Appendix E: Watershed Condition Framework and Conservation Watershed Network

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Introduction

One of the original purposes for establishing the National Forest System was to protect our Nation's water resources. The 2012 planning rule includes a newly created set of requirements associated with maintaining and restoring watersheds and aquatic ecosystems, water resources, and riparian areas in the plan area. The increased focus on watersheds and water resources in the 2012 planning rule reflects the importance of this natural resource, and the commitment to stewardship of our waters.

The 2012 planning rule requires that plans identify watersheds that are a priority for restoration and maintenance. The 2012 planning rule requires all plans to include components to maintain or restore the structure, function, composition, and connectivity of aquatic ecosystems and watersheds in the plan area, taking into account potential stressors, including climate change, how they might affect ecosystem and watershed health and resilience. Plans are required to include components to maintain or restore water quality and water resources, including public water supplies, groundwater, lakes, streams, wetlands, and other bodies of water. The planning rule requires that the Forest Service establish best management practices for water quality, and that plans ensure implementation of those practices.

Plans are also required to include direction to maintain and restore the ecological integrity of riparian areas. The Flathead National Forest proposes to maintain riparian areas through riparian habitat conservation areas and standards and guidelines. This direction will also protect native fish and further strengthen the Watershed Conservation Network.

Watershed Condition Framework

The watershed condition framework will be used to identify priority watersheds, develop watershed action plans, and implement projects to maintain or restore conditions in priority watersheds.

Priority areas for potential restoration activities could change quickly because of events such as wildfire or the introduction of invasive species. Therefore, the 2012 planning rule includes priority watersheds as plan content, so that an administrative change could be used to quickly respond to changes in priority.

Benefits from implementing the watershed condition framework are as follows:

- Strengthens the effectiveness of Forest Service watershed restoration
- Establishes a consistent, comparable, credible process for determining watershed condition class
- Enables a priority-based approach for the allocation of resources for restoration
- Improves Forest Service reporting and tracking of watershed condition
- Enhances coordination with external agencies and partners.

The Forest Service Manual 2520, Watershed and Air Management, uses three classes to describe watershed condition:

- Class 1 watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.
- Class 2 watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

- Class 3 watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

The Forest Service Manual classification defines watershed condition in terms of “geomorphic, hydrologic and biotic integrity” relative to “potential natural condition.” Geomorphic functionality or integrity can be defined in terms of attributes such as slope stability, soil erosion, channel morphology, and other upslope, riparian, and aquatic habitat characteristics. Hydrologic functionality or integrity relates primarily to flow, sediment, and water-quality attributes. Biological functionality or integrity is defined by the characteristics that influence the diversity and abundance of aquatic species, terrestrial vegetation, and soil productivity.

In each case, integrity is evaluated in the context of the natural disturbance regime, geoclimatic setting, and other important factors within the context of a watershed. The definition encompasses both aquatic and terrestrial components, because water quality and aquatic habitat are inseparably related to the integrity and, therefore, the functionality of upland and riparian areas within a watershed. The three watershed condition classes are directly related to the degree or level of watershed functionality or integrity:

- Class 1 = Functioning Properly
- Class 2 = Functioning at Risk
- Class 3 = Impaired Function.

In this framework, a watershed is considered in good condition if it is functioning in a manner similar to one found in natural wildland conditions.[1, 2] This characterization should not be interpreted to mean that managed watersheds cannot be in good condition. A watershed is considered to be functioning properly if the physical attributes are appropriate to maintain or improve biological integrity. This consideration implies that a class 1 watershed in properly functioning condition has minimal undesirable human impact on natural, physical, or biological processes and is resilient and able to recover to the desired condition when or if disturbed by large natural disturbances or land management activities.[3] By contrast, a class 3 watershed has impaired function because some physical, hydrological, or biological threshold has been exceeded. Substantial changes to the factors that caused the degraded state are commonly needed to set them on a trend or trajectory of improving conditions that sustain physical, hydrological, and biological integrity. Defining specific classes for watershed condition is obviously subjective and, therefore, problematic for several reasons. First, watershed condition is not directly observable.[4] In nature, no distinct lines separate a watershed that is functioning properly from impaired condition, and every classification scheme is arbitrary to some extent. Second, watershed condition is a mental construct that has numerous definitions and interpretations in the scientific literature.[5] Third, the attributes that reflect the state of a watershed are continually changing because of natural disturbances (e.g., wildfire, landslides, floods, insects, and disease), natural variability of ecological processes (e.g., flows and cycles of energy, nutrients, and water), climate variability and change, and human modifications.

