Climate Change Impact & Vulnerability "Cheat Sheet"
Watershed Function/Cold Water Systems in the GNLCC Rocky Mountain region

Focal Resources	Current Condition	Direct and Indirect Climate Impacts	Uncertainties	Non-Climate Concerns
Stream flow (quantity, quality, temperature, timing)	• • •	• Decreased spring snowpack, decreased winter precipitation and increased evapotranspiration lead to lower summer base flows. • Higher frequency of winter floods and channel scour from rain on snow events in some watersheds (e.g. those currently near the transition between rain and snow-dominated stream systems). • Lower summer base flows and warmer air temperatures lead to increased water temperatures, especially in late summer. • Increased frequency and severity of drought may increase human withdrawals for irrigation, leading to lower stream flows. • Increased wildfire frequency and severity can increase erosion and sediment load in streams and decrease water quality. •	• Effect of decreased snowpack on stream flows could be somewhat moderated by increased spring precipitation (as projected by some climate models). • • •	• • •
Upland watershed hydrology	• • •	• Warmer temperatures and drier conditions could lead to increased wildfire frequency and severity, which can alter forest structure and upland hydrology (e.g., snow pack dynamics, evapotranspiration, groundwater recharge). • As conditions get drier, conifer forests may transition to shrub/scrub vegetation – the loss of trees could accelerate the loss of snowpack in the spring and summer, leading to earlier and accelerated snowmelt. •	• • •	• • •

Focal Resources	Current Condition	Direct and Indirect Climate Impacts	Uncertainties	Non-Climate Concerns
Riparian condition and function	• •	• Decreased stream flows decreases amount of water available to riparian vegetation, which may decrease riparian condition. •	• •	• • •
Native cold water fish	• • •	• Lower summer base flow and warmer air temperatures lead to increased water temperatures, which have a negative effect on cold-water fish reproduction and survival. • Some non-native fish may have a competitive advantage over native fish due a greater tolerance of (or preference for) warmer water temperatures. • Lower base flows and human barriers (culverts, irrigation infrastructure, etc.) may inhibit ability of fish to move into cold water refuges during warm periods. • Larger reaches of inhospitable habitat may favor less mobile, resident life histories at the expense of more mobile ones. • Late winter or early spring floods caused by rain-on-snow events and earlier and accelerated snowmelt can scour river/stream bottoms, stripping fish eggs. •	• Thermal tolerances of different species (and different stocks/lineages) may vary, because of different evolutionary histories. • What is a minimum habitat size that's needed to support a persistent population? Does this size change in the future if disturbance regimes change? • Which habitats are currently occupied by native fishes of concern, and how close are they to thermal tolerances? • How much warmer will stream temperatures be in 2050 and 2100? • Certain problematic non-native species may decline as much or more than some native species in response to climate change. •	• • •
Other cold water aquatic species	• •	• A suite of cold water species—amphibians, crayfish, and mollusks—are likely to exhibit shifts in distribution and abundance in response to warming waters and longer base-flow periods, thus entire communities are likely to change. • Because many mollusks are dependent on fish as intermediate hosts for their larva, changes in fish distributions in response to climate will cascade into changes that affect mollusks. •	• In some cases, the ecology of these species is poorly known (e.g., the fish-species-specificity of larval mollusks), so surprises will be common. • •	• • •