

A Spatially Explicit and Quantitative Vulnerability Assessment of Coldwater Fish Habitat and Riparian Corridors in the Intermountain West

Appendix 2 of the Final Report: Feedback on and Changes to Assessment Indicators

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We presented the methods and results of our initial assessments of coldwater fish habitat and riparian corridors at SRLCC Adaptation Forums (https://southernrockieslcc.org/geographical_area/four-corners-region) in August and September of 2017. We used feedback from attendees to refine our indicators of exposure, sensitivity, and adaptive capacity. In the tables below, we list comments on indicators recorded during breakout group sessions focused on coldwater fish habitat and riparian corridors. We also describe our actions taken during the assessment revision to address the comments. In the final table, we list indicators that were recommended, but left out of the revised assessment, along with explanations for their omission.

Table A2.1. Adaptation forum comments and actions on coldwater fish exposure indicators.

Indicator	FC comments	URG comments	Action
Projected change in mean annual flow 2040	This indicator is important and urgent.	This indicator is important and urgent.	Combined with other projections into single indicator
Projected change in mean summer flow 2040	This indicator is important and urgent.	This indicator is important and urgent.	Combined with other projections into single indicator
Projected change in stream temperature 2040	This indicator is important and urgent. Change in summer flow was the most important variable among those listed. A better descriptor variable might be change in low flow, as summer flow may not be the lowest flow of the year.	This indicator is important and urgent.	Combined with other projections into single indicator
Pollution sources in catchment	This indicator is not important or urgent. Pollution (such as leaking mines) could be important in specific cases, but only in the stream affected, not for the watershed as a whole.	Pollution is locally important, but not at the landscape scale. Pollution is not a significant factor overall, but it needs to be evaluated on a local level. Certain specific streams may be seriously affected by pollution (such as old mines).	Removed from indicator set because this exposure is not as important at this scale
Road density in catchment	This indicator is important and urgent. Road density by	This indicator is not important or urgent. Type of roads, road	Removed from indicator set because this indicator is more useful

	itself isn't as critical as what types of roads; how far they are from the river, etc. Perhaps a more refined road indicator would work better. Road density is also likely underestimated in current datasets	crossings, and culverts are more important than road density. Roads overall are not an important indicator, but are also much more important at a local level on site-specific locations.	if road type is known and applied at a smaller scale
Road crossing density	This indicator is important and urgent	This indicators is important or urgent.	Updated with newer data
Nitrate deposition	This indicator is not important or urgent. Nitrate/Ammonium deposition would largely affect lower elevation warmer stream segments, not coldwater fisheries. However, some measure of water quality could be important.	This indicator is not important or urgent. It is of low importance overall, but may be important in some instances. In particular, grazing in high elevation sites may significantly increase the importance of this factor.	Removed from indicator set because this of low importance at this scale
Kfactor erosion index	This indicator is important and urgent.	This indicator is not important or urgent. It is of low importance overall, but may be important in some instances. Grazing in may significantly increase the importance of this factor.	Removed from indicator set because this of low importance at this scale

Table A2.2. Comments and actions on coldwater fish sensitivity indicators.

Indicator	FC comments	URG comments	Action
Native trout presence	This indicator is not important or urgent.	This indicator is important and urgent. Native trout presence is a critical factor for protection of current populations	Removed from indicator set because newer data are only available at the reach scale
Non-trout sensitive species presence	This indicator is not important or urgent.	This indicator is important but not urgent. Native fish of other species are not as useful an indicator as native trout.	Removed from indicator set because this exposure is not seen as important to coldwater fish habitat
Threatened and endangered fish distribution	This indicator is not important or urgent.	Not discussed	Retained this variable because it is an indicator of compromised habitat conditions for coldwater fish
Riparian vegetation departure	This indicator is important and urgent	This indicator is important but not urgent.	Retained this variable, recalculated for HUC12 scale
Mean catchment elevation	This indicator is important and urgent	This indicator is important but not urgent.	Recalculated as % of watershed >2286 m (following Dolores River assessment methods)
Dam density in watershed	This indicator is important but not Urgent. Active water diversions rather than number of dams would be a better descriptor as this would	This indicator is not important or urgent. Number of dams was not considered important because many of their effects are downstream.	Replaced with diversions and moved to exposures

	include additional barriers to fish movement.	There are many more road crossings and culverts than dams, so these are more important to consider when assessing sensitivity. Their greater numbers increase the chances for affecting runoff into streams (affecting water quality) and reducing or restricting movement of fish.	
Wildfire hazard potential	This indicator is important and urgent	This indicator is important and urgent and should be an exposure. Fires can have very important effects on streams and watersheds. Effects vary greatly depending on the frequency and severity of fires and other factors (drought, snowpack, slope, vegetation, etc.).	Recalculated for HUC12 watersheds and moved to exposures

Table A2.3. Comments and actions on coldwater fish adaptive capacity indicators.

