 180 native fish species, and the Western Native Trout Initiative covers 21 salmonid species across 12 western states. Because of the large landscapes they represent, the partnerships are using multispecies aquatic assessments developed for specific river basins to aid in conservation delivery. These assessments yield a conservation value for every catchment in a basin based on known and modeled native fish distributions (including salmonids), riverine connectivity, and threats to aquatic habitats. The conservation values are scaled between 0 (low) and 1 (high) and have been used to evaluate the landscape context of conservation projects submitted for funding through the National Fish Habitat Partnership. While assessments are complete for some basins (e.g., upper and lower Colorado basins, upper Rio Grande basin),

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the partnerships are currently working with additional partners to fund aquatic assessments in new geographies (e.g., Bonneville and Lahontan basins). Multispecies assessments are used in conjunction with the knowledge of field biologists to inform on-the-ground conservation across large landscapes and make conservation delivery more efficient for the many imperiled native fishes in the western United States.

The Conservation Need

Freshwater fishes are threatened globally. Only 46% of 7,301 freshwater fish species have had their distribution mapped and threats identified, and 31% of those are threatened with extinction (Darwall and Freyhof 2016). North America alone has more than 700 species of freshwater fish (Page and Burr 1991), which, along with mollusks, snails, and crayfishes, are highly imperiled, and many species are listed as endangered or are known to have gone extinct (Taylor et al. 2007; Jelks et al. 2008; Haag and Williams 2014). The imperilment status of freshwater organisms exceeds that of their terrestrial counterparts (Master et al. 2000). The rich aquatic biodiversity in North America is threatened by, and imperiled due to, habitat degradation and loss, invasive species, overharvest, chemical and organic pollution, and global climate change, which are a result of myriad human activities (Allan and Flecker 1993; Closs et al. 2016; Darwall and Freyhof 2016).

Restoration of aquatic resources is now a multibillion dollar per year enterprise (Bernhardt et al. 2005). Restoration programs exist in every corner of North America, as well as in many parts of the world (Cowx and Welcomme 1998; Palmer et al. 2007). Much early restoration was focused on restoring water quality degraded from point source pollutants, but efforts today are more often focused on integrated restoration of ecosystem processes and ecological integrity (Karr and Dudley 1981; Beechie et al. 2013; Jones et al. 2018). Restoration can vary in scope from singular projects implemented at one location during one year to watershed- or landscape-scale programs that implement hundreds of projects over decades (Bernhardt et al. 2007; Pierce et al. 2019, this volume).

Implementation of a landscape-scale program requires efficient allocation of scarce resources to maximize conservation benefits, as there are many different sites or watersheds in which to potentially implement conservation actions (Williams et al. 2007; Roni et al. 2013). Maximizing conservation benefit can be guided by effective goal development, resource assessment, planning, and prioritization (Knight et al. 2006; Ferrier and Wintle 2009). Advances in spatial data and assessment methods over the past 40 years have helped to facilitate a better understanding of resources across broad landscapes (Ferrier and Wintle 2009), and this understanding has allowed spatial conservation assessment and prioritization to become more available as a formal part of conservation planning and decision making (Knight et al. 2006).

In this chapter, we (1) introduce the Desert Fish Habitat Partnership (DFHP) and the Western Native Trout Initiative (WNTI)—two regional partnerships in the western United States under the National Fish Habitat Partnership (NFHP), (2) present an overview of multispecies assessment and prioritization and its recent convergence on a common analytical framework developed for aquatic systems, (3) demonstrate how the DFHP and WNTI have partnered to acquire funding to develop multispecies aquatic assessments specific to large river basins, and (4) give examples of how these assessments are currently used to inform efficient conservation decision making and partnership collaboration.

Fish Habitat Partnerships

The National Fish Habitat Action Plan was developed in 2006 to address degradation and loss of fish habitat across the United States (www.fishhabitat.org). The plan brought together anglers; conservation groups; scientists; tribal governments; state, territorial, and federal agencies; and industry leaders that saw the need to foster voluntary, nonregulatory, science-based action to protect, restore, and enhance aquatic systems across the United States. This group is now recognized as the NFHP. Since 2006, the NFHP Board has approved 20 self-organized regional and resource-based fish habitat partnerships (FHPs) covering a multitude of aquatic habitat types across all 50 states and the District of Columbia (Figure 1). The partnerships share a responsibility to pass along healthy fish habitats and intact aquatic systems to future generations. Federal, state, tribal, and privately raised funds are leveraged under the NFHP through regional FHPs to address the nation's biggest fish habitat challenges.

The DFHP was formed in 2005 to conserve native desert fishes by protecting, restoring, and enhancing their habitats in cooperation with state and tribal fish and wildlife agencies, federal resource agencies, research and private organizations, and engaged individuals (www.desertfhp.org; DFHP 2015). The DFHP supports on-the-ground projects that protect the most underserved, imperiled desert fish species by addressing critical fish and aquatic habitat conservation needs in the Great Basin and Mohave, Sonoran, and

