MCR Sthd 5-year Status Review Briefing Paper

MCR Steelhead DPS Recovery Viability Criteria/Scenarios 2016 Population Status Summaries Final 9/8/17

Biological Structure of Salmonid Populations: Historically, most salmon and steelhead species contained multiple populations connected by some small degree of genetic exchange that reflected the geography of the river basins in which they spawned, and with some spawners straying in from other areas. The species are essentially metapopulations defined by the common characteristics of populations within a geographic range. Recovery planning efforts focus on this biologically based hierarchy, which extends from the species level to a level below a population, and reflects the degree of connectivity between the fish at each geographic and conceptual level.

Evolutionarily Significant Unit and Distinctive Population Segment: A salmon evolutionarily significant unit (ESU) or steelhead distinct population segment (DPS) is a distinctive group of Pacific salmon or steelhead that is uniquely adapted to a particular area or environment. ESUs and DPSs may contain multiple populations that are connected by some degree of migration, and hence may have a broad geographic range across watersheds, river basins, and political jurisdictions.

Major Population Groups: A major population group (MPG) is an aggregate of independent populations within an ESU/DPS that share similar genetic and spatial characteristics. There are four MPGs in the Middle Columbia River Steelhead (MCR) DPS: (1) **Cascades Eastern Slope Tributaries MPG**, (2) **Yakima MPG**, (3) **John Day MPG**, and (4) **Walla Walla and Umatilla MPG** (ICTRT 2003; ICTRT 2005).

Independent Populations: McElhany et al. (2000) defined an independent population as: "…a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season." For our purposes, not interbreeding to a "substantial degree" means that two groups are considered to be independent populations if they are isolated to such an extent that exchanges of individuals among the populations do not substantially affect the population dynamics or extinction risk of the independent populations over a 100-year time frame. Independent populations exhibit different population attributes that influence their abundance, productivity, spatial structure and diversity. Independent populations are the units that are combined to form alternative recovery scenarios for MPGs and ESU/DPS viability.

Population-Specific Recovery Viability Criteria: The viable salmonid population (VSP) concept (McElhaney et al. 2000) is based on the biological parameters of abundance, productivity, spatial structure, and diversity for an independent salmonid population to have a negligible risk of extinction over a 100-year time frame. The VSP concept identifies the attributes, provides guidance for determining the conservation status of populations and larger-scale groupings of Pacific salmonids, and describes a general framework for how many and which populations within an ESU/DPS should be at a particular status for the ESU/DPS to have an acceptably low risk of extinction. The National Marine Fisheries Service (NMFS)-appointed Interior Columbia Technical Recovery Team (ICTRT) developed viability criteria metrics (Figure 1) based on the McElhaney et al. 2000 VSP concept (ICTRT 2007). The 2009 MCR Steelhead Recovery Plan Recovery Plan (NMFS 2009a) adopted the 2007 ICTRT viability criteria as recovery criteria for the threatened Middle Columbia River Steelhead DPS.

Abundance / Productivity Rating	Spatial Structure / Diversity Rating: Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (<5%)	Viable	Viable	Viable	Maintained
Moderate (<25%)	Maintained	Maintained	Maintained	High Risk
High	High Risk	High Risk	High Risk	High Risk

Figure 1. Viability Criteria Metrics (ICTRT 2007).

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MCR Steelhead DPS Viability Criteria: For the MCR Steelhead DPS to be viable, **all four MPGs** in the DPS should be viable (low risk). However, it may not be necessary for all of the populations to attain the lowest risk level for the MPG to be viable (ICTRT 2007; NMFS 2009a[1]). See Figures 3, 5, 7, and 9 below.

In 2015, the Northwest Fisheries Science Center (NWFSC 2015, *in* Table 37) summarized the MCR steelhead DPS status relative to the 2007 ICTRT and 2009 MCR Recovery Plan (NMFS 2009a) Abundance/Productivity (A/P) and Spatial Structure/Diversity (SS/D) viability metrics (Figure 1) for the independent populations within each of the four MPGs comprising the MCR Steelhead DPS (Table 1).

Highlighted in Table 1 below (NWFSC 2015 *in* Table 37) are the MCR Steelhead populations that need to improve to reach viability. See Figures 2, 4, 6, and 8 below for NWFSC 2015 MCR steelhead population **viability status ratings** (NWFSC 2015), and, Figures 3, 5, 7, and 9 for the 2009 NMFS MCR Recovery Plan (NMFS 2009a) population **recovery scenarios**.

Table 1. Summary NMFSC 2015 MCR Steelhead DPS status relative the 2007 ICTRT viability criteria, grouped by MPG (Table 37, *in* NWFSC 2015).