[1] Karr, J.R. and L.W. Chu. 1999. *Restoring life in running rivers: better biological monitoring*. Washington, DC: Island Press. 206 p.
[2] Lackey, R.T. 2001. “Values, policy, and ecosystem health.” *Bioscience* 51: 437–443.
[3] Yount, J.D. and G.J. Niemi. 1990. “Recovery of lotic communities and ecosystems from disturbance—a narrative case study.” *Environmental Management* 14: 547–570.
[4] Suter, G.W. 1993. “Critique of ecosystem health concepts and indexes.” *Environmental Toxicology and Chemistry* 12: 1533–1539.
[5] Lackey, R.T. 2001. “Values, policy, and ecosystem health.” *Bioscience* 51: 437–443.

The Flathead National Forest completed our watershed condition framework in 2011. The Forest Service identified five class 2 hydrologic unit code (HUC) 12 watersheds and 176 class 1 hydrologic unit code 12 watersheds. There were no class 3 watersheds identified. Table E-1identifies the class 2, Functioning at Risk, watersheds and their priority for restoration. Figure B-06 shows the locations of the class 2 watersheds.

Cold and Jim creeks are the highest priority for restoration because they are important bull trout streams in the Swan River drainage. Beaver, Meadow and Logan are predominantly brook trout streams and although it is desirable to move these watersheds to a class 1, it would be a wiser investment to prioritize restoration work in the Conservation Watershed Network for native fish as described below.

The watershed condition framework is one component of our aquatic conservation strategy and is designed to restore watersheds to their natural potential condition. These watersheds require short-term investments to restore them. Another component is to restore impaired waterbodies on the state 303(d) list that have completed total maximum daily loads (also referred to as TMDLs). These watersheds would also require short-term investments. The final component in the strategy is the Conservation Watershed Network, which is designed to provide long-term protection, connectivity, and survival of native fish.

Total Maximum Daily Loads

The Montana Water Quality Act requires the Montana Department of Environmental Quality to develop TMDLs for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. The Montana Department of Environmental Quality submits the TMDLs to the U.S. Environmental Protection Agency for approval. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. Total maximum daily loads provide an approach to improve water quality so that streams and lakes can support and maintain their state-designated beneficial uses.

An indication of the quality of stream habitat and water quality on the Flathead National Forest can be derived from the TMDL determination and 303(d) listing process. In 1996, the year after the implementation of *Inland Native Fish Strategy*[6] (INFISH), there were 22 streams on the forest that were listed as impaired due to siltation. During the TMDL development for streams on the forest from 2004 to 2014, no TMDL was required for 17 of those streams because data collected to support TMDL development indicated that they were no longer impaired for sediment and were removed from the 303(d) list without a required TMDL. In other words sediment, which was leading factor toward impairment, was no longer impacting beneficial uses.

On the Flathead National Forest, the Montana Department of Environmental Quality determined that sediment continues to impair aquatic life in Logan, Sheppard, Coal, Goat, and Jim creeks, and the Department provided sediment TMDLs for those waterbody segments. Therefore, TMDLs have been developed for all streams on the Forest where required. Three waterbodies that are downstream of our Forest boundary, Swan Lake,[7] Haskill Creek,[8] and the Stillwater River,[9] also have sediment TMDLs that

[6] USDA. 1995. Inland Native Fish Strategy: Environmental Assessment—Decision Notice and Finding of No Significant Impact. “Interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, western Montana, and portions of Nevada.” USDA, Forest Service. Intermountain, Northern, and Pacific Northwest Regions. 211 pp.

[7] Montana Department of Environmental Quality. 2014. *Montana 2014 Final Water Quality Integrated Report*. Helena, Montana.

[8] Ibid.

[9] Ibid.

have been developed. Fish Creek is a recent example of a stream that was on the 1996 303(d) list and continued through the 2014 303(d) list for sediment impairment, but data collected to support TMDL development in 2014 indicated that it is no longer impaired for sediment and will be removed from the 303(d) list.[10]

For the five streams with sediment TMDLs, excess sediment may be limiting their ability to support aquatic life. Water quality restoration goals for sediment were established on the basis of fine sediment levels in trout spawning areas and aquatic insect habitat, stream morphology and available in-stream habitat as it related to the effects of sediment, and the stability of streambanks. The Montana Department of Environmental Quality believes that once these water quality goals are met, all water uses currently affected by sediment will be restored. The Department's water quality assessment methods for sediment impairment are designed to evaluate the most sensitive use; thus, ensuring protection of all designated uses. For streams in western Montana, the most sensitive use assessed for sediment is aquatic life.