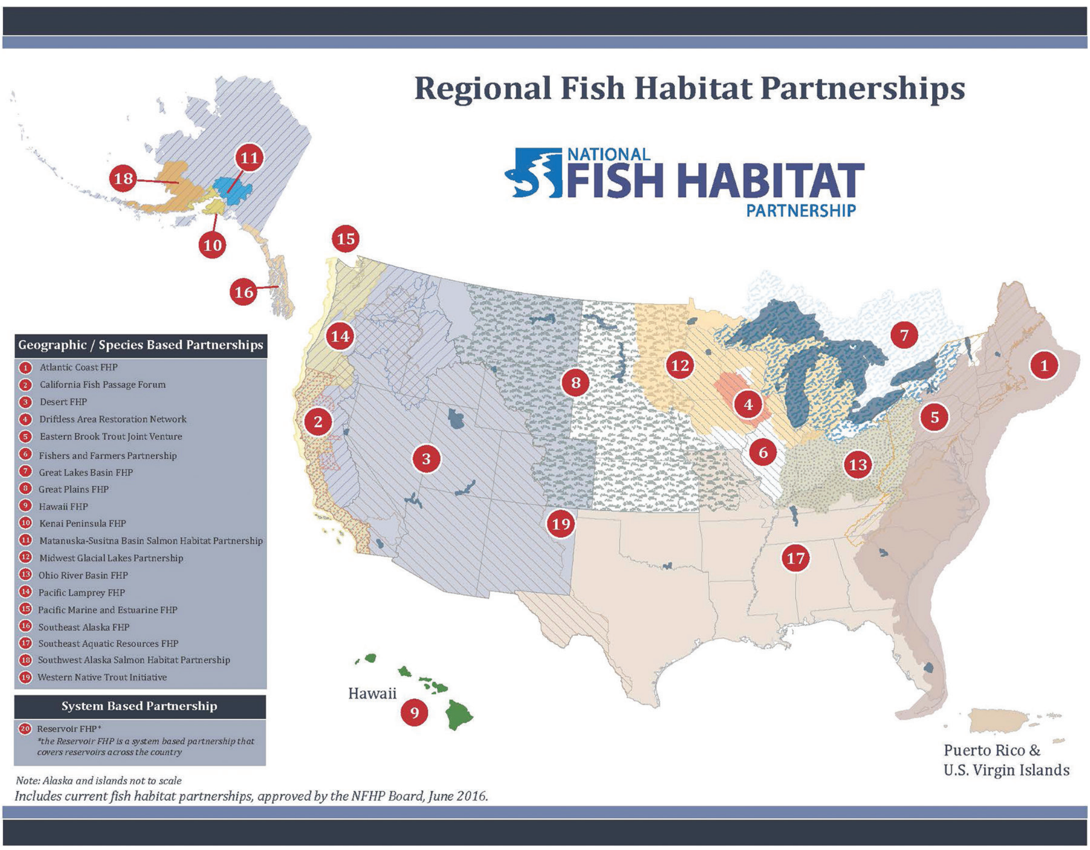

Figure 1. Individual fish habitat partnerships recognized by the National Fish Habitat Partnership Board.

Chihuahuan deserts in the western United States. These lands support 179 nonsalmonid native fish taxa prioritized for conservation by the DFHP under the guidance of state wildlife action plans and the NFHP (DFHP 2015). By identifying priority species and habitats, working across geopolitical boundaries, integrating and applying the best available science, and promoting community involvement, the DFHP identifies and prioritizes necessary conservation actions to protect and restore desert fish habitats. Through 2018, the DFHP has directed more than US$2.6 million in federal NFHP funds, leveraged with matching contributions, towards 28 habitat protection and restoration projects to benefit desert fishes.

The WNTI works collaboratively across 12 western U.S. states to conserve, protect, restore, and recover 21 native trout and char species across their historical ranges. Operating under the guidance of the Western Association of Fish and Wildlife Agencies since 2006, and a recognized FHP since 2007, the WNTI is governed by a steering committee that represents 12 western state fish and wildlife agencies, five federal natural resource management agencies, tribes, and nonprofit conservation organizations. The WNTI and its partners invest private and public resources toward completing the highest-impact on-the-ground projects led by local communities and resource agencies across the western United States. To achieve its mission, the WNTI works together with its partners to establish joint priorities for conservation by combining science-based assessments with expert and local knowledge to establish joint priorities for native trout conservation at a landscape scale. Through its Campaign for Western Native Trout, the WNTI catalyzes education, outreach, and stewardship by raising awareness for the importance of healthy watersheds and facilitating greater public support for native trout conservation within local communities. Between 2006 and 2017, the WNTI directed almost $5.5 million in federal NFHP funds leveraged with just over $25 million public and private matching dollars for 141 priority conservation projects. The WNTI and its partners have removed 87 barriers to fish passage, reconnected or improved 1,817 km (1,129 mi) of native trout habitat, assessed 671 watersheds or populations, and placed 30 protective fish barriers to conserve important native trout conservation populations (WNTI 2008, 2016). Details for these projects can be found at www.westernnativetrout.org.

Multispecies Aquatic Conservation Assessments

Assessment of aquatic systems and species can take many forms. It can range from assessment of water quality or single species in individual water bodies (Zale et al. 2012) to broadscale surveys designed to draw regional inferences on the status and trend of ecological integrity (Karr 1993). More recently, assessment of aquatic systems has included spatially explicit assessments of habitat condition, ecological threats, and species diversity using existing data sets (Kuehne et al. 2017). This trend has been facilitated by recognition of the need to go beyond single-species approaches to focus on ecosystems and entire communities for many applications (Franklin 1993), as well as continued advancement of spatially explicit data sets representing various aquatic ecosystem components and improved approaches to predict species distributions (Olden 2003; Leathwick et al. 2010; Mainali et al. 2015; Dauwalter et al. 2017). Single-species assessment approaches are sometimes necessary, especially for species listed under the Endangered Species Act. However, biodiversity applications necessarily focus on multiple (sometimes hundreds) species, and some conservation planning decisions are most efficient if based on multispecies assessment information (Kuehne et al. 2017). Some contemporary multispecies aquatic conservation assessment frameworks now integrate conservation biology principles underpinning protected area or reserve selection (representation, complementarity, etc.; Table 1) with ecological integrity and threat assessment information in a spatially explicit framework. The assessment output is a conservation rank or value for each spatial planning unit (catchment, watershed, hydrologic unit) across entire river basins that are used to guide conservation planning (Moilanen et al. 2008; Hermoso et al. 2012).

Methods for assigning conservation value to spatial planning units can generally be categorized as scoring-based or complementarity-based approaches (Ferrier and Wintle 2009). Scoring-based approaches are relatively straightforward as they assign an independent score for each planning unit based on specified factors of interest (e.g., habitat quality, presence–absence of focal species, species richness, and threats). Multiple factors are often scored and summed (or multiplied) into a final composite score intended to reflect conservation value. For example, if each planning unit in Figure 2A receives one point for each species present, planning unit 1 would have the highest score (and thus highest conservation value). Planning units 2 and 3 would have the same score (tied conservation value) despite different species composition and not accounting for a species not yet represented in planning unit 5. While scoring approaches have utility for some applications, they fail to account for which species are present (community composition) and complementarity, that is, how different planning units complement each other when considered as a set (McKinney 1997), which is one of the conceptual underpinnings of contemporary systematic conservation planning (Margules and Pressey 2000; Sarkar and Illoldi-Rangel 2010; Linke et al. 2011).

