

Changing seasonality of Arctic hydrology disrupts key biotic linkages in Arctic aquatic ecosystems.



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Overview

Arctic grayling (*Thymallus arcticus*) are an important circumpolar species that provide a model system for understanding the impacts of changing seasonality on arctic ecosystem function. Grayling serve as food for other biota, including lake trout, birds and humans, and as top-down controls in stream ecosystems. Grayling spend their summers in streams but are obligated to move back into deep overwintering lakes in the fall, suggesting that processes that influence their population dynamics will have effects that reverberate throughout the Arctic watersheds.

Our objective is to assess how the shifting seasonality of Arctic river hydrology as a result of changing climate may disrupt key biotic linkages within and between lake and stream components of watersheds on the North Slope of the Brooks Mountain Range, Alaska.

Improved understanding of these processes will advance our general understanding of the role of animals in ecosystem dynamics, life-history evolution and ecosystem management.

Study site - Upper Kuparuk River

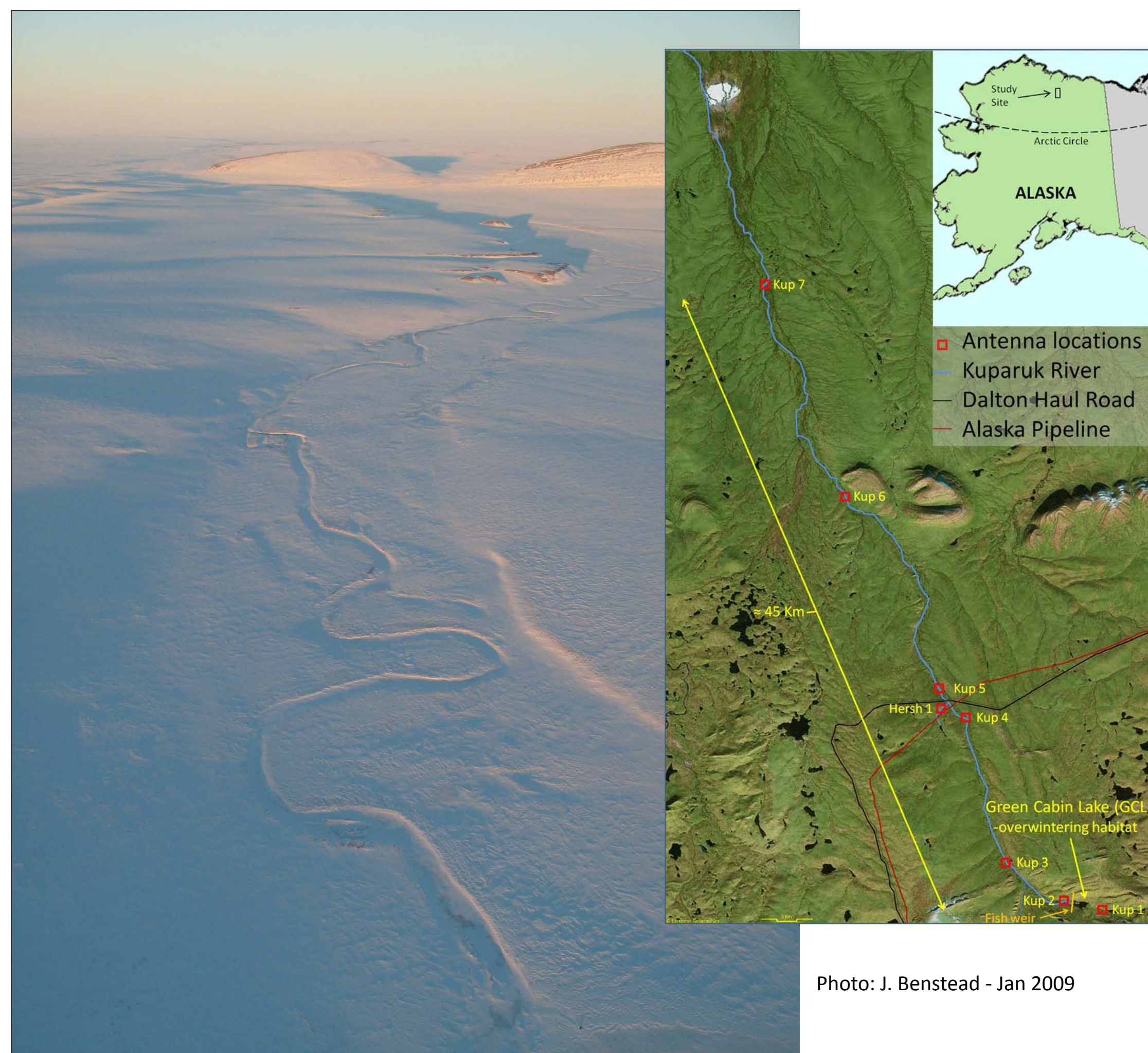
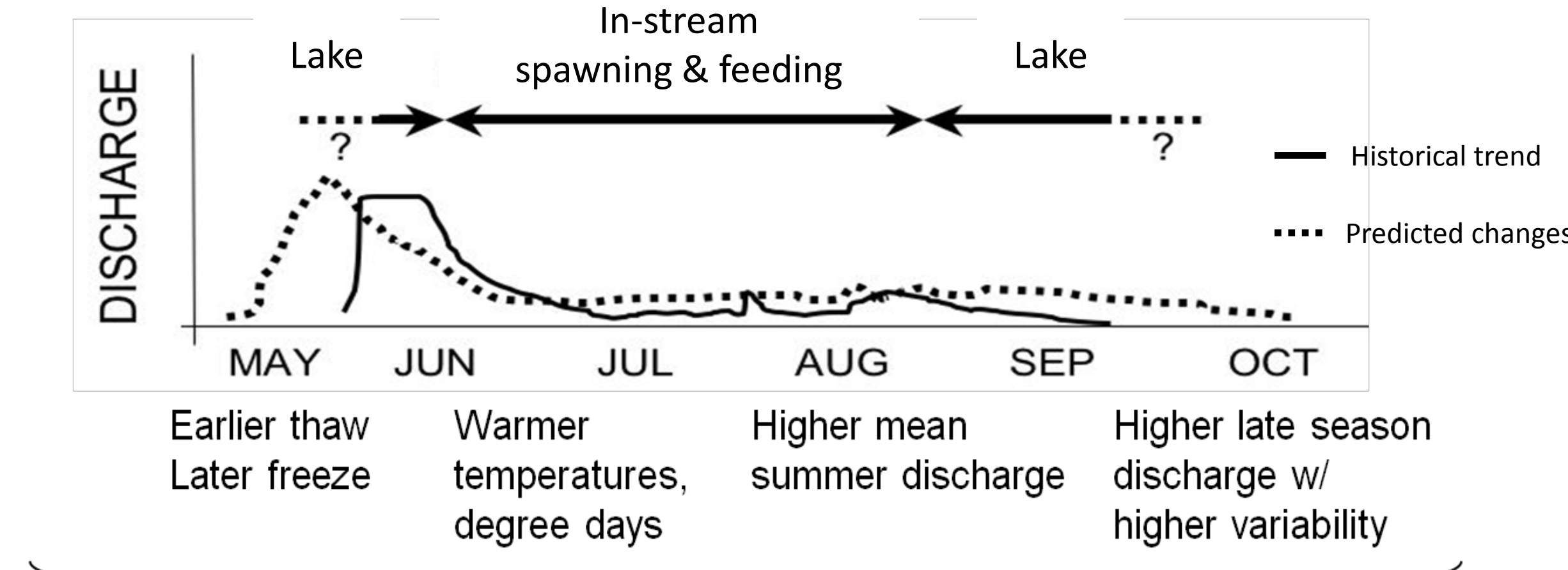


Photo: J. Benstead - Jan 2009

Hypotheses

1. Migration

Grayling migration into overwintering habitat may be changing due to changing seasonality of environmental conditions:

