Appendix C: Ecological Indicator Rating Criteria

Indicators	Functional (High)	Moderately Impaired (Medium)	Impaired (Low)
Natural vs. Human Disturbance	Environmental disturbances are natural and depending on the system could include floods, mass wasting, wildfire, icing, channel avulsion, wind storms, volcanic-related events, and forest stand disease. The magnitude and frequency of disturbance is within the range of natural variation. Disturbances are generally short-lived ("pulse") and are important for creating complex aquatic habitat with respect to channel adjustment, wood dynamics, and sediment processes. Time between natural disturbance events is long enough for ecological systems to adjust and for species to thrive.	Environmental disturbances have been moderately altered, possibly with new human-related disturbances introduced. The magnitude and frequency of disturbance has been altered and extends beyond the range of natural variation. Floods, wildfires, and mass wasting may now occur at a greater magnitude, frequency, or duration. These changes create more frequent adjustment of channels and associated habitat. Time between natural disturbance events is too short for ecological systems to fully adjust and for species to thrive. Basins dominated by commercial forestry and valley bottoms dominated by agricultural production frequently fall within this category.	Environmental disturbances have been severely altered, with new human-related disturbances introduced. The magnitude and frequency of disturbance is mostly outside the range of natural variation. Changes may reduce or increase disturbance frequency, in some cases resulting in longer-lived "press" disturbances where permanent features or management regimes have added unnatural stability to the system. In other cases, extreme events become the norm. In response to these changes, aquatic habitats are either stagnate and simplified or are in near-constant adjustment, with different processes responding in different ways. Urbanized and dam-controlled systems frequently fall within this category.
Hydrologic Alteration	Magnitude, timing, duration, and frequency of flows within a watershed are not altered relative to natural conditions of an undisturbed watershed of similar size, geology, and geography. Zero or minimal increases in the drainage network that is correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total < 8%. Road density <1 mile/miles^2 (Road density thresholds from USFWS 1998).	Some evidence of altered magnitude, timing, duration and/or frequency of flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography. Low to moderate increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total between 8 and 14.9%. Road density 1-2.4 miles/miles^2 (Road density thresholds from USFWS 1998).	Pronounced changes in magnitude, timing, duration and/or frequency of flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography. Substantial increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total > 15%. Road density >2.4 miles/miles^2 (Road density thresholds from USFWS 1998).
Sediment Processes	Channel sediment processes are in a dynamic equilibrium or are adjusting as expected to natural disturbance. Hillslope sediment contributions to the reach are similar to natural conditions. In known historical spawning areas, gravels or small cobbles make up >50% of the bed materials. ≤12%fines/sand (<2 mm) in spawning gravel (adapted from NMFS 1996).	Channel sediment processes are moderately impaired with respect to bed incision, aggradation, lateral erosion, and fine sediment contribution; and are affected by human features or other human-related disturbance. There are human-related hillslope sediment contributions to the reach that have some effect on channel dynamics, sediment sizes, and sediment distribution. In known historical spawning areas, Gravels or small cobbles make up 30-50% of the bed materials. 12-17% fines (<2 mm) in spawning gravel (adapted from NMFS 1996).	Channel sediment processes are severely impaired with respect to bed incision, aggradation, lateral erosion, and fine sediment contribution; and are highly affected by human features and other human-related disturbance There are human-related hillslope sediment contributions to the reach that severely alter channel dynamics, sediment sizes, and sediment distribution. In known historical spawning areas, gravels or small cobbles make up <30% of the bed materials. >17% fines (<2 mm) in spawning gravel (adapted from NMFS 1996).