Complementarity-based approaches provide an efficient pathway to maximize the number of species represented in a minimum number (or a set number) of planning units. For example, in Figure 2A, planning unit 1 has the highest conservation value because it represents five species. The next highest conservation value would be assigned to planning unit 5 because it is the only planning unit that contains two new species not represented in planning unit 1; that is, planning unit 5 complements planning unit 1, and together, they represent the greatest number of species across a set of two planning units. Thus, the value of an individual planning unit depends

Table 1. Definitions of terms and concepts used in spatial conservation planning and prioritization (Kukkala and Moilanen 2013).

Definitions
Systematic conservation planning: a structured approach to identify priority areas based on their complementarity
Complementarity: the contribution of a spatial planning unit toward a measure of biodiversity (i.e., functional, community, species) that complements other units
Comprehensiveness: the representation of many biodiversity features across all planning units in a set
Efficiency: representation of the highest amount of biodiversity features in the fewest number of planning units
Irreplaceability: a measure of uniqueness associated with a spatial planning unit based on the biodiversity features represented
Representation: the occurrence of a biodiversity feature in a selected set of spatial planning units
Representativeness: the total number biodiversity features represented in a selected set of spatial planning units
Redundancy: the replication of the measure of biodiversity across spatial planning units

A)

Species	Planning Unit 1	2	3	4	5	Range
A	1	1	1	1	0	**4**
B	1	0	1	1	0	**3**
C	1	1	0	0	1	**3**
D	1	0	1	1	0	**3**
E	1	1	1	0	0	**3**
F	0	1	0	0	1	**2**
G	0	0	0	0	1	**1**
Richness	**5**	**4**	**4**	**3**	**3**	

B)

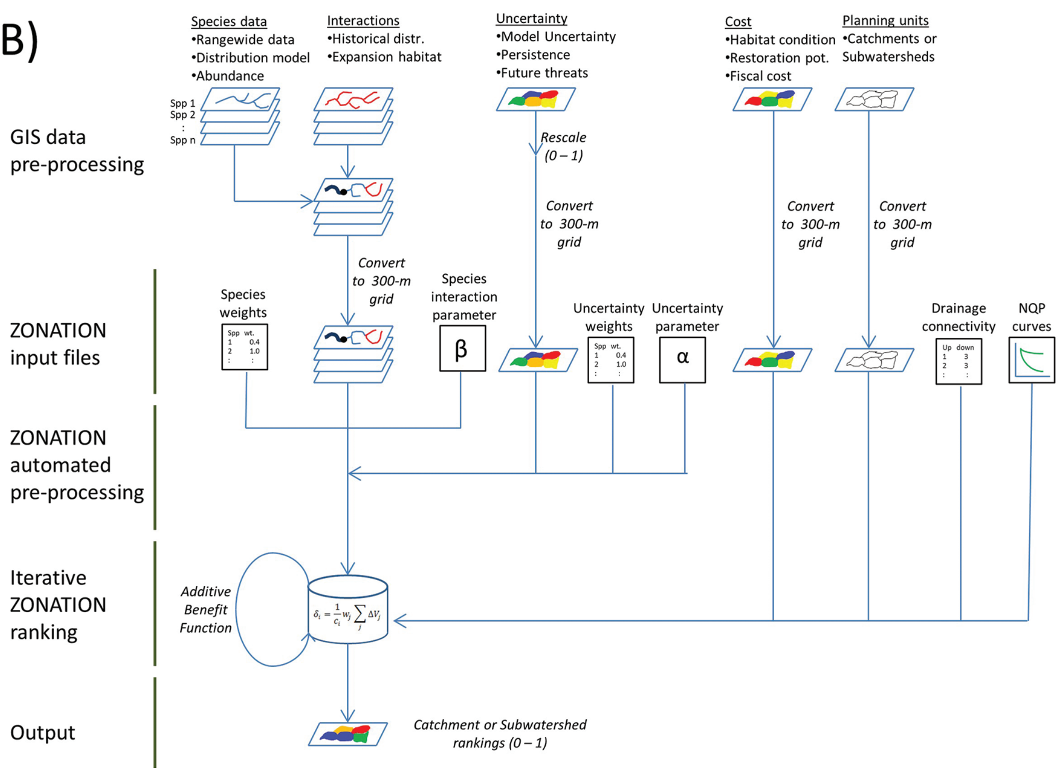

Figure 2. Simple set of planning units and species presence data showing **(A)** complementarity and species representation versus **(B)** one example of a more complex analysis workflow that incorporates different types of species data, connectivity among planning units, habitat condition, species interactions, and other ecological factors in a complementary-based algorithm.

on what is represented in the other planning units and whether they complement one another. A set of planning units with high complementarity will have the highest benefit : cost (number of species : number of units) ratio for conservation purposes (Nel et al. 2009). Complementarity is often the fundamental basis for the complex algorithms implemented in popular spatial conservation prioritization software (e.g., Marxan, Zonation, ConsNet, and C-Plan; Moilanen et al. 2009).

Quantitative approaches to conservation assessment can also incorporate more than just species representation by including factors that contribute to species persistence, such as habitat types and condition, human threats, stream connectivity, dispersal capabilities, or minimum home range size (Margules and Pressey 2000; Nel et al. 2011). Figure 2B depicts one example of the complexity and ecological reality that can now be incorporated into aquatic conservation assessments, which includes species representation, abundance, and persistence; historical distributions; interactions between species; minimum habitat requirements based on home range size; and the effect of current habitat conditions or future threats on the landscape. Each of these factors can be integrated into a comprehensive and quantitative assessment of entire river basins where each planning unit can be assigned a conservation value between 0 (low value) to 1 (high value). The exact nature of their integration depends on how the analysis is constructed, which can vary considerably. High conservation values reflect important planning units for the representation of native fish species balanced by the habitat condition or threat level, watershed connectivity, and, in some cases, proximity to protected areas (e.g., national parks). For example, two watersheds with different threat levels can be valued differently despite equal species representation (composition) because watersheds with high threat value (e.g., urbanization) are risky places to invest in conservation and therefore should be down weighted in their value. The availability of these approaches has led to their increased use in freshwater conservation planning applications (Wenger et al. 2009; Dauwalter et al. 2011; Howard et al. 2018; Birdsong et al. 2019, this volume).