	Abundance/Productivity Metrics				Spatial Structure and Diversity Metrics			Overall Viability Rating
	ICTRT Minimum Threshold	*Natural Spawning Abundance*	*ICTRT Productivity*	*Integrated A/P Risk*	*Natural Processes Risk*	*Diversity Risk*	*Integrated SS/D Risk*	
Eastern Cascades MPG								
Fifteen Mile Creek	500	356 (.16)	1.84 (.19)	**Moderate**	Very Low	Low	**Low**	**Maintained**
Deschutes (Westside)	1,500 (1,000)	634 (.13)	1.16 (.15)	**High**	Low	Moderate	**Moderate**	**High Risk**
Deschutes (Eastside)	1,000	1,749 (.05)	2.52 (.24)	**Low**	Low	Moderate	**Moderate**	**Viable**
Klickitat River	1,000			**Moderate??**	Low	Moderate	**Moderate**	**Maintained(?)**
Rock Creek	500				Moderate	Moderate	**Moderate**	**High Risk?**
Crooked River (ext)	*2,000*							***Extirpated***
White Salmon R.(ext)	*500*							***Extirpated.***
Yakima River MPG								
Satus Creek	1,000 (500)	1127 (.17)	1.93 (.12)	**Low**	Low	Moderate	**Moderate**	**Viable**
Toppenish Creek	500	516 (.14)	2.52 (.19)	**Low**	Low	Moderate	**Moderate**	**Viable**
Naches River	1,500	1,244 (.16)	1.83 (.10)	**Moderate**	Low	Moderate	**Moderate**	**Moderate**
Yakima R Upper Mainstem	1,500	246 (.18)	1.87 (.10)	**Moderate**	Moderate	High	**High**	**High Risk**
John Day River MPG								
John Day Lower Mainstem Tribs	2,250	1,270 (.22)	2.67 (.19)	**Moderate**	Very Low	Moderate	**Moderate**	**Maintained**
Middle Fork John	1,000	1,736 (.41)	3.66 (.26)	**Low**	Low	Moderate	**Moderate**	**Viable**
North Fork John Day	1,000	1,896 (.19)	2.48 (.23)	**Very Low**	Very Low	Low	**Low**	**Highly Viable**
South Fork John	500	697 (.27)	2.01 (.21)	**Low**	Very Low	Moderate	**Moderate**	**Viable**
John Day Upper Mainstem	1,000	641 (.21)	1.32 (.18)	**Moderate**	Very Low	Moderate	**Moderate**	**Maintained**
Umatilla/Walla Walla MPG								
Umatilla River	1,500	2,379 (.11)	1.20 (.32)	**Moderate**	Moderate	Moderate	**Moderate**	**Maintained**
Walla Walla River	1,000	877 (.13)	1.65 (.11)	**Moderate**	Moderate	Moderate	**Moderate**	**Maintained**
Touchet River	1,000	382 (.12)	1.25 (.11)	**High**	Low	Moderate	**Moderate**	**High Risk**

[1]The Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan (NMFS 2009a) consists of eight component plans: Oregon (ODFW 2010), Klickitat (NMFS 2009b), Rock Creek (NMFS 2009c), Southeast Washington (SRSRB 2011), Yakima (YBFWRB 2009), White Salmon River Watershed (NMFS 2013), Mainstem Columbia River Hydropower Projects Module (NMFS 2008), and the Columbia River Estuary Module (NMFS 2011a).

Cascades Eastern Slope Tributaries MPG:

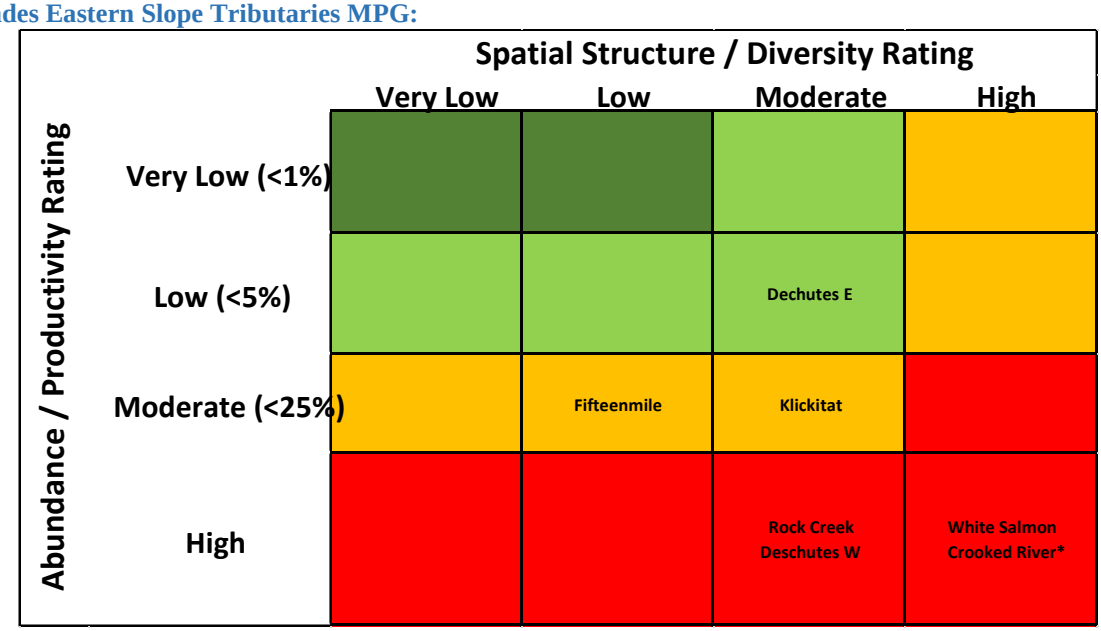

Figure 2. 2015 Viability Status Rating for MCR Steelhead Populations in the Cascades Eastern Slope Tributaries Major Population Group (NWFSC 2015).