Three of the five impaired streams (Coal, Goat and Jim creeks) are important bull trout streams and Sheppard Creek supports a pure westslope cutthroat trout population that competes with brook trout. Restoration efforts in these watersheds will focus on reducing sediment levels through best management practices for roads and reduction of roads.

[10] Montana Department of Environmental Quality. 2014. *Montana 2014 Final Water Quality Integrated Report*. Helena, Montana.

Table E-1. Watershed Condition Framework class 2 watersheds on the Flathead National Forest

Current Priority Level	Watershed Name	Attributes Rated at Risk in Watershed Condition Framework Assessment	Current Planning Efforts	Overlapping Priorities and Partnerships	Notes
High	Cold Creek	Riparian/wetlands, road density, best management practices (BMPs), soil productivity	Chilly James. Scoped in February 2014	SW Crown Collaborative Forest Landscape Restoration Program (CFLRP), Bull Trout Cons Strategy Priority Watershed	Cold Ponds Wetland Restoration Project, Bull trout Conservation Strategy Watershed. Bull trout numbers are decreasing due to lake trout in Swan Lake.
High	Jim Creek	303(d) listed stream, riparian/wetlands, soil productivity, road density, functioning at risk condition class (FRCC), weeds	Chilly James. Scoped in February 2014	SW Crown CFLRP, Bull Trout Conservation Strategy Priority Watershed, Swan Total Maximum Daily Load Tech Advisory Group.	Bull trout numbers are decreasing due to lake trout in Swan Lake. Opportunity for riparian/wetland restoration and weed treatments. No in-stream fish habitat restoration needs identified 303(d) listing resulting from historic logging practices and poor road conditions.
High	Beaver Creek	Road density, BMPs, weeds, insects and disease, non-native fish	Beaver Creek. Proposed Action March 2014	SW Crown CFLRP	Opportunities to slow non-native fish invasion and reduce road density.
High	Meadow Creek	Channel morphology, riparian/wetlands, water quality, non-native species	Griffin Creek II Decision. December 2013	Montana Fish Wildlife & Parks	Opportunities to restore riparian conditions and water quality in Meadow Creek. Riparian fencing followed by large-scale willow planting. Remove lodgepole pine encroachment. Establish beaver populations.
Moderate	Middle Logan	303(d) listed stream, non-native fish, road density, riparian/wetlands, FRCC, water quality	None	Montana Fish Wildlife & Parks	Logan Creek road relocation, Sanko Creek cutthroat restoration, road treatments into gravel pit.

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Conservation Watershed Network for Native Fish

A Conservation Watershed Network (figure B-07) is a collection of watersheds where management emphasizes habitat conservation and restoration to support native fish and other aquatic species. The goal of the network is to sustain the integrity of key aquatic habitats to maintain long-term persistence of native aquatic species. Designation of Conservation Watershed Networks, which should include watersheds that are already in good condition or could be restored to good condition, are expected to protect native fish and help maintain healthy watersheds and river systems. Selection criteria for inclusion should help identify those watersheds that have the capability to be more resilient to ecological change and disturbance induced by climate change. For example, watersheds containing unaltered riparian vegetation will tend to protect streambank integrity and moderate the effects of high stream flows. Rivers with high connectivity and access to their flood-plains will experience moderated floods when compared to channelized and disconnected stream systems. Wetlands with intact natural processes slowly release stored water during summer dry periods, whereas impaired wetlands are likely less effective retaining and releasing water over the season. For all of these reasons, Conservation Watershed Networks represent the best long-term conservation strategy for native fishes and their habitats.

Many watersheds on the forest that support the healthiest populations of native trout already have their headwaters protected through lands managed as Congressionally-designated wilderness areas (Bob Marshall, Great Bear and Mission Mountain Wildernesses) or the Flathead's wild and scenic rivers. These special places are the building blocks of a conservation network as naturally functioning headwaters have a large influence on the function of downstream stream reaches.[11, 12]

Of the native aquatic species present in the plan area, bull trout depend on the largest connected habitat areas, often called habitat patches. The definition we use for the term "habitat patch" as it relates to bull trout is defined by Rieman and McIntyre,[13] "contiguous stream areas believed suitable for spawning and rearing." Some potential fish conservation areas may be more challenging to conserve if the habitat patches are small and disconnected, especially considering potential effects of climate change.[14, 15, 16] This is especially true for bull trout because spawning adults and juveniles depend on large areas of connected stream reaches with cold water less than 11 degrees centigrade in late summer months, and often tens of thousands of acres in size.