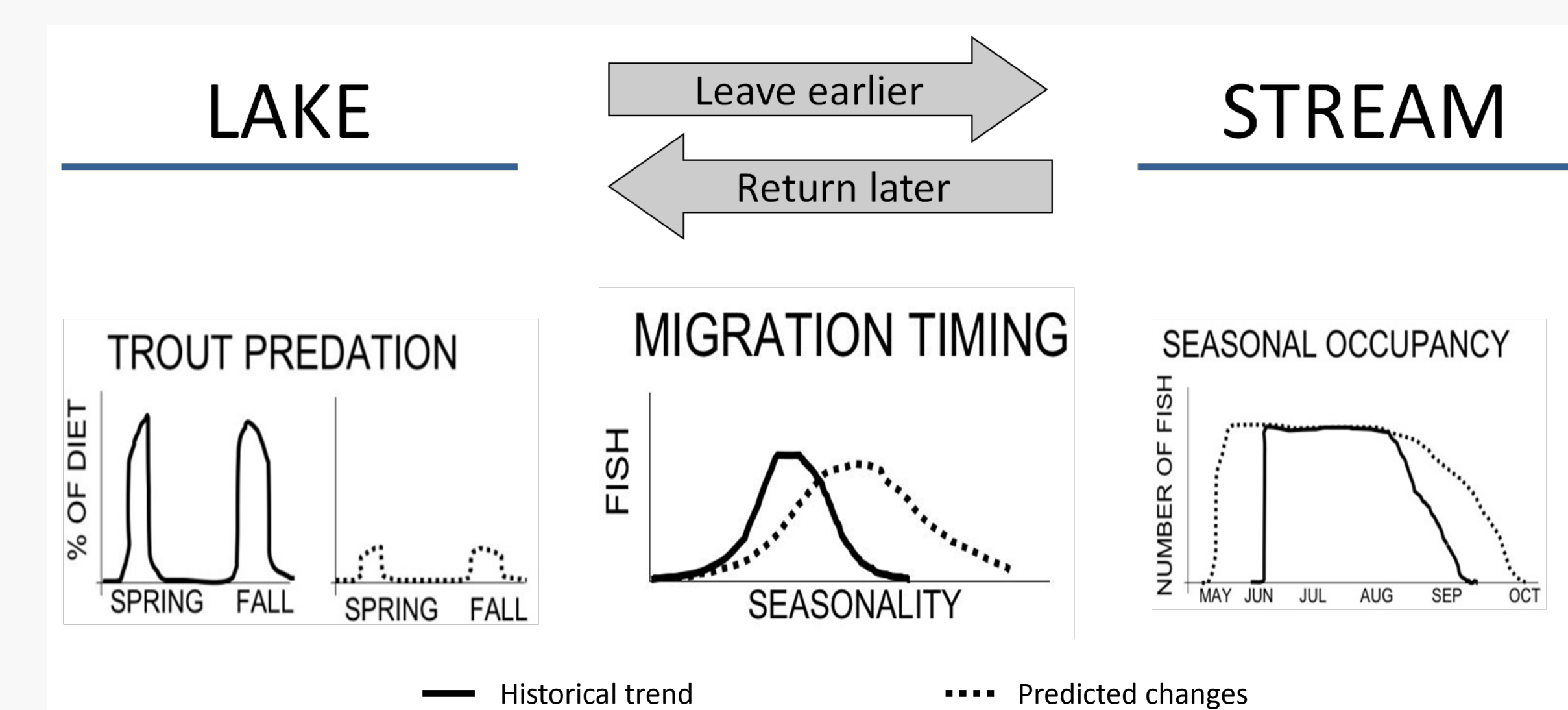


Predicted changes in river hydrology and grayling migration.

In 2010, over 1000 Arctic grayling were PIT tagged and tracked at 8 stream-width antenna stations throughout the study site to determine migration dynamics and timing of movement into overwintering lakes.