Cascades Eastern Slope Tributaries MPG Recovery Criteria (ICTRT 2007; NMFS 2009a; NMFS 2009b; NMFS 2009c; NMFS 2013; ODFW 2010):

- Achieve viable status (low risk) for the Klickitat, Fifteenmile, and both the Deschutes Eastside and Westside populations, with one highly viable population.
- Achieve at least "maintained" status (moderate risk) for the Rock Creek population.
- Further bolster MPG viability with natural recolonization of the White Salmon population into its historical habitat, and with reintroduction of steelhead into the Crooked River.

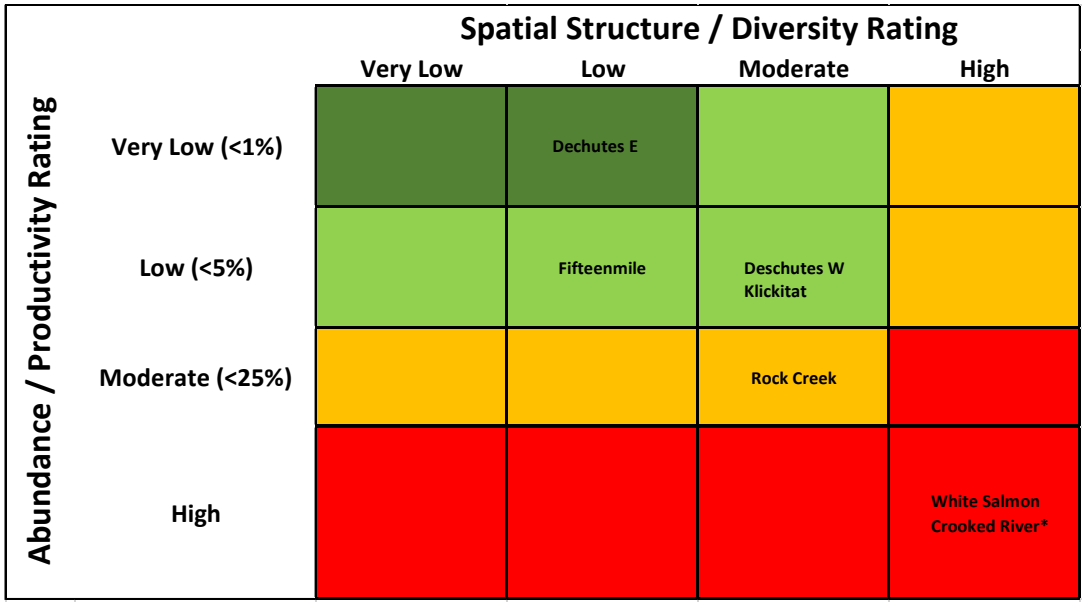

Figure 3. Recovery Scenario for MCR Steelhead Populations in the Cascades Eastern Slope Tributaries Major Population Group (ICTRT 2007; NMFS 2009a; NMFS 2009b; NMFS 2009c; NMFS 2013; ODFW 2010).

Cascades Eastern Slope Tributaries MPG:

Key Population-Specific Threats/Limiting Factors (NMFS 2016):

- Lack of long-term abundance and productivity monitoring data sets for the Klickitat and Rock Creek populations.
- Tributary overshoot of the Fifteenmile Creek population. Approximately 77 percent of wild Fifteenmile Creek steelhead overshoot above the Dalles Dam (Faber et al. 2014; Ruzycki et al. 2015; ODFW 2017).
- Passage issues in the upper Deschutes-Crooked River including blocked or limited access to historical habitat at Opal Springs diversion dam in the Crooked River* (extirpated Crooked River population).
- Reduced streamflows and elevated water temperatures (Fifteenmile Creek, Deschutes River Eastside, and Deschutes River Westside populations).
- Naturally spawning stray hatchery fish influence on viability of wild fish in the Deschutes River Eastside and Westside populations.
- Lack of long-term monitoring capacity to effectively evaluate (1) viability criteria and threats criteria status/trends and (2) recovery progress (all populations).

Top Five-Year Near-Term MPG Recovery Priorities (NMFS 2016):

- Apply BMPs (Best Management Practices) to protect existing high quality habitats and conserve ecological processes (all populations).
- Continue to support and implement the Fifteenmile Action Plan for Stream Temperature (FAST) to improve streamflows and water temperatures (Fifteenmile Creek population).
- Increase summer stream flow and decrease summer water temperatures (Fifteenmile Creek, Deschutes River Eastside and Deschutes River Westside populations).
- Provide upstream passage at Opal Springs Dam on the lower Crooked River* (RM 8), a tributary to the upper Deschutes River (extirpated Crooked River* population).*
- Continue habitat restoration actions in Klickitat River tributaries (White Creek and Teepee Creek for long-term riverine functions, and complete ongoing floodplain connectivity and in-stream habitat complexity actions on the Klickitat River mainstem (Klickitat population).
- Advance water conservation agreements with agricultural and domestic water users and continue to work with partners to implement high priority tributary habitat restoration and protection actions (all populations).