Bull trout habitat in the western United States is naturally patchy, and can be fragmented into smaller less suitable habitat patches by warming stream reach segments.[17] The modeling performed by Isaak and

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[11] Allan, J.D., D.L. Erickson and J. Fay. 1997. "The influence of catchment land use on stream integrity across multiple spatial scales." *Freshwater Biology* 37: 149–161.
[12] Feld, C.K. and C.W. Lorenz. 2013. "Upstream river morphology and riparian land use overrule local restoration effects on ecological status assessment." *Hydrobiologia* 704: 489–501.
[13] Rieman, B.E. and J.D. McIntyre. 1995. "Occurrence of bull trout in naturally fragmented habitat patches of varied size." *Transactions of the American Fisheries Society* 124 (3): 285–296.
[14] Ibid.
[15] Dunham, J.B., B.E. Rieman, and J. Peterson. 2002. "Patch-based models to predict species occurrence- Lessons from salmonid fishes in streams" *In* Scott, J.M., P. Heglund, M. Morrison, J. Haufler, and B. Wall, eds., *Predicting Species Occurrences: Issues of scale and accuracy*: Covela, CA, Island Press, pp. 327–334.
[16] Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce and D. Myers. 2007. "Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River basin." *Transactions of the American Fisheries Society* 136 (6): 1552–1565.
[17] Isaak, D., M. Young, D. Nagel, D. Horan and M. Groce. 2015. "The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century." *Global Change Biology* 21:2540–2553.

others[18] assigns a probability of occupancy for bull trout and westslope cutthroat trout based upon cold water habitats (< 11ºC), stream slope, and brook trout prevalence. The model looks at a baseline period from 1970–1999 referred to in the paper as 1980, and then predicts changes habitat patches for the future periods 2040 and 2080. Modelled warming is based on 10 global climate change models. Figure B-58 displays the distribution of cold water habitats with occupancy probabilities for bull trout on the Flathead National Forest in 1980 and 2040. Figure B-59 displays the distribution of cold water habitats with occupancy probabilities for westslope cutthroat trout in 1980 and 2040, respectively. Many cold water patches are predicted to exist for both species along the Continental Divide. Many more patches exist for westslope cutthroat trout in the model when compared to bull trout because they persist in smaller patches. In a recently published paper by Isaak and others,[19] the researchers refined predictions for water temperature changes, which effects patch size and probabilities of persistence in 2040. The moderate scenario prediction for 2040 in their 2015 paper could now be considered a more extreme prediction and is unlikely to occur until decades later.

Considering studies about patch size and climate effects on patch size, identifying large habitat patch areas, typically 5th code watersheds with known stable local populations of bull trout form the basis of identifying a conservation watershed network for the Flathead Plan Revision. Because so much of the habitat in the Columbia Headwaters Recovery Unit[20] is fragmented by natural barriers, as well as by numerous dams constructed for power and water use, a goal in identifying the Conservation Watershed Network is identifying multiple adjacent 5th code watersheds, including watersheds with some risk of damage from the effects of changing climate. Watersheds that would benefit from storm-proofing treatments (a strategy to help protect watersheds from climate change discussed in appendix C) are identified in FW-CWN-OBJ-01. Simply stated, the larger a functioning and connected habitat patch, the greater the chances that cold water dependent bull trout and westslope cutthroat populations are likely to persist. It’s important to note here that even in smaller habitat patches, standards and guidelines proposed in this revision in combination with delineated riparian management zones are expected to maintain and improve existing habitat conditions for these smaller patches, even when not included in the Conservation Watershed Network.

Multi-scale Analysis

Multi-scale analysis was used to develop the Forest’s Conservation Watershed Network, starting with the scale of the Columbia River Basin. The best available science indicates the Flathead is and will be important for conservation of native fish (bull trout and westslope cutthroat trout) across their range.[21, 22, 23, 24] The Flathead River basin is along the spine of the continent and is predicted to provide

[18] Isaak, D., M. Young, D. Nagel, D. Horan and M. Groce. 2015. “The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century.” *Global Change Biology* 21:2540–2553.
[19] Isaak, D., M. Young, C. Luce, S. Hostetler, S. Wenger, E. Peterson, J. Ver Hoef, M. Groce, D. Horan and D. Nagel. 2016. “Slow climate velocities of mountain streams portend their role as refugia for cold-water biodiversity.” *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.1522429113.
[20] USFWS. 2015. Columbia Headwaters Recovery Unit Implementation Plan for bull trout (*Salvelinus confluentus*). Kalispell, Montana. 184 pp.
[21] Ibid.
[22] Isaak, D., M. Young, D. Nagel, D. Horan, and M. Groce. 2015. “The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century.” *Global Change Biology* 21:2540–2553.
[23] Shepard, B.B., B.E. May, and W. Urie. 2005. “Status and conservation of westslope cutthroat trout within the western United States.” *North American Journal of Fisheries Management* 25 (4): 1426–1440.
[24] Muhlfeld, C.C., T.E. McMahon, M.C. Boyer and R.E. Gresswell. 2009. “Local habitat, watershed, and biotic factors influencing the spread of hybridization between native Westslope Cutthroat Trout and introduced Rainbow Trout.” *Transactions of the American Fisheries Society* 138:1036–1051.