2. Grayling trophic link

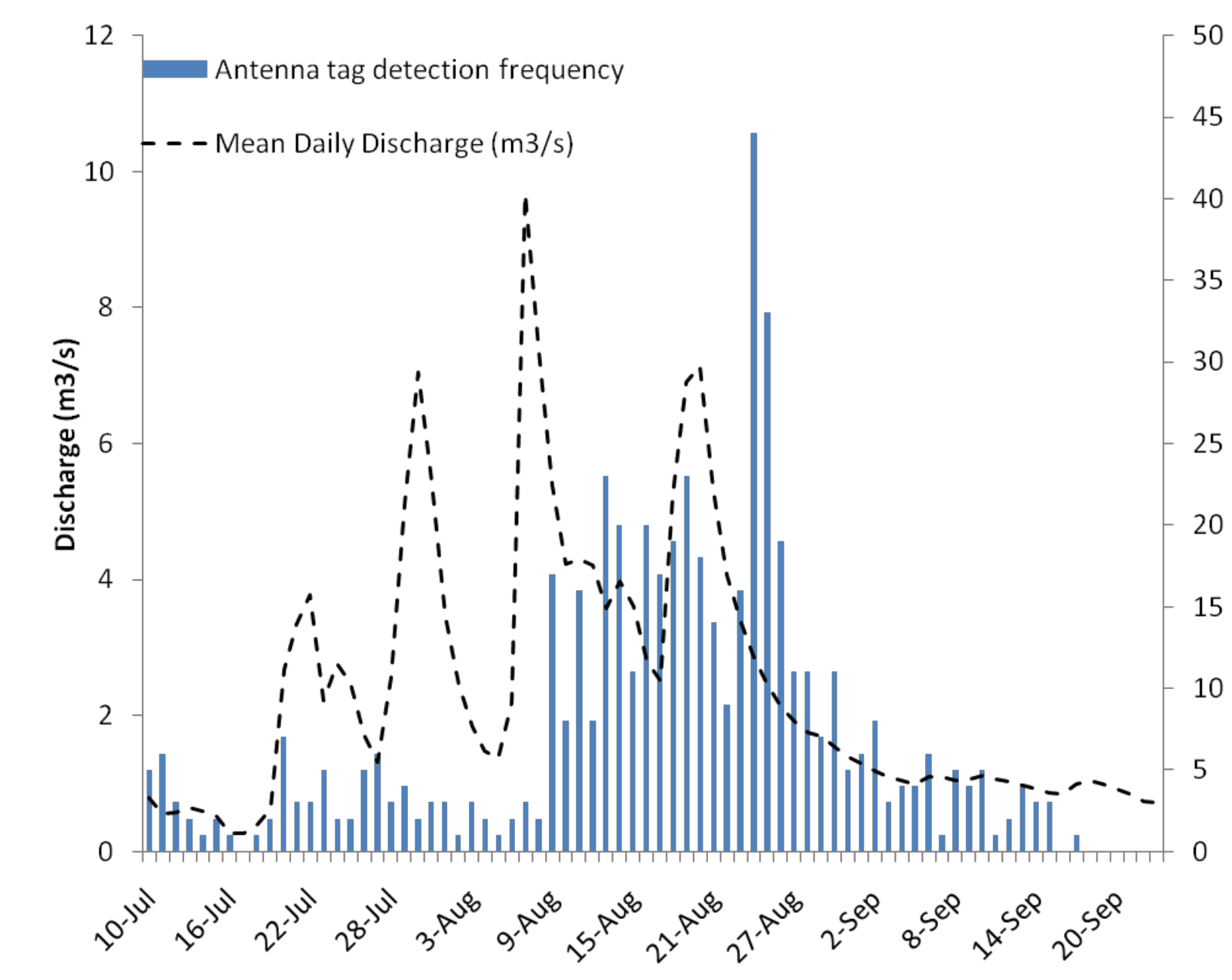
Decreased abundance and shorter residency of grayling in overwintering habitat reduces lake trout predation on migrating grayling, decreasing lake trout condition and population size.



Resident lake trout are too large to subsist on plankton and thus are expected to be supported by the benthic prey such as sculpin in lakes without a pelagic forage fish. Seasonally present, migrating grayling may provide a trophic supplement.