Key Five-Year MPG Research and Monitoring Recommendations (NMFS 2016):

- Maintain data collection in the Klickitat River and Rock Creek watersheds to develop long–term abundance and productivity numbers. Both the Klickitat and Rock Creek populations are potentially more viable than current 2015 ranking indicates; long-term data set is lacking.
- Evaluate the population-specific incidence and effects of tributary overshoot on the Fifteenmile Creek, Deschutes River Eastside and Deschutes River Westside populations.
- Fully implement high priority Recovery Plan research and monitoring actions to evaluate population abundance and survival, status/trends of factors limiting steelhead viability, effectiveness of implemented recovery actions, and extent of "all-H" threat amelioration needed to reach population and MPG viability (all populations).
- Monitor steelhead genetics, population structure, hatchery influence, and introgression with non-DPS stocks (all populations); Monitor disease transmission risk, particularly for the Fifteenmile Creek, Deschutes River Eastside, and Deschutes River Westside populations.
- Conduct DPS-wide spatial structure reassessment to evaluate the processes that influence each population's geographic distribution including adequate streamflow and water temperature, and projected climate change alterations to distribution.

* The Upper Deschutes Crooked River steelhead population is a "non-essential" ESA 10j experimental population. Non-essential means the reintroduced population will contribute to restoring the species but MCR steelhead recovery can be achieved without the population as described in 50 CFR 222 (81FR33416: NOAA Fisheries issued final regulations regarding experimental populations under section 10(j)(1) of the ESA. May 26, 2016). http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/esa_10j_designations.html

Yakima MPG:

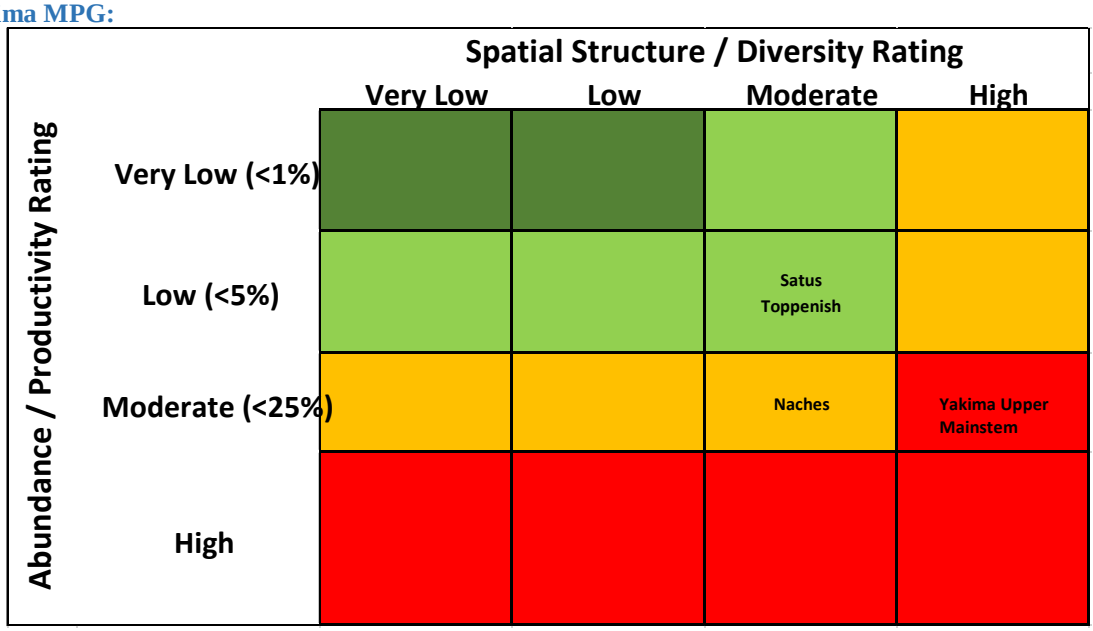

Figure 4. 2015 Viability Rating for MCR Steelhead Populations in the Yakima Major Population Group (NWFSC 2015).

Yakima MPG Recovery Criteria (ICTRT 2007; NMFS 2009a; YBFWRB 2009):

- Achieve viable status (low risk) for two populations, including at least one of the two classified as a large population - the Naches River and the Upper Yakima River.
- Achieve at least "maintained" status (moderate risk) for the remaining two populations.

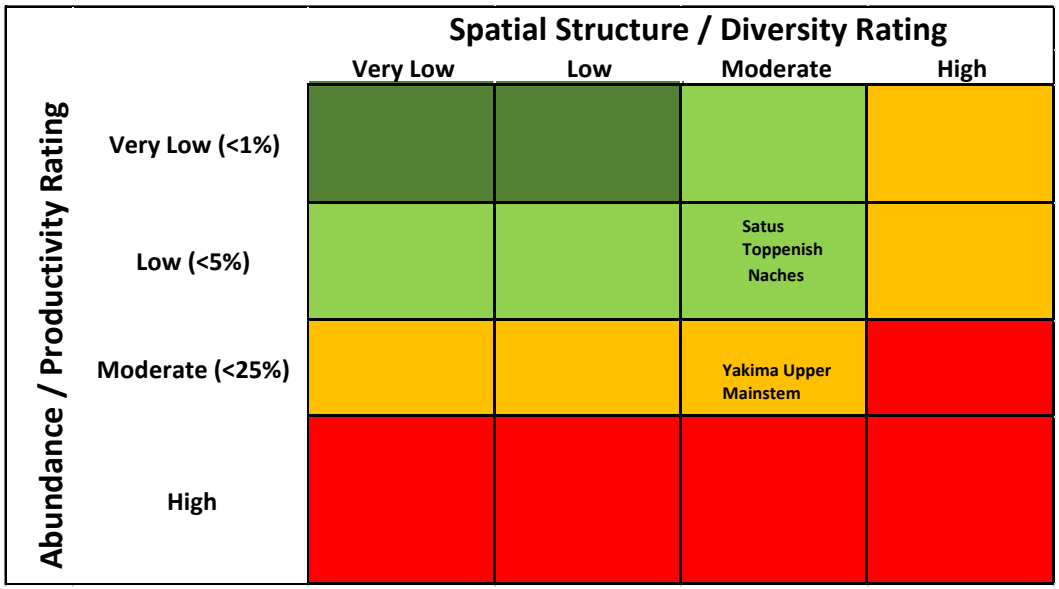

Figure 5. Recovery Scenario for MCR Steelhead Populations in the Yakima Major Population Group (ICTRT 2007; NMFS 2009a; YBFWRB 2009).