cold water into the future due to high elevation and slow climate velocities of mountain streams.[25] We then looked at the climate shield model[26] and temperature model[27] across the Flathead River basin (6th hydrologic unit code) to look closer where cold water is predicted to persist into the future in the face of climate change. The models both identified that cold water is predicted to persist in many of our local bull trout populations that were previously identified as priority watersheds under INFISH.[28] Therefore, we carried over our priority bull trout watersheds and those watersheds designated as critical habitat by the USFWS[29] into our network.

The forest also needed to take a closer scale look at our westslope cutthroat trout populations at the subbasin level (8th hydrologic unit code). There are many pure populations of westslope cutthroat trout on the forest, unlike many other watersheds across their range where brook trout have either outcompeted them or rainbow trout have hybridized with them. The South Fork Flathead River subbasin is extremely unique for its size in that there are no brook trout or rainbow trout populations above Hungry Horse Dam. The large patch size, proximity to each other, and connectivity (10th and 12th field hydrologic unit code scale) of these populations makes conservation important, as throughout westslope cutthroat trout range, only small fragmented populations exist.[30, 31]

Lastly, the Forest identified two 12th field hydrologic unit codes in each 8th field hydrologic unit code where storm-proofing would be targeted in the first decade of the plan. Reach scale data, barriers and road data were used to identify watershed for restoration priority while integrating terrestrial restoration priorities for grizzly bear, for example. See appendix C, for an additional description and an example of multi-scale analysis.

Multi-scale analysis is consistent with guidance contained in the Interior Columbia Basin Ecosystem Management Project memorandum of understanding[32] approved by senior managers in several of the western federal land management and regulatory agencies (i.e., Environmental Protection Agency, National Marine Fisheries Service, USFWS, Bureau of Land Management, and the USFS). The memorandum updated science findings from the original Interior Columbia Basin Ecosystem Management Project effort of the late 1990s and guides inclusion of best available science into land management plan revisions.

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[25] Isaak, D., M. Young, C. Luce, S. Hostetler, S. Wenger, E. Peterson, J. Ver Hoef, M. Groce, D. Horan and D. Nagel. 2016. “Slow climate velocities of mountain streams portend their role as refugia for cold-water biodiversity.” *Proceedings of the National Academy of Sciences*. doi:10.1073/pnas.1522429113.
[26] Isaak, D., M. Young, D. Nagel, D. Horan and M. Groce. 2015. “The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century.” *Global Change Biology* 21:2540–2553.
[27] Jones, L.A., C.C. Muhlfeld, L.A. Marshall, B.L. McGlynn and J.L. Kershner. 2014. “Estimating thermal regimes of bull trout and assessing the potential effects of climate warming on critical habitats.” *River Research and Applications* 30: 204–216. doi: 10.1002/rra.2638.
[28] USDA. 1995. Inland Native Fish Strategy: Environmental Assessment—Decision Notice and Finding of No Significant Impact. “Interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, western Montana, and portions of Nevada.” USDA, Forest Service. Intermountain, Northern, and Pacific Northwest Regions. 211 pp.
[29] USFWS. 2010. Endangered and threatened wildlife and plants; revised designation of critical habitat for bull trout in the coterminous United States; final rule. October 18, 2010. *Federal Register* 75:63898-64070.
[30] Rieman, B.E. and J.D. McIntyre. 1995. “Occurrence of bull trout in naturally fragmented habitat patches of varied size.” *Transactions of the American Fisheries Society* 124 (3): 285–296.
[31] Shepard, B.B., B.E. May and W. Urie. 2005. “Status and conservation of westslope cutthroat trout within the western United States.” *North American Journal of Fisheries Management* 25 (4): 1426–1440.
[32] USDA. 2014. The Interior Columbia Basin Strategy, Interagency Memorandum of Understanding. A strategy for applying knowledge gained by the Interior Columbia Basin Ecosystem Management Project to the revision of land use plans and project implementation. Forest Service Agreement No. 03-RMU-11046000-007. 6 pp.

