Centennial Valley Arctic Grayling Adaptive Management Project 2018 Spring Update

- The Centennial Valley Arctic Grayling Adaptive Management Plan (AMP) is being implemented to identify limiting factor(s) for Arctic grayling in the upper Centennial Valley (CV) of southwestern Montana. Non-native hybrid Yellowstone cutthroat trout, spawning habitat, and overwinter habitat have been identified as the three most likely factors that could limit long-term viability of grayling in the upper CV. Long-term viability is expected to be maintained by 1) conserving genetic diversity, 2) establishing spawning and/or refugia in at least two tributaries, and 3) maintaining a spawning population of $\geq$ 1,000 fish. The latter is based on the Species Status Assessment Workshop for Arctic grayling conducted in 2014.
- The AMP focus is on identifying factors that cause the spawning population to decline below 1,000 fish and, if that occurs, management actions that will most effectively return the population to objective. An emphasis on learning through 'management as experiment' during the first phase of the AMP is being accomplished via two experiments that 1) reduced non-native hybrid Yellowstone cutthroat trout population (2013–2016) and 2) will maximize availability of spawning habitat (2017–2020). Experiments are being developed for altering winter habitat. To date, natural variability has provided opportunity to explore the hypothesized relationship between grayling spawning population and area of suitable winter habitat in Upper Red Rock Lake (Upper Lake).
- The estimated number of Arctic grayling in the 2018 Red Rock Creek spawning population was **387 (95% CI = 168–682**), which is not significantly different from the previous year ($\hat{N}$ = 176, 95% CI = 159–213; Figure 1). Peak predicted grayling spawning was 14 May.
- The estimated number of Yellowstone cutthroat trout in the Red Rock Creek spawning population was **916**, an approximate reduction of **72%** from the highest estimated population in 2014 ($\hat{N}$ = 3282) and an increase of **237%** from 2017 ($\hat{N}$ = 387; Figure 1). No angler harvest of Yellowstone cutthroat trout occurred.

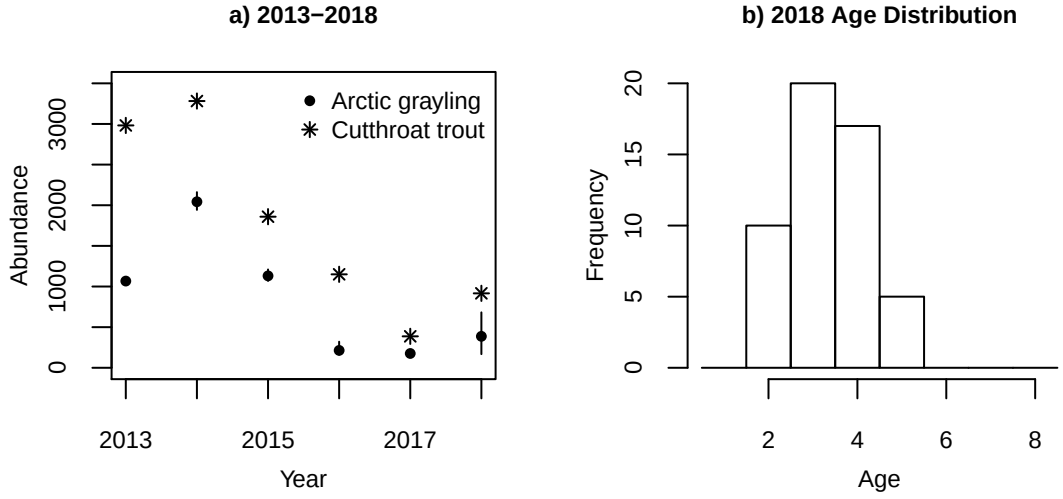

Figure 1. a) Arctic grayling and non-native hybrid Yellowstone cutthroat trout abundance estimates and 95% confidence intervals (grayling only) from Red Rock Creek, 2013–2018, and b) age distribution of the 2018 grayling spawning population.

- Thirty-two grayling (≈ 8% of the spawning population) were estimated as caught and released by anglers. Based on the estimated number of grayling caught and water temperature, 0–3 grayling mortalities would be expected, representing 0–0.8% of the spawning population (Boyd 2008).
- Approximately 358 anglers handled an estimated 1267 Yellowstone cutthroat trout, which is more than the total estimated Yellowstone cutthroat trout population. This could be explained by anglers catching some fish multiple times, underestimation of the Yellowstone cutthroat trout population by the electrofishing survey, or overestimation of angler catch by the creel surveys. It is likely that all three occurred to some degree; however, it is reasonable to assume that the majority of the Yellowstone cutthroat trout population was handled by anglers.
- We will continue to learn how grayling respond to Yellowstone cutthroat trout population reductions, the first management experiment undertaken as part of the AMP, as 1) grayling cohorts spawned during low trout abundances recruit, and 2) Yellowstone cutthroat trout spawning population recovers.
- Suitable winter habitat within Upper Lake (i.e., water depth below the ice $\geq$ 1 m and dissolved oxygen $\geq$ 4 ppm) reached a minimum during February sampling at an estimated 19 ha. Grayling spawning population was reduced to $\leq$ 214 fish in all years when <10 ha of suitable winter habitat was available in Upper Lake (Figure 2).
- Suitable spawning habitat was most recently quantified in 2017, with an estimated total area of suitable spawning habitat (A_{ts}) of 0.1 ha, and weighted area of suitable habitat (A_{tw}) of 4 ha, in Red Rock and Elk Springs creeks. Surveys to estimate area of suitable spawning habitat will be completed again in 2019.