Yakima MPG:

Key Population-Specific Threats/Limiting Factors (NMFS 2016):

- Blocked or limited access to historical habitat at dams: Cle Elum (Upper Yakima population), Rimrock (Naches population), Upper Yakima tributaries Caribou and Wilson/Naenum (Upper Yakima River population).
- Bureau of Reclamation-altered spring outmigration flow regimes in Yakima River watershed (all populations).
- Degraded habitat conditions and reduced instream flows limiting productivity of many steelhead-producing tributaries in the Yakima River watershed, including Manastash, Ahtanum, Swauk, and Teanaway (Upper Yakima River population), and, Cowiche Creeks (Naches population).
- Legacy effect of hatchery fish influence (Upper Yakima River population).

Top Five-Year Near-Term MPG Recovery Priorities (NMFS 2016):

- Provide full passage in, and restore access to the Upper Cle Elum (Upper Yakima River population), and/or Caribou (Upper Yakima River population) or Wilson/Naneum Creeks (Upper Yakima River population). Maintain access in currently accessible areas (all populations).
- Manage flows and infrastructure at the Bureau of Reclamation's Yakima Project diversions and other diversions in a manner that supports high survival rates for steelhead juveniles and smolts (all populations). NMFS consultation with Bureau of Reclamation for the Yakima Project on MCR Steelhead Operations and Maintenance WCR-2015-264 is in progress.
- Maintain and/or improve instream flows and habitat conditions in Manastash, Ahtanum, Swauk, and Teanaway Creeks (Upper Yakima River population), and in Cowiche Creek (Naches population).
- Restore complex floodplain habitats in mainstem reaches (Wapato, Gap to Gap-*in progress*, Lower Naches (Naches and Upper Yakima populations), as well as in Kittitas and Cle Elum reaches (Upper Yakima River population).
- Continue implementation of high priority actions in the Yakima Integrated Plan (all populations).
- Advance water conservation agreements with agricultural and domestic water users and continue to work with partners to implement high priority, tributary habitat restoration and protection actions (all populations).

Key Five-Year MPG Research and Monitoring Recommendations (NMFS 2016):

- Fully implement high priority Recovery Plan research and monitoring actions to evaluate population abundance and survival, status/trends of factors limiting steelhead viability, effectiveness of implemented recovery actions, and extent of "all-H" threat amelioration needed to reach population and MPG viability (all populations).
- Monitor steelhead genetics, population structure, hatchery influence (all populations).
- Conduct DPS-wide spatial structure reassessment to evaluate the processes that influence each population's geographic distribution including adequate streamflow and water temperature, and projected climate change alterations to distribution.

John Day MPG:

Abundance / Productivity Rating	Spatial Structure / Diversity Rating: Very Low	Low	Moderate	High
Very Low (<1%)		John Day N. Fork		
Low (<5%)			John Day M. Fork John Day S. Fork	
Moderate (<25%)			John Day Lower Main. John Day Upper Main.	
High				

Figure 6. 2015 Viability Rating for MCR Steelhead Populations in the John Day Major Population Group (NWFSC 2015).

John Day MPG Recovery Criteria (ICTRT 2007; NMFS 2009a; ODFW 2010):

- Achieve viable status (low risk) for the Lower Mainstem John Day River, North Fork John Day River, and either the Middle Fork John Day River or Upper Mainstem John Day River populations, with one highly viable (very low risk) population.

Abundance / Productivity Rating	Spatial Structure / Diversity Rating: Very Low	Low	Moderate	High
Very Low (<1%)		John Day N. Fork		
Low (<5%)			John Day M. Fork John Day S. Fork John Day Lower Main.	
Moderate (<25%)			John Day Upper Main.	
High				

Figure 7. Recovery Scenario for MCR Steelhead Populations in the John Day Major Population Group (ICTRT 2007; NMFS 2009a; ODFW 2010).

John Day MPG:

Key Population-Specific Threats/Limiting Factors (NMFS 2016)

- Tributary overshoot – approximately 52% of wild John Day steelhead overshoot above McNary Dam (Carmichael et al. 2012; Ruzycki and Tattam 2014; Ruzycki et al. 2015; ODFW 2017).
- Reduced stream flow and elevated water temperatures (all populations).
- Fish passage and screening in the Lower Mainstem- and Upper Mainstem John Day River population areas.
- Naturally spawning stray out-of-DPS hatchery fish influence on viability of wild fish (all populations; due to Snake River fish transportation practices).
- Lack of long-term monitoring capacity to effectively evaluate (1) viability criteria and threats criteria status/trends and (2) recovery progress (all populations).