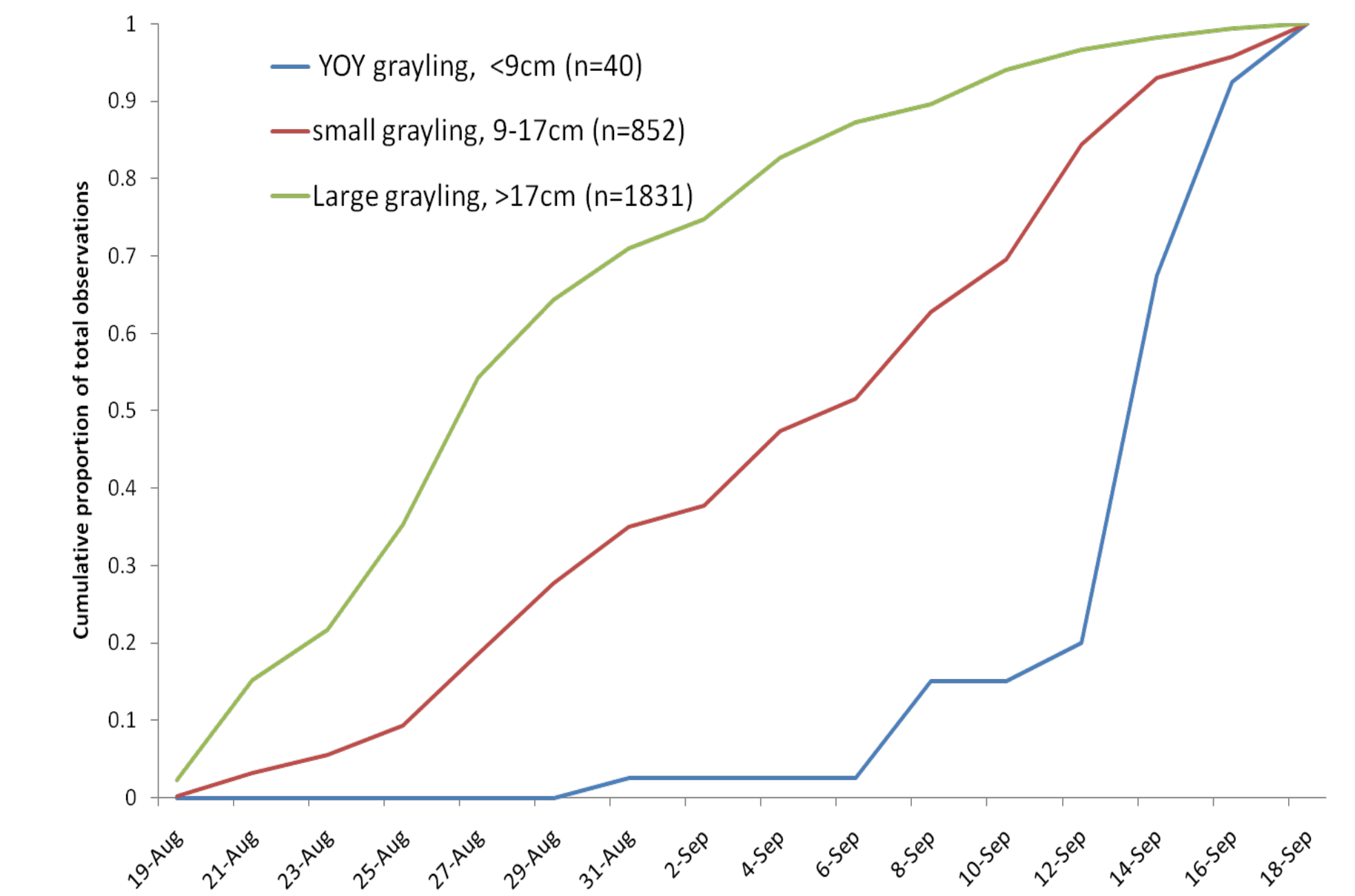
Results and Conclusions

Migration timing and discharge in Kuparuk River



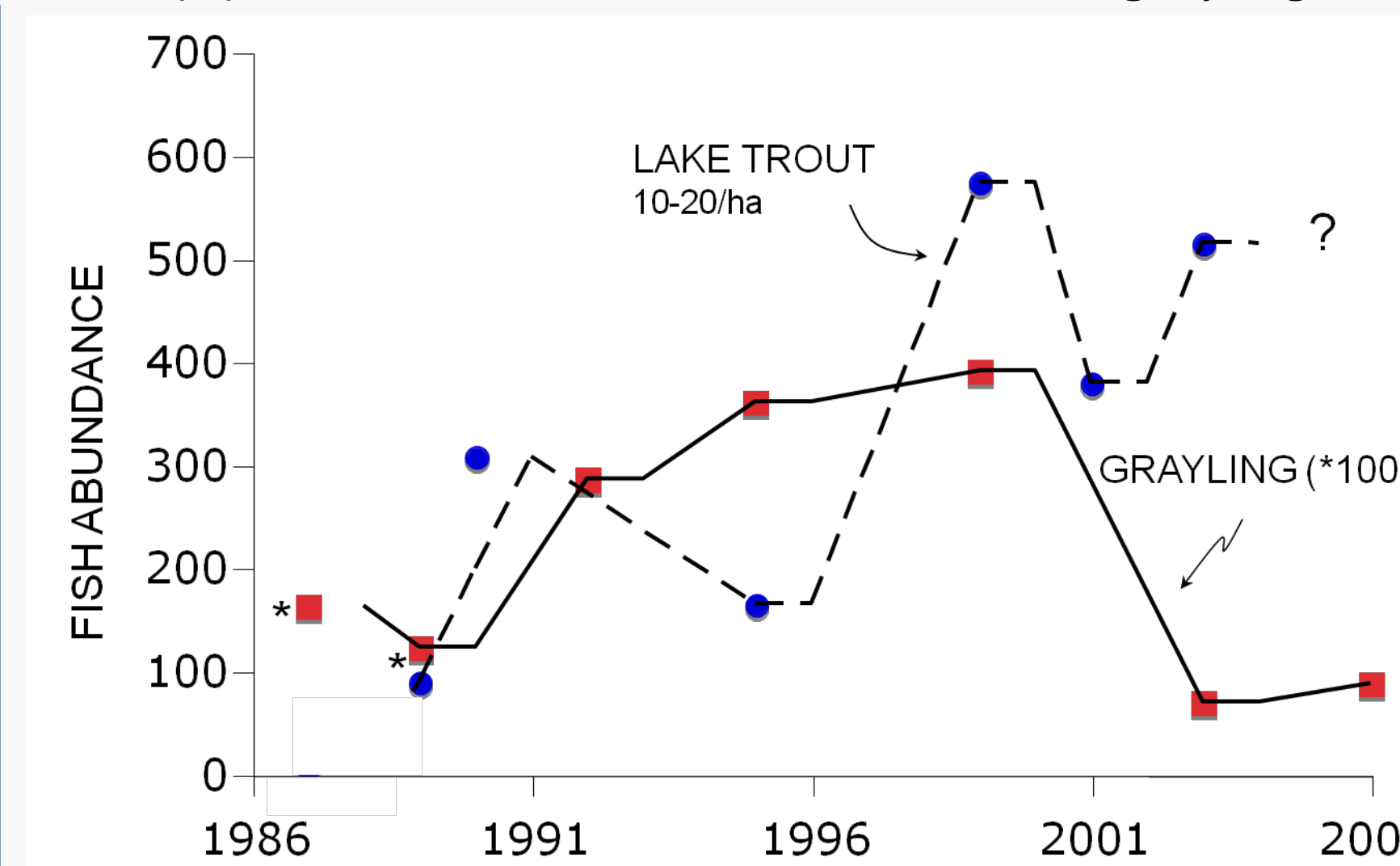
Day length may prime grayling migration readiness, but flooding events may be the cue the grayling use to initiate migration. Many fish used high discharge events in the stream as an opportunity to move into lakes, suggesting that higher discharge during periods of rapid change in daylength in the fall is a key requirement for migration.