Partnering on multispecies aquatic conservation assessments

Because of the large landscapes they cover, the DFHP and WNTI have together pursued development and use of multispecies aquatic assessments that identify hydrologic units important for native fish diversity to inform partnership decision making within river basins (the WNTI has also supported development of species-specific rangewide status assessments; e.g., Gresswell 2011; Muhlfeld et al. 2015). As described above, these assessments produce a rank for all catchments (land area draining a ~1-km National Hydrography Dataset stream segment; USEPA and USGS 2005) or subwatersheds (Hydrologic Unit Code 12, ~30,000 ha; NRCS et al. 2008) that effectively represents the conservation value of that unit based on fish species richness and representation of rare species (representation, complementarity, and comprehensiveness), aquatic connectivity relative to species biology, and threats to aquatic systems. Each assessment was also developed individually using data sets and analysis decisions unique to the focal basin based on input from stakeholder workgroups (details can be found in respective assessment reports or publications). Despite some differences, each assessment produced a conservation value for each spatial planning unit that was scaled to range from 0 (low conservation value) to 1 (high conservation value). The initial assessment effort focused on the lower Colorado River basin, whereby the U.S. Geological Survey initiated an aquatic gap analysis to identify riverine fishes that were inadequately represented (gaps) within the existing network of protected lands (e.g., national parks; Whittier et al. 2006, 2011). The analytical framework used known and modeled species distributions, riverine connectivity, species-specific home range sizes, and an ecological threat index (Paukert et al. 2011). The utility of the lower Colorado River assessment resulted in interest in an equivalent assessment in the upper Colorado River basin, which was funded through the U.S. Fish and Wildlife Service Multistate Conservation Grant program to the National Fish Habitat Partnership Board, administered by the Western Association of Fish and Wildlife Agencies and WNTI and completed by the University of Missouri (Whittier and Sievert 2014). This led the partnerships to pursue development of additional basin-specific assessments. The upper Rio Grande assessment was funded by the Southern Rockies Landscape Conservation Cooperative, administered by the Western Association of Fish and Wildlife Agencies and WNTI and completed by Siglo Group (Labay et al. 2018). The Bonneville, and Lahontan and Central Nevada basin assessments have been pursued but not initiated due to lack of funding (Table 2; Figure 3). The diverse partners represented in each assessment effort represents a synergy towards combining resources to accomplish a common goal, that is, developing the assessment and shepherding it towards meaningful and targeted delivery of aquatic conservation on the landscape.

The convergence of multispecies aquatic assessments around a general analytical framework resulted in additional assessments being developed within DFHP and WNTI geographies using methods similar to those used for the lower and upper Colorado River basins. Williams et al. (2019, this volume) explored the utility of the native fish conservation area concept in the upper Snake River basin with an analytical framework that incorporated known and modeled species distributions, aquatic connectivity interrupted by large dams, land protection status, and information on integrity and future security of habitats at the scale of subwatersheds (Hydrologic Unit Code 12). Likewise, similar analysis methods were used to develop a similar aquatic assessment (fish and other aquatic organisms) for the state of California (Howard et al. 2018). The California analysis was also at the subwatershed scale and used species distribution data, aquatic connectivity, and proximity to protected areas as used

Table 2. Funding sources and lead entities in developing the multispecies aquatic assessment for use in fish habitat partnership decision making.

Region/basin	Funding	Assessment lead
Upper Colorado River	U.S. Fish and Wildlife Service Multistate Conservation Grant/ Western Native Trout Initiative	University of Missouri
Lower Colorado River	U.S. Geological Survey (USGS) National Gap Program	USGS/Kansas State University
Upper Snake River	National Fish and Wildlife Foundation	Federation of Fly Fishers/ Trout Unlimited
Rio Grande	Southern Rockies Landscape Conservation Cooperative	Siglo Group
California	The Nature Conservancy	The Nature Conservancy/ Trout Unlimited
Bonneville basin	Not completed	
Lahontan and central Nevada basin	Not completed	
Mid-Columbia	Not completed	