Top Five-Year Near-Term MPG Recovery Priorities (NMFS 2016):

- Apply BMPs to protect existing high quality habitats and conserve ecological processes (all populations).
- Increase summer stream flows and decrease summer water temperatures in the John Day River watershed (all populations), along with targeted restoration of stream function (structure and floodplain connectivity) and associated riparian conditions.
- Continue to improve passage and screening in the Lower Mainstem- and Upper Mainstem John Day River population areas.
- Advance water conservation agreements with agricultural and domestic water users and continue to work with partners to implement high priority, tributary habitat restoration and protection actions (all populations).
- Continue to implement Snake River steelhead barging protocols to reduce hatchery stray rates in the John Day River MPG (all populations).

Key Five-Year MPG Research and Monitoring Recommendations (NMFS 2016):

- Evaluate the population-specific incidence and effects of tributary overshoot on the John River MPG (all populations).
- Fully implement high priority Recovery Plan research and monitoring actions to evaluate population abundance and survival, status/trends of threats limiting steelhead viability, effectiveness of implemented recovery actions, and extent of “all-H” threat amelioration needed to reach population and MPG viability (all populations).
- Monitor steelhead genetics, population structure, and introgression with non-DPS stocks (all populations).
- Conduct DPS-wide spatial structure reassessment to evaluate the processes that influence each population’s geographic distribution in terms of adequate stream flow and water temperature, and projected climate change alterations to distribution.

Walla Walla and Umatilla MPG 2016:

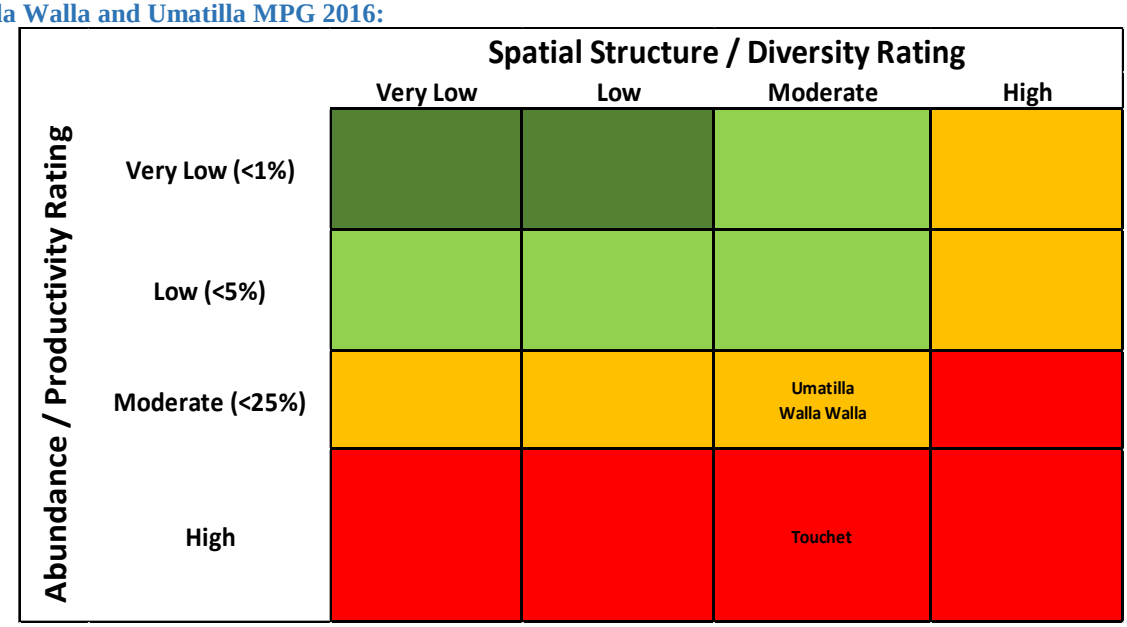

Figure 8. 2015 Viability Rating for MCR Steelhead Populations in the Walla Walla and Umatilla Major Population Group (NWFSC 2015)

Walla Walla and Umatilla MPG Recovery Criteria (ICTRT 2007; NMFS 2009a; ODFW2010; SRSRB 2011):

- Achieve viable status (low risk) for two populations, with one highly viable (very low risk).
- Achieve viable status (low risk) for the Umatilla River population as the only large population.
- Achieve viable status (low risk) for either the Walla Walla River or Touchet River population.

