**Research Question:**
Does a reduction of herrings in cod diets have the potential to impact cod growth?

**Introduction**
Anthropogenic activities in the 19th and 20th centuries severely affected the capacity of rivers to support populations of river herring because of damming and other river blockages (Hall et al., 2010; Rounsefell and Stringer, 1945).

The overfishing of nearshore marine systems for cod, *Gadus morhua*, has had negative effects on cod numbers (Ames, 2004; Drinkwater, 2005; Fogarty et al., 2007; Mateo, 2007; and Mayo et al., 2009).

To explore our research question, we used the Wisconsin Bioenergetics Model (Hanson et al., 1997).

The model is an energy balance equation that takes into account parameters for individual fish species based on laboratory observations (Hanson et al., 1997).

Water temperature, diet proportions, and energy densities of diet items, are used to calculate consumption rates of fish to determine growth rates.

The model takes into account the metabolic costs of respiration, excretion, and egestion. (Figure 1).

**Materials and methods**
Cod were caught using hook and line within eight km of the Kennebec-Androscoggin River mouth between June and September of 2010 & 2011.

Local fishing guides were hired to assist in collecting samples and to provide local knowledge regarding best places to focus sampling effort.

Captured fish underwent gastric lavage to flush diet items from their stomach (Figure 2). After length and weight measurements were collected; fish were returned to the water alive.

Stomach contents were analyzed in the lab using established keys and a dissecting microscope.

Diet items were counted and weighed to develop diet compositions for cod. Diet analysis for 2010 is complete; 2011 diet samples have not been processed yet.

For model development, we used diet composition data sets collected by the National Marine Fisheries Services (NMFS) from 1973–1998 (Link and Garrison, 2002) (Figure 3).

**Results**
Simulations were run to estimate the reduction in cod growth due to reductions in consumption of herrings.

The simulations represent baseline, 25, 50, 75, and 100% reductions.

The total elimination of herrings in cod diets reduced yearly growth of age-3 cod by 101%. (Figure 4).

Cod could not sustain growth curves without herrings in diet.

**Conclusions**
Our bioenergetics modeling results suggest that reductions in river herring in the diets of cod could negatively impact cod growth.

Recent efforts to restore river herring could positively influence cod growth as well as other fish species that depend on river herring as prey (Lichter et al., n.d.).

Future research includes bioenergetics modeling of the effects diet composition have on spawning stock biomass and age structure shifts of cod populations in the Gulf of Maine.

**Bioenergetics model results** will be applied to bioeconomic modeling to illustrate the economic implications imposed on surrounding coastal communities resulting from the absence of marine resources.

When assessing a marine system’s ability to support fish populations, fisheries managers need to have knowledge of how the absence of certain prey fish can influence growth of predatory fish.

**Literature cited**


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