Migration timing by size class into overwintering lakes

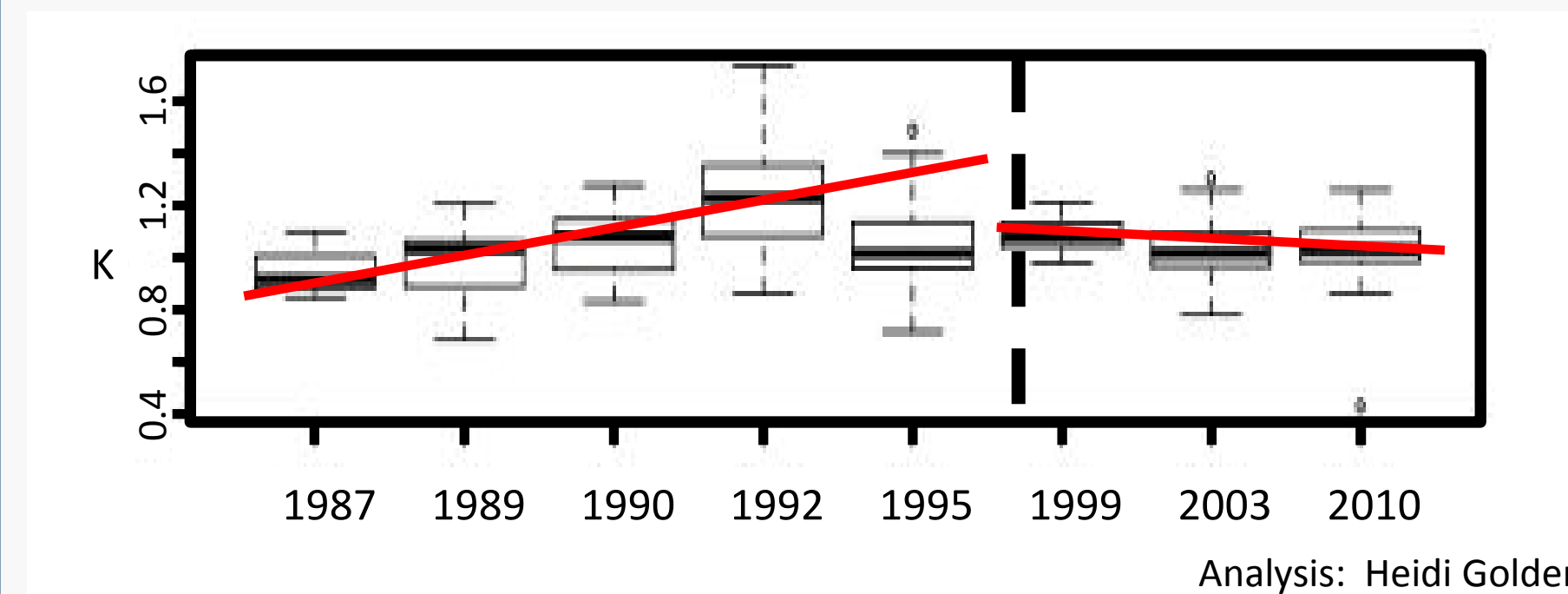


Timing of migration into overwintering lakes was related to size, with larger fish moving first and smaller fish moving later when long periods of darkness begin. Large and abundant resident lake trout rely on seasonal predation of small grayling for growth (see below).