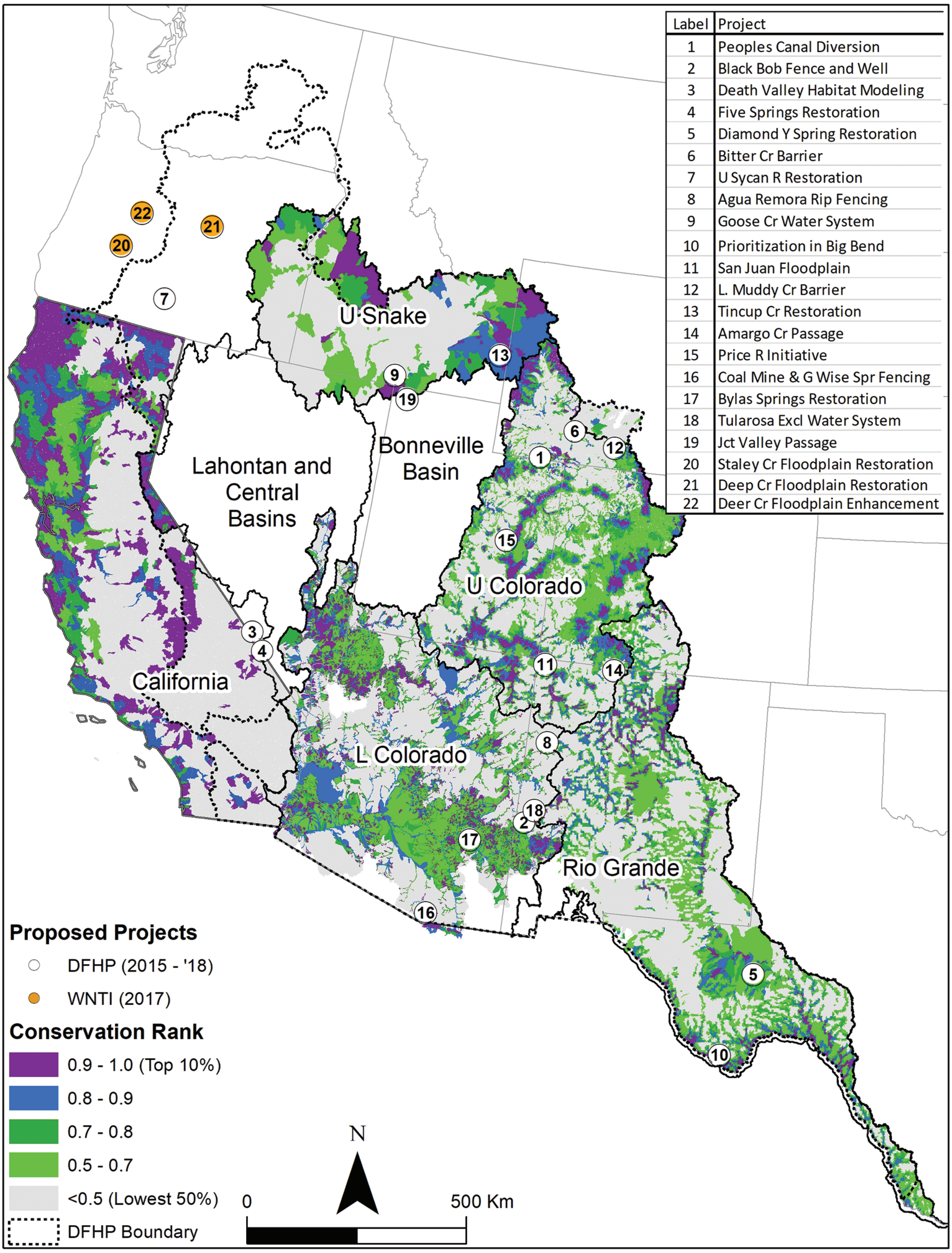

Figure 3. Multispecies aquatic assessments completed within the Desert Fish Habitat Partnership domain and projects submitted to the Desert Fish Habitat Partnership for funding from 2015 to 2018. Projects submitted to the Western Native Trout Initiative in 2017 with a strong nontrout element that were evaluated for cosponsorship are also shown.

previously in other basins. While these two assessments used the common analytical framework as previous assessments, the analyses were also slightly tailored to their goals, focal species, and focal landscapes.

Assessment use in decision making

The primary objective of the DFHP is to focus funding on imperiled habitats and fishes unique to the deserts of North America that are underrepresented by current conservation efforts. By prioritizing funding for these nearly 180 species, the DFHP provides immediate benefits to these species and their habitats, and the partnership directly assists in achieving priority conservation needs that have been established by state, federal, private, and tribal partners. Scientific assessments as described above are used by the DFHP to help inform decisions on funding habitat conservation, restoration, and enhancement projects.

From 2015 to 2018, the DFHP received 22 project proposals for funding (Figure 3). The project funding process begins with development of a request for proposals that is distributed to partners. Proposals are then submitted to the DFHP, usually through coordination with one of the four basin coordinators. These coordinators then review and rank the basin-specific proposals. Upon completion of the reviews and initial project ranking, the proposals are then reviewed, ranked, and voted on by the DFHP Steering Committee. The DFHP coordinator then submits the ranked projects for funding to the U.S. Fish and Wildlife Service. As part of the project review process, the DFHP Science and Data Committee overlays project locations on the basin-specific aquatic assessments and extracts the catchment or subwatershed rank (0 = low value, 1 = high value) to provide an important landscape context on which to evaluate each proposal (i.e., to help answer the question "how important is the watershed to native fish conservation relative to the others in the basin given ecological threats and connectivity?") (Figure 3; Table 3). Because the assessments are focused on rivers and streams and only partially incorporate data on spring and ciénega habitats, and some assessments have not yet been completed (Bonneville, Lahontan and central Nevada, and interior Columbia basins), the conservation values from the assessments are not yet formally integrated into the DFHP project ranking criteria on which proposals are evaluated (but see Appendix IV in DFHP 2015). Projects are submitted to the WNTI through a similar and parallel annual request-for-proposals process. Those that have a strong nonsalmonid component have been simultaneously submitted to the DFHP for potential DFHP–WNTI co-sponsorship (Figure 3).

Three examples of projects shown in Figure 3 illustrate use of assessment information to contextualize the importance of projects proposed for funding to the FHPs. The Tincup Creek Stream Restoration Project near the Idaho–Wyoming border represents one such cosponsored project. The Tincup Creek project was submitted to both the WNTI and DFHP for funding in 2016 (for 2017 funding allocation) by Trout Unlimited and the Caribou-Targhee National Forest. The proposed project aimed to arrest streambank erosion and reconstruct the stream channel (Box 1). Tincup Creek supports a diverse fish assemblage that includes both native Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* and a rich assemblage of nongame species, including the imperiled Northern Leatherside Chub *Lepidomeda copei*. Thus, the project benefited a native trout that is the focus of the WNTI and native nongame species ranked highly by the DFHP. The diverse Tincup Creek fish assemblage is reflected in the upper Snake River basin assessment, where the subwatershed in which the project was located was highly ranked (Table 3; Figure 4; Williams et al. 2019).

The Black Bob Allotment project was proposed in 2015 (for 2016 funding) by the U.S. Forest Service to help protect the ripar-

Table 3. The conservation value of a catchment/subwatershed in which a proposed project is located as determined from the regional multispecies aquatic assessments for streams and rivers. Conservation values range from 1 (high value) to 0 (low value).

Year	Proposed project	Assessment region	Conservation value
2015	Peoples Canal Diversion	Upper Colorado	0.77
	Black Bob Fence and Well	Lower Colorado	0.77
	Death Valley Habitat Modeling	–	[ab]
	Five Springs Restoration	Lower Colorado	[ab]
	Diamond Y Spring Restoration	Rio Grande	0.71[b]
2016	Bitter Creek Drop Structure	Upper Colorado	0.51
	Upper Sycan River Restoration	Interior Columbia	[a]
	Agua Remora Riparian Fencing	Lower Colorado	0.15
	Goose Creek Group Allotment Pipeline Project	Upper Snake	0.98
	Big Bend Restoration Prioritization	Rio Grande	[a]
	San Juan River Floodplain Wetland Restoration	Upper Colorado	0.91
2017	Lower Muddy Creek Barrier	Upper Colorado	0.85
	Tincup Creek Restoration	Upper Snake	0.90
	Amargo Creek Connectivity and Habitat Enhancement	Upper Colorado	0.77
2018	Price River Restoration Initiative	Upper Colorado	0.63
	Coal Mine & George Wise Spring Fencing	Lower Colorado	0.26[b]
	Bylas Springs Restoration	Lower Colorado	0.75[b]
	Tularosa Exclosure and Water System	Lower Colorado	0.79
	Junction Valley Fish Passage	Upper Snake	0.93