Indicators	Functional (High)	Moderately Impaired (Medium)	Impaired (Low)
Large Wood Processes	Large wood processes are intact, including: 1) Sources – there are available large trees in riparian/floodplain areas 2) Recruitment processes – lateral channel dynamics allow for wood to be recruited, and 3) Retention – channel structure and complexity are sufficient to retain large wood Wood accumulates in the same frequency and types of configurations (e.g. jam types) expected under natural conditions. Large wood counts [use Fox and Bolton Western Washington #s (Fox and Bolton 2007)]	Large wood processes are moderately impaired: 1) Sources – clearing in riparian and floodplain areas has reduced the availability of large trees 2) Recruitment processes – lateral channel dynamics have been altered, reducing wood recruitment potential. 3) Retention – channel structure and complexity are not fully adequate to retain large wood in the channel for long periods. Wood accumulations are less and the types of configurations have changed from natural conditions. Large wood counts [use Fox and Bolton Western Washington #s (Fox and Bolton 2007)]	Large wood processes are severely impaired: 1) Sources – substantial clearing in riparian and floodplain areas has reduced or eliminated the availability of large trees 2) Recruitment processes – lateral channel dynamics have been severely altered, or eliminated altogether by bank armoring, thus reducing or eliminating wood recruitment potential. 3) Retention – channel structure and complexity no longer allow for the retention of large wood in the channel. Wood accumulations are non-existent or are severely altered from natural conditions. Large wood counts [use Fox and Bolton Western Washington #s (Fox and Bolton 2007)]
Channel Type and Form	Geomorphic channel type and form are similar to natural conditions that would be expected for the biophysical setting. This includes channel planform, profile, and cross-section as well as the form and function of individual habitat units such as pools and riffles. For low gradient (0.1% to 1% slope) alluvial systems with salmonid use, meets NMFS pool frequency and quality thresholds for "Properly Functioning" (NMFS Matrix of Pathways and Indicators 1996)	Geomorphic channel type and form have been moderately affected in response to anthropogenic influence. For low gradient (0.1% to 1% slope) alluvial systems with salmonid use, meets NMFS pool frequency and quality thresholds for "At Risk" (NMFS Matrix of Pathways and Indicators 1996)	A whole new geomorphic channel type and form have developed in response to anthropogenic influence. This could include conversion of a highly sinuous system to straight, or multi-threaded to single threaded, or significant widening or narrowing of the channel. For low gradient (0.1% to 1% slope) alluvial systems with salmonid use, meets NMFS pool frequency and quality thresholds for "Not Properly Functioning" (NMFS Matrix of Pathways and Indicators 1996)
Floodplain Connectivity	The magnitude, frequency, and duration of floodplain inundation is similar to undisturbed conditions. Overbank flows regularly occur (often in the 1-2 year recurrence range) and maintain floodplain wetland, nutrient exchange, and vegetation processes. The floodplain areas themselves are similar to natural conditions with respect to vegetation and topographic complexity.	There is a reduced linkage of floodplains with the main channel due to human features (e.g. levees) or human-induced process changes (e.g. incision from confinement). Overbank flows occur less frequently (often in the 2-5 year recurrence range) causing moderate impairment with respect to floodplain processes. The floodplain areas themselves are moderately impaired with respect to vegetation and topographic complexity.	Severe reduction in hydrologic connectivity with floodplains due to human features and process changes. Overbank flows occur much less frequently (often greater than 5 year recurrence) causing severe impairment with respect to floodplain processes. The floodplain areas themselves are severely impaired with respect to vegetation and topographic complexity. Vegetation clearing, floodplain filling, and land-use conversion are extensive.
Lateral and Vertical Channel Dynamics	Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach.	Channel migration is occurring at a faster or slower rate relative to natural rates, but significant change in channel width or planform is not detectable; large woody debris is still being recruited. Measurable trend of aggradation or incision that has the potential to, but has not yet caused, disconnection of the floodplain or a visible change in channel planform (e.g. single thread to braided.)	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain and large woody debris recruitment; or channel migration is occurring at an accelerated rate such that channel width has at least doubled, possibly resulting in a channel planform change, and sediment supply has noticeably increased from bank erosion. Enough incision or human infrastructure has occurred that the floodplain and off-channel habitat areas have been disconnected from the main channel; or enough aggradation has occurred to create a visible change in channel planform (e.g. single thread to braided.)

Indicators	Functional (High)	Moderately Impaired (Medium)	Impaired (Low)
Off-Channel Habitat Connectivity and Refugia	Reach is within the expected natural variation with respect to the abundance of connected peripheral and transitional habitats. These may include side channels, flood overflow channels, floodplain wetlands, abandoned oxbows, wall-based channels, or groundwater-fed channels. Within the active channel there are adequate refugia habitats, such as backwaters, alcoves, or large boulder eddies. There are no human-made barriers that prevent access to off-channel or tributary areas.	Reach is moderately impaired with respect to the availability and connectivity of peripheral and transitional habitats. There may be human-made barriers that limit or prevent access to off-channel or tributary areas.	Reach is severely impaired with respect to the availability and connectivity of peripheral and transitional habitats. There are human-made barriers that limit or prevent access to off-channel or tributary areas.
Riparian Processes	Riparian processes are within the range of natural variation and support natural processes including bank erosion resistance, wood recruitment, canopy cover, and nutrient exchange. Threshold values below adapted from USBR Reach-Based Ecosystem Indicators (e.g. USBR 2009). Riparian Disturbance: <20% anthropogenic disturbance in the 200-foot riparian buffer zone (e.g. agriculture and grazing, residential, roads, etc.) and <1 mile/miles^2 road density in the 200-foot riparian buffer zone. Riparian Structure: >80% large trees (>21" DBH) in the riparian buffer zone (defined as a 200ft buffer along each bank) based on habitat assessment data. Canopy Cover: Trees and shrubs within one site potential tree height distance (~100 feet) have >80% canopy cover that provides thermal shading to the river.	Riparian processes are moderately impaired and extend beyond the range of natural variation. Riparian Disturbance: 20-50% anthropogenic disturbance in the 200-foot riparian buffer zone (e.g. agriculture and grazing, residential, roads, etc.) and 1-2.4 miles/miles^2 road density in the 200-foot riparian buffer zone. Riparian Structure: 50-80% large trees (>21" DBH) in the riparian buffer zone (defined as a 200ft buffer along each bank) based on habitat assessment data. Canopy Cover: Trees and shrubs within one site potential tree height distance have 50-80% canopy cover that provides thermal shading to the river.	Riparian processes are severely impaired and extend well beyond the range of natural variation. Riparian Disturbance: >50% anthropogenic disturbance in the 200-foot riparian buffer zone (e.g. agriculture and grazing, residential, roads, etc.) and >2.4 miles/miles^2 road density in the 200-foot riparian buffer zone. Riparian Structure: <50% large trees (>21" DBH) in the riparian buffer zone (defined as a 200ft buffer along each bank) based on habitat assessment data. Canopy Cover: Trees and shrubs within one site potential tree height distance have <50% canopy cover that provides thermal shading to the river.

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