Indicator	FC comments	URG comments	Action
Current cold water temperatures projections	This indicator is important and urgent	This indicator is important and urgent	Retained as indicator, recalculated for HUC12s
Riparian vegetation departure: index values range from 0 (complete loss) to one (no change), to greater than one (increase in riparian vegetation)	This indicator is important and urgent.	This indicator is not important or urgent.	Removed as indicator because there is a similar component in the beaver capacity indicator
Riparian shading cover	This indicator is important and urgent.	This indicator is not important or urgent.	Removed as indicator because there is a similar component in the beaver capacity indicator
Reservoir storage in watershed	This indicator important but not urgent.	This indicator is not important or urgent. Water storage may be helpful for maintaining stream flows, but overall is	Removed as indicator

		not significant due to limited number of dams.	
Slope	Not discussed	This indicator is important but not urgent. Slope is very important as it can provide barriers to fish movement. It is important to consider when management decisions are made as to where to place fish, etc.	Removed as indicator because there is a similar component in the beaver capacity indicator
Beaver capacity	This is a very useful indicator but not urgent.	This indicator is important and urgent. Beaver capacity is very important as beavers can affect other factors (such as slope and vegetation cover). There are some policy/political issues to consider when reintroducing beavers. Some landowners or water districts may oppose them over fears over flooding, restricting water deliveries, etc.	Retained as an indicator, recalculated with newer data, developed land cover added to represent potential management conflicts
Herbaceous wetland cover	Not discussed	This indicator is important and urgent	Recalculated with newer data and combined with springs as a new indicator

Protected public land in catchment	Not discussed	This indicator is important and urgent. Both amount of public land and amount of protected land are important. Amount of public land is more important as there are any more options for management on public lands. Protected lands are important as refugia for native fish.	Removed from indicator list to reduce correlation with highly protected land.
Highly protected land in catchment	Not discussed	This indicator is important and urgent. Both amount of public land and amount of protected land are important. Amount of public land is more important as there are any more options for management on public lands. Protected lands are important as refugia for native fish.	Recalculated for HUC12 watersheds.
Density of springs in catchment	Not discussed	This indicator is important but not urgent. Springs are important as refugia for native fish.	Combined with herbaceous wetland cover for a new indicator

Table A2.4. Adaptation forum comments and actions on riparian corridors exposure indicators.

Indicator	FC comments	URG comments	Action
Projected change in mean annual flow volume for 2040	This indicator is somewhat urgent and important	This indicator is useful, but not as important as low flow and peak flow indicators. Similar mean flows can represent different events. For main stem Rio Grande, a very high spring runoff flow and very low summer flow can have the same annual mean flow as an average runoff and average summer low flow, yet the scenario with very high spring runoff has the potential to be much more beneficial to the riparian corridor.	Combined with other projections into single indicator
Projected change in mean summer flow volume for 2040	This indicator is very urgent and important. Mean summer flow may be more urgent than projected change in mean annual flow.	Low flow is a very important indicator; Replace with the Q 7,10 metric (estimate of the lowest average flow that would be experienced during a consecutive 7-day period with an average recurrence interval of ten years) as it is a better indicator than mean summer flow	Combined with other projections into single indicator
Change in center of flow mass timing	This indicator is urgent and important	The magnitude, duration, and timing of peak flow events is	Combined with other projections into single indicator

		a very important indicator; Center of flow mass timing may not capture all of the magnitude, duration, and timing components?	
Riparian vegetation departure: values range from 0 (complete loss) to one (no change), to greater than one (increase in riparian vegetation)	This is the most urgent and important of the exposure indicators.	Consider comparison based on historical conditions. It is difficult to define baseline historical conditions. Width and length of riparian vegetation is important in high elevation, headwater stream segments; While not the best metric, riparian vegetation departure should still be included; This is not as important for lower elevation, main stem Rio Grande; The 79% decrease for affected segments is questionably high. Reassess with different threshold	Retained as an indicator, recalculated for HUC12 watersheds.
Agriculture cover in riparian buffers	This indicators is somewhat urgent and important	While important, this is not a good indicator of exposure. For lower elevation main stem Rio Grande, agriculture can provide a buffer from urban effects and can be important for adaptive capacity.	Removed from indicator set, replaced as a component of natural cover in adaptive capacity