[a] Scientific assessment not available or was not available the year project was proposed.
[b] Spring system. Stream and river assessment may be irrelevant.

ian vegetation and streambanks of the San Francisco River in New Mexico. The proposed project was to restrict livestock from the river channel by constructing 5.5 km of fence along the river channel to complement 5.5 km of natural features restricting livestock access to the river. The project also installed a well to supply an off-stream water source. The San Francisco River is inhabited by the Loach Minnow *Rhinichthys cobitis*, an endangered nongame species, and other species of greatest conservation need such as Sonora Sucker *Catostomus insignis* and Desert Sucker *C. clarkii*. The value of San Francisco River habitat to native fishes is reflected by the project catchment being in the top 23% of all catchments included in the lower Colorado River basin assessment (Table 3; Figure 4; Whittier et al. 2011).

The Goose Creek Group Allotment project was proposed by Trout Unlimited and the U.S. Bureau of Land Management in 2015 (for 2016 funding) to update off-stream watering infrastructure and improve riparian health and instream habitat in the Goose Creek watershed in Idaho. The proposed project, when completed, will install more than 21 km of new pipeline and 15 water troughs to reduce livestock reliance on streams for water. The project will improve riparian vegetation, instream habitat, and water quality in Goose Creek and its tributaries. The main stem provides habitat for Northern Leatherside Chub, Bluehead Sucker *Catostomus discobolus*, and

Box 1. Restoration of Tincup Creek in the Upper Snake River Basin

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The Tincup Creek Stream Restoration Project began in 2017 and is a large-scale, multiphased project led by Trout Unlimited and the U.S. Forest Service, Caribou-Targhee National Forest. The project provides a unique opportunity to improve habitat conditions for Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri*, Northern Leatherside Chub *Lepidomeda copei*, boreal toad *Bufo boreas boreas*, and western pearlshell mussel *Margaritifera falcata*, all native species that have been designated by federal and state management agencies as species of concern. There are also other native aquatic species present within the project area that together form a diverse assemblage of native species. Because of the native fish assemblage, the Tincup Creek watershed ranks high for native fish conservation value in the upper Snake River basin as a potential native fish conservation area (Williams et al. 2019), and the project has been named as one of the 2017 "Waters to Watch" by the National Fish Habitat Partnership.

The project goals are to restore channel processes and floodplain function on 6.5 km of stream that were degraded by accidental spraying of floodplain willows in the late 1950s. The design reconnects the stream to its floodplain and improves habitat by narrowing the stream, elevating riffles, stabilizing eroding banks on outside meanders, and reconnecting historical meanders. Project work is being accomplished with on-site native materials such as gravel, whole willow clumps, and sod mats. In addition, 500 large trees with rootwads have been brought in to provide stability and habitat complexity. The project's focus on healthy stream function and processes is expected to increase habitat complexity and quality through time and benefit all life stages of a diverse assemblage of native fishes. For example, rootwads with wood cover are expected to benefit Northern Leatherside Chub as well as juvenile trout.

To successfully complete a project of this magnitude, it has been necessary to enlist the help of a wide array of partners, including financial and volunteer support from local Trout Unlimited chapters; in-kind support from Agrium, the Bear Lake Grazing Association, the Idaho Department of Fish and Game, local grazing permittees, Caribou County, and the Idaho Transportation Department; and funding support to date from the Desert Fish Habitat Partnership, Caribou-Targhee National Forest, Jackson Hole One Fly, the Idaho office of the U.S. Fish and Wildlife Service, and the Western Native Trout Initiative. Making a measurable impact has required cooperation and engagement from many sources as well as a project design that focuses on stream function to meet a suite of conservation objectives for multiple native species.

Box continues

Box 1. Continued

Box Figure 1. Tincup Creek before channel restoration (June 6, 2017).

Box Figure 2. Tincup Creek after channel restoration (September 14, 2017).

Box continues

Box 1. Continued

Box Table 1. Funding sources as of 2017 for Tincup Creek restoration project.

Contributor	In-kind	Cash
U.S. Forest Service	✓	✓
National Trout Unlimited	✓	
Jackson Hole Trout Unlimited		✓
Snake River Cutthroats Trout Unlimited		✓
Jackson Hole One Fly		✓
Western Native Trout Initiative		✓
Agrium/Bear Lake Grazing Association	✓	
Idaho Fish and Game Department	✓	
Desert Fish Habitat Partnership		✓
U.S. Fish and Wildlife Service		✓
Caribou County	✓	
Idaho Transportation Department	✓	
National Forest Foundation		✓
Idaho Department of Environmental Quality		✓
Trout Unlimited–Orvis Embrace-A-Stream		✓
Subtotal	$69,000.00	$185,500.00
Grand total	$254,500.00	

Yellowstone Cutthroat Trout—all species of greatest conservation need in Idaho—as well as a diverse set of other native fishes linked to healthy riparian and diverse instream habitats (Dauwalter et al. 2014; Walrath et al. 2016; Dauwalter et al. 2018). The diverse fish assemblage and the occurrence of two rare species in Goose Creek and its tributaries is why this subwatershed ranks within the top 2% of all subwatersheds in the upper Snake River basin (Table 3; Williams et al. 2019).