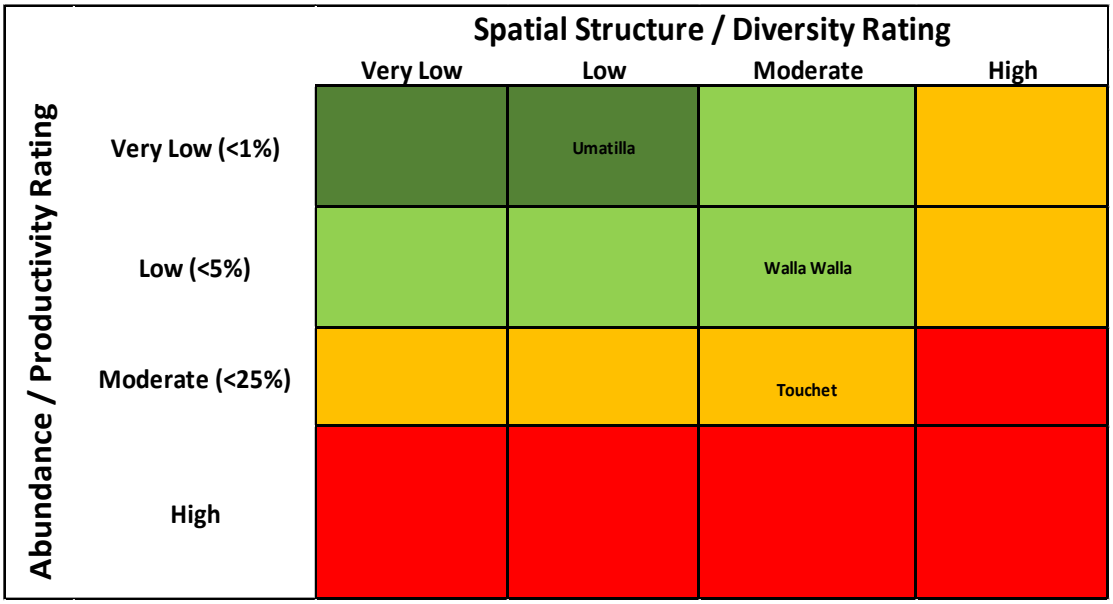

Figure 9. Recovery Scenario for MCR Steelhead Populations in the Walla Walla and Umatilla Major Population Group (ICTRT 2007; NMFS 2009a; ODFW 2010; SRSRB 2011)

Walla Walla and Umatilla MPG:

Key Population-Specific Threats/Limiting Factors (NMFS 2016):

- Tributary overshoot – approximately ~37% of wild Umatilla River steelhead overshoot above McNary Dam (Carmichael et al. 2012; Ruzycki and Hanson 2014; Ruzycki et al. 2015; ODFW 2017).
- Blocked or limited access to historical habitat above Bennington Dam and Nursery Bridge Dam (Walla Walla population), and, above McKay Dam (Umatilla population).
- Continued non-compliance with NMFS 2011b Biological Opinion on the Operation and Maintenance of the Mill Creek Flood Control Project – includes Bennington Dam (Walla Walla population).
- Bureau of Reclamation-altered flow regimes in the Umatilla River watershed (Umatilla population).
- Naturally spawning stray hatchery fish influence on viability of wild fish (Umatilla population).
- Reduced stream flow levels, elevated water temperature, fish passage, and screening (Umatilla, Walla Walla, and Touchet populations).
- Lack of long-term monitoring capacity to effectively evaluate (1) viability criteria and threats criteria status/trends and (2) recovery progress (primarily Touchet population).

Top Five-Year Near-Term MPG Recovery Priorities (NMFS 2016):

- Apply BMPs to protect existing high quality habitats and conserve ecological processes.
- Continue U.S. Army Corps of Engineers, Bureau of Reclamation, and fisheries co-managers implementation of flow and passage improvements in the Umatilla, Walla Walla and Touchet Rivers – specifically Bennington Dam, Mill Creek channel, and Nursery Bridge (Walla Walla population).
- Provide passage (1) and evaluate reintroduction feasibility over McKay Dam, a high priority passage action identified by the State of Oregon (Umatilla population), and (2) up Mill Creek, a tributary to the Walla Walla River to achieve abundance, productivity, and spatial structure goals for summer-run steelhead (Walla Walla population).
- Support development and implementation of a long-term study and design for passage and adequate flood risk reduction in the Nursery Bridge – Milton-Freewater (Oregon) levee system (Walla Walla population).
- Implement priority actions identified in the recovery plan that will reduce water temperatures and increase stream flows to increase habitat availability and connectivity for all steelhead life stages in the Walla Walla and Umatilla MPG.
- Address Bureau of Reclamation flow management issues in the lower Umatilla River (Umatilla population).
- Evaluate the feasibility of removing the abandoned Boyd Hydroelectric facility infrastructure on the mainstem Umatilla River (Umatilla population).
- Advance water conservation agreements with agricultural and domestic water users and continue to work with partners to implement high priority tributary habitat restoration and protection actions (all populations).
- Implement the Bi-State Walla Walla River Flow Enhancement Study preferred alternative (Walla Walla population).
- Comply with NMFS 2011b Biological Opinion on the Operation and Maintenance of the Mill Creek Flood Control Project (Walla Walla population).

Key Five-Year MPG Research and Monitoring Recommendations (NMFS 2016):

- Evaluate the population-specific incidence and effects of tributary overshoot on the Walla Walla and Umatilla MPG.
- Fully implement high priority Recovery Plan research and monitoring actions to evaluate population abundance and survival, status/trends of factors limiting steelhead viability, effectiveness of implemented recovery actions, and extent of “all-H” threat amelioration needed to reach population and MPG viability.
- Conduct DPS-wide spatial structure reassessment to evaluate the processes that influence each population’s geographic distribution including adequate stream flow and water temperature, and projected climate change alterations to distribution.

References:

Carmichael, R.W., Ruzycki, J.R. and I.A. Tattam. 2012. Potential FCRPS impacts to Oregon's Middle Columbia River steelhead populations resulting from adult entrapment above mainstem Columbia River dams. ODFW (Oregon Department of Fish and Wildlife) Whitepaper. Northeast Region Fish Research and Monitoring Program, Oregon Department of Fish and Wildlife, La Grande, Oregon.