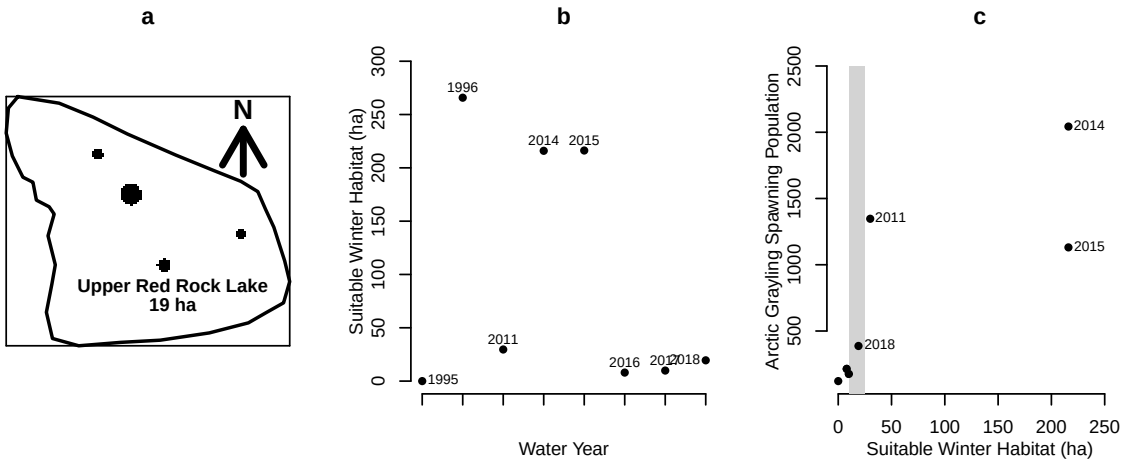

Figure 2. a) Extent of minimum area of suitable Arctic grayling winter habitat in Upper Red Rock Lake, 2018, b) annual estimate of minimum area of suitable habitat for water years 1995–2018, and c) grayling spawning population as a function of minimum area of suitable winter habitat for years when both were estimated (1995 [0 ha], 2016 [8 ha], and 2017 [9 ha] points are plotted but not labelled). The shaded polygon represents an hypothesized threshold (10–25 ha) of suitable winter habitat where 1) enough winter habitat is available to sustain grayling population at objective ($N \geq$ 1,000 fish, > 25 ha suitable habitat), and 2) winter habitat presumably reduces grayling survival, resulting in grayling population below objective ($\hat{N} \leq$ 214, <10 ha suitable habitat).

- The *Winter Habitat*, *Spawning Habitat*, and *Non-native Fish* models predicted 67, 217, and 840 grayling, respectively, in the 2018 Red Rock Creek spawning population. The *Winter Model* continues to be the most supported model, although the *Spawning Habitat Model* was also relatively well supported (Table 1). The *Non-native Fish Model* continued to poorly predict grayling population. Thus, data collected to date provide support for overwinter habitat in Upper Lake and spawning habitat being drivers of grayling abundance in the upper CV.

Table 1. Arctic grayling spawning abundance model predictions, observed abundance, and relative model weights for 2018. Model weights, which sum to 1, are a measure of relative support for a model given the data.

Model	2018 Prediction	Observed	Model Weights
Winter Habitat	67	387	0.552
Spawning Habitat	217	387	0.350
Non-native Fish	840	387	0.098

- Management actions to assess the effect of spawning habitat on grayling abundance continued in 2018. Spawning habitat was maximized by 1) restoring connectivity to, and habitat within, Elk Springs Creek, and 2) providing access to all spawning habitat in Red Rock Creek by breaching beaver dams ($n = 14$). However, the influence of Yellowstone cutthroat trout abundance and spawning habitat on grayling recovery from the recent decline is currently confounded because the system has both low abundance of Yellowstone cutthroat trout and high per-capita suitable spawning habitat. Therefore, strong grayling cohorts produced by the 2017 or 2018 spawning populations, as predicted by both the *Spawning Habitat* and *Non-native Fish* models, could be related to either, or both, low Yellowstone cutthroat trout abundance or high per-capita spawning habitat. Disentangling the relative influence of these two factors requires maintaining one relatively constant while allowing the other to vary. This is currently being achieved by the second management experiment of the AMP, which maximizes the per-capita area of spawning habitat available to grayling until Yellowstone cutthroat trout return to relatively high abundances (i.e., as soon as 2020).
- No management actions to improve winter habitat are presently identified or planned. However, an alternative analysis to assess costs, logistical and legal feasibilities, and likely effects on grayling of all winter habitat enhancement approaches will occur. Assessing the potential for future management actions to mitigate winter habitat is currently hampered by low grayling abundance. Based on three years where winter habitat and grayling spawning population were estimated, a threshold level of 10–25 ha of winter habitat appears necessary to overwinter grayling populations greater than the 1,000 fish objective (Figure 2).

LITERATURE CITED

Boyd, J. 2008. Effects of water temperature and angling on mortality of salmonids in Montana streams. Thesis. Montana State University, Bozeman, Montana. 56 pgs.

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