Informing Efficient Conservation Delivery

Organizations and partnerships representing large geographies often have the difficult task of deciding where to focus conservation efforts with limited resources. Numerous approaches to aquatic conservation assessment have been developed to help with this task (Kuehne et al. 2017). Assessment frameworks range from simple overlays of spatial data on environment and human stressors to very quantitative optimization algorithms focused on the conservation principles of comprehensiveness, representation, and others while accounting for species biology (home ranges), landscape connectivity, threats, climate change, and other factors, as described herein and elsewhere (Pressey and Cowling 2001; Moilanen et al. 2009). Algorithms, and the assessment outputs they produce (rankings and priority areas), are not a panacea, but instead serve to guide and inform rather than prescribe planning decisions. They are part of the planning process and not the process itself. The assessments simply highlight important areas and become part of a decision support system, in which humans are integral, for conservation decision mak-

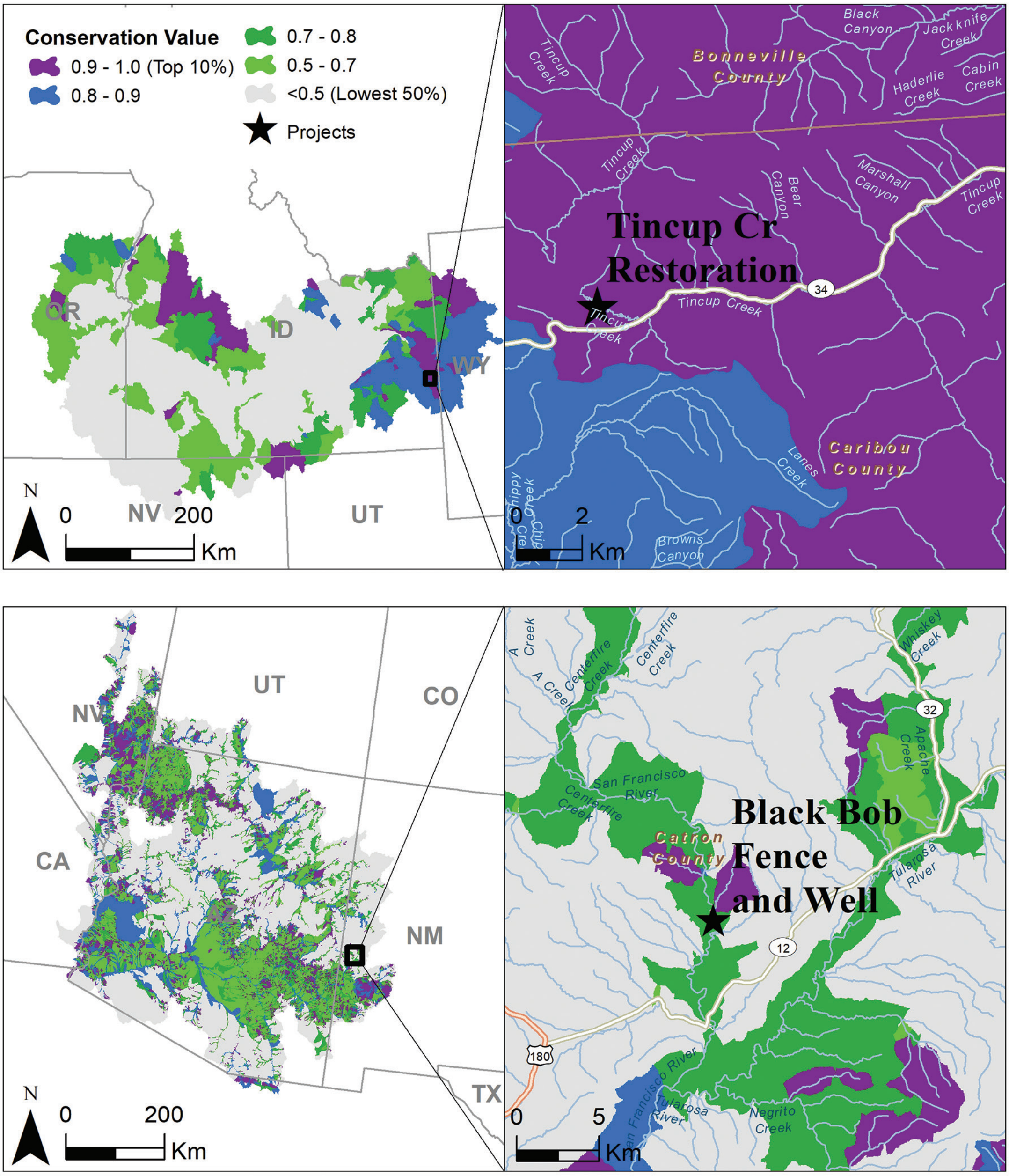

Figure 4. Catchment conservation values (ranks) for the upper Snake River basin (top left) and lower Colorado River basin (bottom left) and specifically for the Tincup Creek watershed proposed for restoration (top right; conservation value = 0.90) and San Francisco River where the Black Bob Allotment project was proposed (bottom right; conservation value = 0.77) (Table 3).

ing (Pressey and Cowling 2001). When good data are available, quantitative assessment and prioritization can enhance the explicitness, repeatability, and scientific credibility of conservation decision making (Ferrier and Wintle 2009).

As partnerships representing large geographies, the DFHP and WNTI have had to be creative in completing aquatic assessments in focal river basins (and WNTI focal species and subspecies) that represent both the scale at which the partnerships operate and a scale appropriate to the conservation priorities and historical ranges of native fishes. As demonstrated above, the partnerships have had to work together to identify diverse funding sources and diverse partners to pursue development of basin-specific assessments. Likewise, basin-specific aquatic assessments naturally align with the regional biogeography of fishes. For example, the historical distribution of native trouts largely align with the individual basins for which assessments were completed: Colorado River Cutthroat Trout *O. c.pleuriticus* in the upper Colorado River basin, Apache Trout *O. apache* and Gila Trout *O. gilae* in the lower Colorado River basin; Rio Grande Cutthroat Trout *O. c. virginalis* in the upper Rio Grande basin. For assessments not yet completed, Bonneville Cutthroat Trout *O. c. utah* occur naturally only in the Bonneville basin and Lahontan Cutthroat Trout *O. c. henshawi* occur in the Lahontan basin (Behnke 2002). Nongame fish distributions are also, mostly, unique to individual basins at the same scale (Smith 1981). Trout-based rangewide assessments funded by the WNTI have produced spatial data on trout populations across the species' (or subspecies') ranges that have been used directly in some assessments (e.g., upper Snake River; Muhlfeld et al. 2015; Williams et al. 2019).