Urban development in riparian buffers	This indicators is somewhat urgent and important	This indicator is important and urgent where urbanization occurs; What about exposure to water infrastructure such as acequias, canals, low head diversion dams?	Removed from indicator set, replaced as a component of natural cover in adaptive capacity
Dams in watershed	This indicator is very important and somewhat urgent. Groundwater pumping might be more urgent as knowing about it might help prevent future damage.	Effects of dams are evident not only in stream segments but also far downstream. This indicator is important, but static so not especially urgent.	Recalculated with newer data
Nonagriculture, nonnative, introduced, or managed vegetation	This indicator is important, and somewhat urgent.	This indicator is urgent and important to both high and lower elevation segments.	Removed from indicator set, replaced as a component of natural cover in adaptive capacity

Table A2.5. Comments and actions on riparian corridors sensitivity indicators.

Indicator	FC comments	URG comments	Action
Wildfire hazard potential	This indicator is important and somewhat urgent.	In the Upper Rio Grande watershed, higher elevation segments should be shown in map as much more sensitive; true fire potential/risk is not captured; assessment should be much more generous as 10% is too low.	Retained and recalculated for HUC12s with new cut off value
Threatened and endangered riparian species present	This indicator is important and urgent	This is not the most useful indicator as presented. T&E is already addressed significantly in other forums and may be redundant. Should also include fish and other “species of concern”. Could also include indicator for critical habitat. Presence threshold might be more meaningful if >3 instead of 0-3, for example. Biodiversity would be a better metric.	Retained and recalculated for HUC12s, threatened and endangered fish included as an additional indicator
Deciduous or wetland riparian vegetation cover	This indicator is somewhat urgent and important. If vegetation isn’t present you	Important but not as urgent as wildfire and T&E species.	Removed from indicator set, replaced as a component of

won't have T&E species,
which makes this more
important.

natural cover in adaptive
capacity

Table A2.6. Comments and actions on riparian corridors adaptive capacity indicators.

Indicator	FC comments	URG comments	Action
Mean catchment elevation	This indicator is very urgent and important. It is actually an indicator of intactness.	Higher elevation riparian areas are more intact, which turns out to be a part of this indicator.	Replaced with an indicator representing intactness of watershed (natural vegetation cover)
Reservoir storage in watershed	This indicator is not important or urgent.	This indicator is important in lower elevation main stem Rio Grande from an infrastructure perspective. It is important in high elevation watersheds from a landscape storage perspective, e.g., wetlands, beavers, etc. Without upstream storage options, stream flow variability is very limited during drought.	Removed from indicator set
Public land ownership	This indicator is somewhat urgent and important	At the Rio Grande this indicator is less useful as there are fewer larger tracts of private ranches. Public land does provide increased adaptive capacity; Land ownership is somewhat important but not as urgent	Removed from indicator list to reduce correlation with highly protected land.
Protected land designation	This indicator is somewhat urgent and important	This is not the best indicator. It is somewhat important but not too urgent.	Recalculated for HUC12 watersheds.

Table A2.7. Coldwater fish indicators and datasets during workshops, but not included in refined assessment.

Element	Indicator	Data source(s)	Reason for omission
Exposure	Nonnative fish	Inland Cutthroat Trout Database	Data are not summarized for the full extent of both focal areas, should be used at smaller watershed scales
	Effects of grazing and other land use on water quality and volume	Watershed Condition Framework	Data are only available for National Forest lands.
Sensitivity	Low flow characteristics	USGS Streamstats	Data are not summarized for our assessment spatial units, should be used at smaller watershed scales

Table A2.8. Riparian corridors indicators and data recommended during workshops, but not included in refined assessment.

Element	Indicator	Data source(s)	Reason for omission
Exposure	Erosion/extreme events	USGS	Data not available at our scale
	Precipitation/flooding/drought	PRISM, USGS	Data not available at our scale
Sensitivity	Land use impacts	Watershed Condition Framework	Data are only available for National Forest lands.
	Groundwater/surface flows	Unknown	Data not available at our scale or extent
	Regenerative/reproductive capacity	Unknown	Data not available at our scale or extent
	Impervious surfaces	NLCD, LANDFIRE	Incorporated as a component of natural cover in adaptive capacity
Adaptive capacity	Regenerative/reproductive capacity	Unknown	Data not available at our scale or extent
	Public perception riparian values	Unknown	Data not available at our scale or extent
	Groundwater/surface flow	USGS, state agencies	Incorporated as an exposure