(A) Abundance of lake trout and Arctic grayling

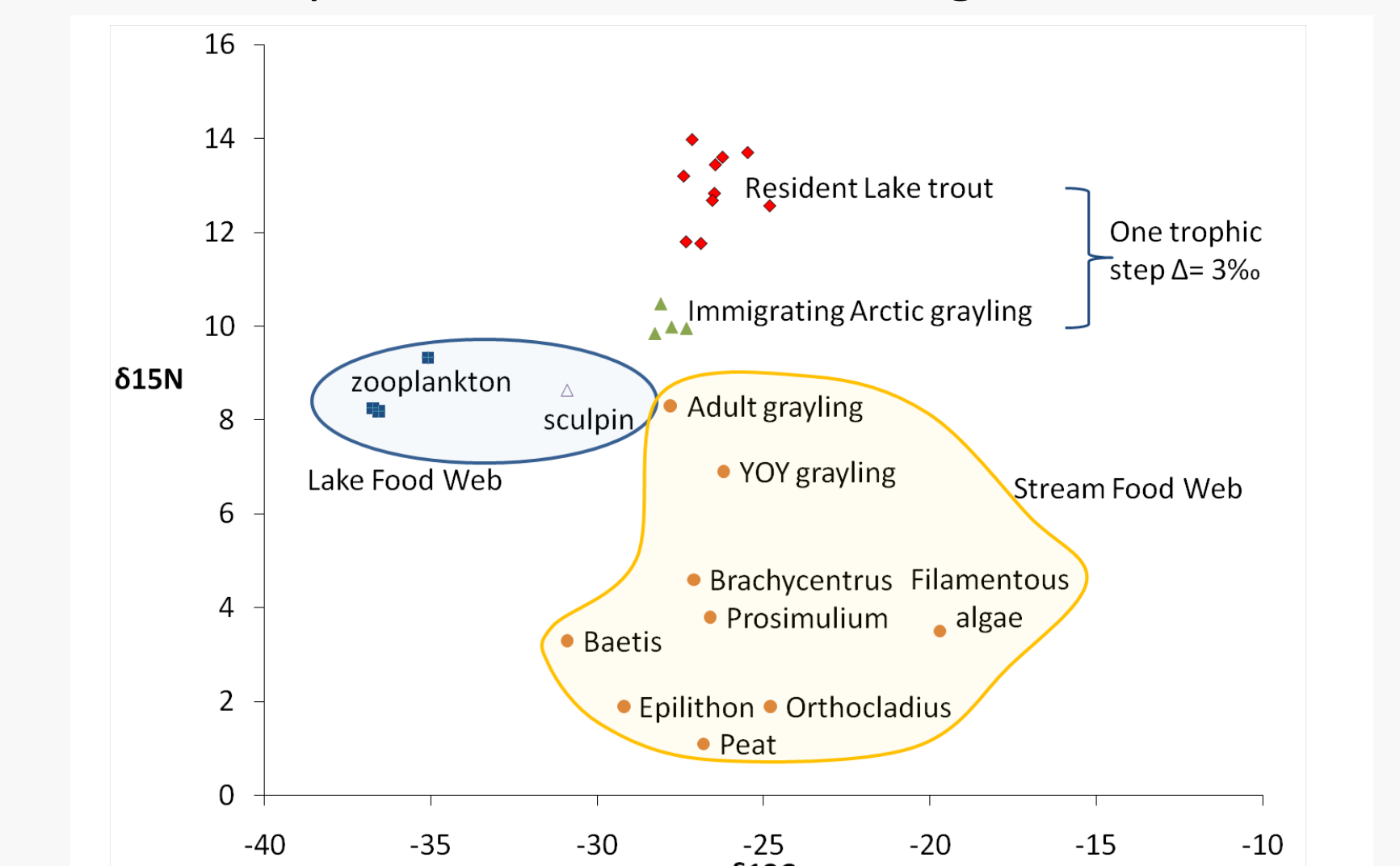


(B) Annual lake trout condition factor (K) in overwinter lakes



Decadal cycles of grayling abundance (panel A) suggest lake trout condition declines (panel B) when grayling populations are low (years following dashed line). Assessment of population dynamics is ongoing.

C-N Isotope values for overwintering lake foodweb



Stream and lake derived stable isotopes indicate a primary trophic dependence on seasonally transported inputs of Kuparuk River nutrients via migrating grayling.

Analysis of lake trout gut contents during the fall migration found that 10-15cm grayling were an important component of the diet.

Grayling were not important in the diet during the summer when few grayling are present in the lake.