The aquatic assessments completed, to date, have largely been used to provide a landscape or basinwide perspective for projects proposed to the FHPs for funding. Both FHPs use a scoring rubric to rank proposed projects. As mentioned earlier, projects proposed to the DFHP for funding include projects on streams and rivers—habitats for which the assessments discussed herein focus—but they also include projects on springs and ciénegas where assessments have not been completed. The lack of consistent information across habitat types and geographies prohibits the assessments from being formally integrated into project-scoring rubrics at this time. However, completed assessments (1) do give important basinwide context to proposed projects, (2) highlight hydrologic units with high value for conserving native fish diversity at a landscape scale because of high species richness or representation of rare species, (3) identify habitat and protection needs by overlaying high-value hydrologic units with human stressor indices or land protection status (Howard et al. 2018; Williams et al. 2019), and (4) can be used to identify focal watersheds for collaboration, efficient use of resources, and targeted long-term conservation efforts (Dauwalter et al. 2011; Birdsong et al. 2015; Labay et al. 2018; Birdsong et al. 2019).

Social, economic, and political considerations also influence where conservation is implemented on the ground. Landscape-scale aquatic assessments, such as those presented here, can be used in conjunction with socioeconomic and political information to ensure that opportunities for conservation action are balanced with biological priorities as a form of informed opportunism (Noss et al. 2002; Pressey and Bottrill 2008). There is a role, then, for assessments to inform conservation and be part of the collaborative decision-making process among diverse stakeholder groups (Barmuta et al. 2011; Souder 2013). The Tincup Creek project is a good example where project managers submitted project funding proposals to both the WNTI and DFHP, and the FHPs used the upper Snake River basin assessment to confirm that the project occurred in a watershed with high conservation value for both native Yellowstone Cutthroat Trout and native nongame fishes (Figure 4). In other cases, strategic opportunities for cosponsorship of projects are clear without assessment information. The DFHP and WNTI cofunded a fish passage project in the Weber River, Utah that is habitat for fluvial Bonneville Cutthroat Trout and the only population of Bluehead Sucker in the Bonneville basin and has a formal watershed advisory group, thus confirming the importance of that watershed despite the lack of a formal multispecies assessment. The Weber River Partnership is highlighted in Thompson and Burnett (2019, this volume).

Others also have used multispecies aquatic assessments to identify focal areas. The Rio Grande basin assessment included a specific step of using native fish-based conservation values to identify focal planning units referred to as native fish conservation areas (NFCAs; Williams et al. 2011; Labay et al. 2018). The authors suggested that identified NFCAs represent units to focus planning, communication, cooperation, and coordination among multiple stakeholders. A similar approach to identify NFCAs based on multispecies aquatic assessment results has been used in Texas to organize facilitated workshops and catalyze cooperative conservation of aquatic resources through a data-driven process (Birdsong et al. 2019). Successful application of this approach in Texas led to a similar assessment and planning approach for the Great Plains under the Great Plains Fish Habitat Partnership and Great Plains Landscape Conservation Cooperative (Labay et al. 2019, this volume). A similar process could be undertaken with the assessments presented herein (Figure 5).

Efficient conservation delivery is a balance between pragmatism, socioeconomic and political forces, and maximizing the representation and persistence of focal biodiversity. There are simply not enough conservation resources available to be wasteful, and many freshwater fishes are imperiled (Darwall and Freyhof 2016). Luckily, spatial conservation assessment methods are more accessible than ever and are being applied to

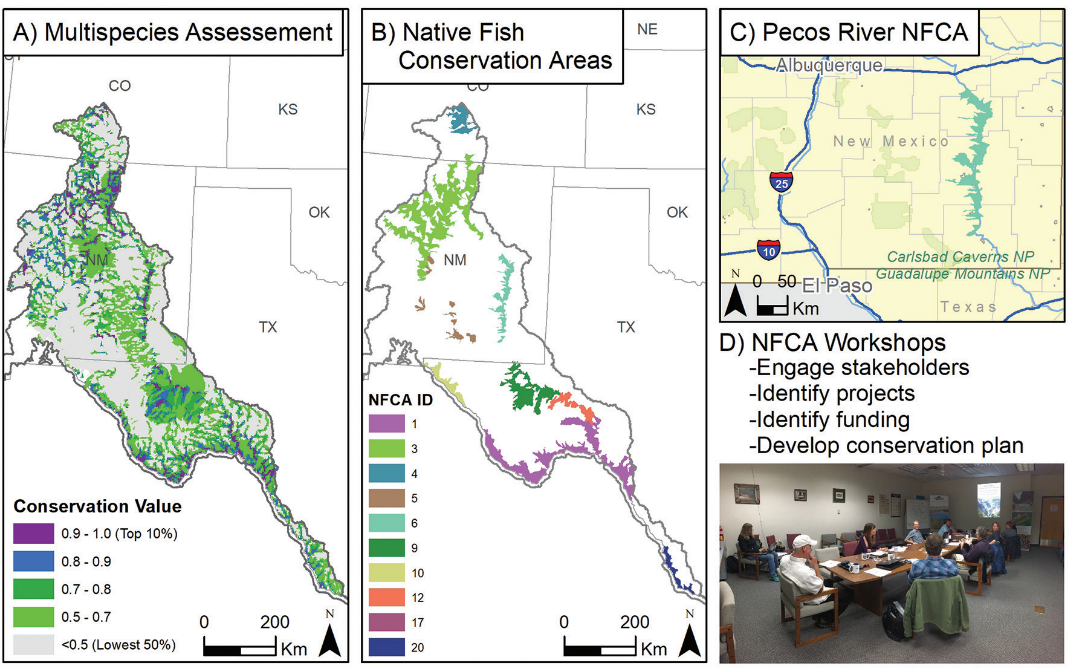

Figure 5. Conceptual process for using **(A)** multispecies aquatic assessments to identify **(B, C)** native fish conservation areas (or focal watersheds) that can be used to organize **(D)** workshops with stakeholders to develop watershed-based conservation plans emphasizing protection and restoration of fish habitats and native fish species.

aquatic systems with watersheds as the focal units. Completed assessments facilitate conservation planning at landscape scales through integration with the local knowledge and pragmatism of field biologists that have expertise on native fishes and in habitat restoration, land protection, and threat abatement. This naturally lends itself to a dual-pronged approach that is both top-down (assessment driven) and bottom-up (local knowledge) to deliver informed and efficient conservation across broad landscapes and large river basins.

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