Faber, D.M., Simpson P., Reagan R., Nelson T., Springston, S., Wilson, W., Poxon B., French R., Ruzycki J.R. and R.W. Carmichael. 2014. Hood River, Fifteenmile Creek, and Deschutes eastside tributaries tributary bypass. Presented at the Middle Columbia Wild Adult Steelhead Tributary Bypass Workshop, November 19, 2014, Walla Walla, Washington.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2003. Independent populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia river domain. NOAA Fisheries. July 2003. 172pp. https://www.nwfsc.noaa.go/research/divisions/cb/genetics/trt/col_docs/independentpopchinsteelsock.pdf

ICTRT (Interior Columbia Basin Technical Recovery Team). 2005. Updated population delineation in the Interior Columbia Basin. Memorandum from ICTRT to NMFS NW Regional Office. May 11, 2005. Seattle, Washington. https://www.nwfsc.noaa.gov/research/divisions/cb/genetics/trt/col_docs/updated_population_delineation.pdf

ICTRT (Interior Columbia Technical Recovery Team). 2007. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Review draft March 2007. Available at: https://www.nwfsc.noaa.gov/trt/col/trt_viability.cfm

McElhany, P., Ruckleshaus M., Ford M.J., Wainwright T. and E. Bjorkstedt. 2000. Viable Salmon Populations and the Recovery of Evolutionarily Significant Units. U.S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS-NWFSC-42. 156 pages. http://www.nwfsc.noaa.gov/assets/25/6190_06162004_143739_tm42.pdf

NMFS (National Marine Fisheries Service). 2008. Recovery Plan Module Mainstem Columbia River Hydropower Projects. September 24, 2008. 40 pages. Portland, Oregon. http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/hydro-module.pdf

NMFS (National Marine Fisheries Service). 2009a. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. NMFS Northwest Region, Portland, Oregon. 260 pages. http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/middle_columbia/middle_columbia_river_steelhead_recovery_plan.html

NMFS (National Marine Fisheries Service). 2009b. Recovery Plan for the Klickitat Population of the Middle Columbia River Steelhead Distinct Population Segment. September 2009. 191pages. http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/middle_columbia/mid-c-klickitat.pdf

NMFS (National Marine Fisheries Service). 2009c. Recovery Plan for the Rock Creek Population of the Middle Columbia River Steelhead Distinct Population Segment. October 2009. 137 pages. http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/middle_columbia/mid-c-rock-crk.pdf

NMFS (National Marine Fisheries Service). 2011a. Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. January 2011. 260 pages. Portland, Oregon. http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/estuary-mod.pdf

NMFS (National Marine Fisheries Service). 2011b. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Operation and Maintenance of the Mill Creek Flood Control Project. Washington. September 26, 2011.

NMFS (National Marine Fisheries Service). 2013. ESA Recovery Plan for the White Salmon River Watershed. June 2013. 186 pages. http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/willamette_lowercol/lower_columbia/final_plan_documents/white_salmon_recovery_plan__june_2013.pdf

NMFS (National Marine Fisheries Service). 2016. 2016 5-Year Review: Summary and Evaluation of Middle Columbia River Steelhead. NMFS West Coast Region, Portland, Oregon. 63 pages. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016_middle-columbia.pdf

NWFSC (Northwest Fisheries Science Center). 2015. Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest. December 21, 2015. 357 pages. https://www.nwfsc.noaa.gov/assets/11/8623_03072016_124156_Ford-NWSalmonBioStatusReviewUpdate-Dec%2021-2015%20v2.pdf

ODFW (Oregon Department of Fish and Wildlife). 2010. Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment. February 2010. 797 pages. https://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/middle_columbia/oregon_mid-c_recovery_plan_feb2010.pdf

ODFW (Oregon Department of Fish and Wildlife). 2017. A.W. Averett and J.R. Ruzycki, personal communication, July 27, 2017 and July 28, 2017.

Ruzycki, J.R. and J. Hanson. 2014. Migration and survival of adult Umatilla River steelhead. Presented at the Middle Columbia Wild Adult Steelhead Tributary Bypass Workshop, November 19, 2014, Walla Walla, Washington.

Ruzycki, J.R. and I.A. Tattam. 2014. Migration and survival of adult John Day River steelhead. Presented at the Middle Columbia Wild Adult Steelhead Tributary Bypass Workshop, November 19, 2014, Walla Walla, Washington.

Ruzycki, J.R, Faber D.M., Tattam I.A., Allen B. and J.D. Bumgarner. 2015. Adult tributary overshoot behavior and fate within the FCRPS. Preliminary research proposal submitted to the Middle Columbia River Steelhead Recovery Steering Committee.

SRSRB (Snake River Salmon Recovery Board). 2011. Snake River Salmon Recovery Plan for Southeast Washington. 2011 Version. Prepared by the Snake River Salmon Recovery Board for the Washington Governor's Salmon Recovery Office. 598 pages. http://www.snakeriverboard.org/wpi/wp-content//uploads/2013/01/Full-Version-SE-WA-recovery-plan-121211.pdf

YBFWRB (Yakima Basin Fish and Wildlife Recovery Board). 2009. 2009 Yakima Steelhead Recovery Plan. Extracted from the 2005 Yakima Subbasin Salmon Recovery Plan with Updates. September 2009. 309 pages. http://www.ybfwrb.org/recovery-planning/steelhead-recovery-plan/