At the broadest of scale considerations, information in USFWS's bull trout recovery plan[33] was reviewed to help place habitat and core populations located within the Flathead National Forest in context with recovery needs of the species across its range in the western United States. For recovery units like the Columbia Headwaters, the Recovery Plan Strategy states, "A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the breadth of the genetic makeup of the species to conserve its adaptive capabilities); resilience (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events[34]).

Additional information contained in the *Columbia Headwaters Recovery Unit Implementation Plan,*[35] was also reviewed. Types of information contained in the two USFWS documents included threats directly influencing individual bull trout survival, as well as threats to habitat. Primary threats were broken into different categories: habitat, demographic, and invasive species. The Flathead does not have habitat listed as a primary threat with the exception of simple core areas, Whitefish Lake and Upper Whitefish Lake. Primary threats listed throughout the rest of the Flathead Basin are demographic and invasive species. Hungry Horse does not have primary threats listed. Recovery actions for the Flathead focus on fish management and invasive species removal to help recover bull trout in the Columbia Headwaters recovery unit. In addition to primary threats, the recovery plan also recommends actions should be pursued to help provide resilience to "difficult to-manage-threats such as climate change."[36]

After USFWS recovery planning documents were reviewed, temperature and probability of cutthroat and bull trout occurrence data collected by Isaak and others[37] was reviewed by Flathead National Forest biologists to compare modeled results to known habitat conditions as well as local fish population information. Bull trout redd count data collected over the past two decades, which can be found in the bull trout section in the draft environmental impact statement, was used by biologists to help understand and validate probability of occurrence data.

Information from Isaak and others[38] was also considered in conjunction with PACFISH/INFISH biological opinion (PIBO) monitoring strategy data. PIBO data has been collected on the Flathead National Forest since 2000 and was used to help identify which watersheds considered for inclusion in the Watershed Conservation Network could be prioritized for potential project work to help protect habitat conditions from the effects of climate change. As the list of watersheds identified for inclusion into the Conservation Watershed Network was refined, the *U.S. Forest Service Bull Trout Conservation Strategy*[39] was reviewed to further identify opportunities to increase effectiveness of the network. Prior to the release of the *USFWS Bull Trout Recovery Plan,*[40] the Northern Region of the Forest Service developed the *U.S. Forest Service Bull Trout Conservation Strategy*. Development of this strategy was intended to meet long-

[33] USFWS. 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus).* USFWS, Pacific Region. Portland, Oregon. 179 pp.
[34] Ibid, pg 33.
[35] USFWS. 2015. Columbia Headwaters Recovery Unit Implementation Plan for bull trout (*Salvelinus confluentus*). Kalispell, Montana. 184 pp.
[36] USFWS. 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus).* USFWS, Pacific Region. Portland, Oregon. pg. 44.
[37] Isaak, D., M. Young, D. Nagel, D. Horan and M. Groce. 2015. "The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century." *Global Change Biology* 21:2540–2553.
[38] Ibid.
[39] USFS. 2013. *U.S. Forest Service Bull Trout Conservation Strategy*. Missoula, Montana.
[40] USFWS. 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus).* USFWS, Pacific Region. Portland, Oregon. 179 pp.

term commitments made by the INFISH strategy[41] to have a long-term restoration strategy for inland native fish. The *U.S. Forest Service Bull Trout Conservation Strategy* has the following three-fold purpose for the Forest Service and USFWS:

- Provide a standard process for updating bull trout habitat and population baselines that can be documented in the consultation process
- Provide a structured assessment of fish populations and habitat conditions, stressors, needs
- Identify opportunities that will further guide the location, type, and extent of projects on NFS lands intended to conserve, restore, and ultimately contribute to bull trout recovery.

The final step in the conservation watershed network identification process compared watersheds identified for the current plan revision against priority watersheds first identified by INFISH. This step was taken to help ensure important information had not been overlooked by this effort.

Summary of Conservation Watershed Network Multi-Scale Analysis

Basin and greater scale

The Flathead does have strong populations of bull trout and westslope cutthroat trout as well as other native species and is expected to provide cold water refugia in the coming century.[42, 43, 44, 45, 46] The USFWS recovery plan documents identified some sub-basins in the Flathead as being especially important in the coming century as the Hungry Horse and Flathead Lake complex core population areas are predicted to maintain some of the coldest habitat to support bull trout in the entire Headwaters of the Columbia. The Headwaters of the Columbia includes the Pend Oreille, Blackfoot, Kootenai, and Clark Fork River basins as well as the Flathead. At the broadest of scales, habitat on the Flathead has been found to have heightened importance for the conservation of cold water dependent species like bull trout and westslope cutthroat in the western United States.

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[41] USDA. 1995. Inland Native Fish Strategy: Environmental Assessment—Decision Notice and Finding of No Significant Impact. “Interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, western Montana, and portions of Nevada.” USDA, Forest Service. Intermountain, Northern, and Pacific Northwest Regions. 211 pp.

[42] USFWS. 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus).* USFWS, Pacific Region. Portland, Oregon. 179 pp.

[43] USFWS. 2015. Columbia Headwaters Recovery Unit Implementation Plan for bull trout (*Salvelinus confluentus*). Kalispell, Montana. 184 pp.

[44] Isaak, D., M. Young, D. Nagel, D. Horan and M. Groce. 2015. “The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century.” *Global Change Biology* 21:2540–2553.

[45] Isaak, D., M. Young, C. Luce, S. Hostetler, S. Wenger, E. Peterson, J. Ver Hoef, M. Groce, D. Horan and D. Nagel. 2016. “Slow climate velocities of mountain streams portend their role as refugia for cold-water biodiversity.” *Proceedings of the National Academy of Sciences*.

[46] Shepard, B.B., B.E. May and W. Urie. 2005. “Status and conservation of westslope cutthroat trout within the western United States.” *North American Journal of Fisheries Management* 25 (4): 1426–1440.

Sub-basin/ Core Area Scale

Dropping down in scale and going core area by core area (i.e., Hungry Horse (South Fork Flathead), Flathead Lake (North and Middle Fork Flathead), and Swan), cold water habitat patches identified by Isaak and others[47] were compared against bull trout redd survey data and core population areas disclosed in the bull trout recovery plan.[48, 49] The South Fork Flathead River sub-basins are particularly unique and the most important sub-basin on the Flathead National Forest proposed for inclusion in the Conservation Watershed Network. Two reasons support this assertion: Hungry Horse is expected to remain one of the coldest, and it does not contain lake trout. Throughout the Flathead basin, introduction of lake trout is considered by many as the most important primary threat to native fish. Hungry Horse Dam construction in 1953 prevented the spread of non-native lake trout into this drainage.[50] In addition, the South Fork subbasin contains genetically pure local populations of westslope cutthroat trout. The only non-native species in the Hungry Horse core area is grayling in Handkerchief Lake. Grayling are incapable of inter-breeding with native trout and char, and do not outcompete native trout.

In addition to Hungry Horse, the Middle and North Fork Complex Core Area (containing two sub-basins) and the Swan sub-basin also have cold water habitat that is likely to persist in the 21st century. Both core areas also have substantial local populations of spawning migratory bull trout. The USFWS recovery planning documents[51, 52] consider the presence of substantial lake trout populations as the greatest primary threat for these two core areas. Other primary threats in the other Flathead core areas are small population size in disjunct lakes such as Frozen, Doctor and Cyclone lakes, and fisheries management. The North and Middle Fork complex core area and the Swan core area have been considered warranted for inclusion in Conservation Watershed Network. In summary at a sub-basin scale, the Flathead National Forest contains three of the most important core areas in headwaters of the Columbia River and these areas are expected to help bull trout withstand potential effects of climate change in the 21st century.

Watershed /Sub-watershed/ Local Population Scale

At the finest scale of consideration, watersheds and sub-watersheds, the following data sets were used in the multi-scale analysis to identify a draft conservation network: priority watersheds originally identified by INFISH in 1995, existing spawning assessments for bull trout, Montana Fish, Wildlife and Parks' cutthroat occupancy data, patch size and temperature data contained in Isaak and others' climate shield model,[53] the *U.S. Forest Service Bull Trout Conservation Strategy,*[54] the *Columbia Headwaters Recovery*

[47] Isaak, D., M. Young, D. Nagel, D. Horan and M. Groce. 2015. "The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century." *Global Change Biology* 21:2540–2553.
[48] USFWS. 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus).* USFWS, Pacific Region. Portland, Oregon. 179 pp.
[49] USFWS. 2015. Columbia Headwaters Recovery Unit Implementation Plan for bull trout (*Salvelinus confluentus*). Kalispell, Montana. 184 pp.
[50] Montana Department Fish, Wildlife and Parks. 2006. South Fork Flathead Watershed Westslope Cutthroat Trout Conservation Program, Final Environmental Impact Statement. Helena, Montana. 410 pp.
[51] USFWS. 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus).* USFWS, Pacific Region. Portland, Oregon. 179 pp.
[52] USFWS. 2015. Columbia Headwaters Recovery Unit Implementation Plan for bull trout (*Salvelinus confluentus*). Kalispell, Montana. 184 pp.
[53] Isaak, D., M. Young, D. Nagel, D. Horan and M. Groce. 2015. "The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century." *Global Change Biology* 21:2540–2553.
[54] USDA. 2013. U.S. Forest Service Bull Trout Conservation Strategy. Missoula, Montana.

Unit Implementation Plan,[55] and local knowledge of Flathead National Forest biologists and hydrologists. These data sets along with professional opinion were considered at the watershed (5th code) and sub-watershed (6th code scales).

The *U.S. Forest Service Bull Trout Conservation Strategy*[56] and the *Columbia Headwaters Recovery Unit Implementation Plan*[57] provide synopses of factors leading to the decline of bull trout and recommendations for improvements in each local population. In general, there are no complete barriers on Flathead NFS lands that are preventing upstream migration of bull trout into spawning areas with the exception of Hungry Horse Dam. Habitat restoration efforts would focus on culvert removals or upsizing of culverts in light of a changing climate to reduce chance of failure that would reduce potential sediment inputs. Road storage and possibly segment relocation could be considered to help reduce potential sediment inputs.

For the Hungry Horse Complex Core Area, all watersheds in the South Fork Flathead subbasin were identified for inclusion into the Conservation Watershed Network. The Sullivan and Wounded Buck sub-watersheds (12th hydrologic unit code) in lower South Fork sub-basin are identified as the highest priorities for storm-proofing on the Flathead National Forest under the Conservation Watershed Network objective in the Conservation Watershed Network section of the Plan.

For the Middle and North Fork Complex Core Area, the following sub-watersheds (12th hydrologic unit code) were identified for inclusion into the Conservation Watershed Network: Clack, Strawberry, Bowl, Trail, Morrison, Dolly, Schafer, Granite, Bear, and Long (Middle Fork); and Upper Whale, Lower Whale, Shorty, Read Meadow, Trail, Tuchuck, Upper Coal, Lower Coal, Southfork Upper Coal, Hallowat, Upper Big and Lower Big Creeks. The Trail subwatershed (12th hydrologic unit code) and the Whale Creek watershed (10th hydrologic unit code) in the North Fork Flathead sub-basin and the Granite and Bear creek sub-watersheds (12th hydrologic unit code) in the Middle Fork Flathead sub-basins are identified as the next four highest priorities for storm-proofing (after Sullivan and Wounded Buck) under the Conservation Watershed Network objective in the Conservation Watershed Network section of the Plan.

The following sub-watersheds (12th hydrologic unit code) in the Swan Sub-basin (8th hydrologic unit code) were identified for inclusion into the Conservation Watershed Network: the Swan River Headwaters, Holland Lake, Elk, Cold, Jim, Piper, Lion, Goat, Woodward, and Lost Creeks. The Goat and Lion creek sub-watersheds (12th hydrologic unit code) are identified as the final priorities for storm-proofing (following after subwatersheds in the South Fork, the Middle Fork, and North Fork Flathead sub-basins) under the Conservation Watershed Network objective in the Conservation Watershed Network section of the Plan. The Cold and Jim creek watersheds, in addition to being recommended for the Watershed Conservation Network, are listed in the draft Plan Revision as priority watersheds for restoration under the Watershed Condition Framework.[58, 59] In addition to sub-watersheds in the Swan and other sub-basins previously discussed, the Stillwater River Headwaters, Swift, and Upper Stillwater

[55] USFWS. 2015. Columbia Headwaters Recovery Unit Implementation Plan for bull trout (*Salvelinus confluentus*). Kalispell, Montana. 184 pp.
[56] USDA. 2013. U.S. Forest Service Bull Trout Conservation Strategy. Missoula, Montana.
[57] USFWS. 2015. Columbia Headwaters Recovery Unit Implementation Plan for bull trout (*Salvelinus confluentus*). Kalispell, Montana. 184 pp.
[58] USDA. 2011. Forest Service watershed condition classification technical guide. Washington, DC: USDA, Forest Service. Watershed, Fish, Wildlife, Air, and Rare Plants Program.
[59] USDA. 2011. Forest Service watershed condition framework, a framework for assessing and tracking changes to watershed condition. Washington, DC: USDA, Forest Service. Watershed, Fish, Wildlife, Air, and Rare Plants Program.

Lake sub-watersheds (12th hydrologic unit code) are identified for inclusion in the Conservation Watershed Network as they contain bull trout critical habitat and disjunct local bull trout populations.