Bioenergetics models are widely used in fisheries research and management and are an important tool for understanding the implications of environmental changes to fish populations (Chipps and Wahl 2013). With growing uncertainty in future environmental conditions and sensitivity of model parameters to environmental flux it is important to directly measure as many components of our models as possible.

Physical changes in ocean systems occur on varied temporal scales. In the last hundred years ocean temperatures have risen by approximately 1°C (Rayner et al. 2003). Small changes in ocean temperatures can have large impacts on natural communities and long term climatic shifts will alter species dispersal, interaction and existence (Sanford 1999, Staudinger *et al* 2013).a

Climate shifts alter not only temperature, but ocean currents and salinity as well. In the late 1980s atmospheric pressure, at sea level in the central Arctic, began to decline precipitously (Greene and Pershing 2007). The fall in pressure increased the outflow of low saline water from the arctic, through the Labrador Sea, resulting in a freshening of the shelf waters of the North Atlantic. This shallow outflow water, which had previously flown through the Fram Strait, resulted in the North Atlantic being colder, fresher, and more stratified in the 1990s than it had been in the 1980s (Green and Pershing 2007).

The largest single year drop in the NAO index of the 20th century occurred in 1996 (Greene and Pershing 2003). The decrease in atmospheric pressure led to a further shift in circulation on the Slope Sea on the North Atlantic continental shelf. By 1998 the Labrador subarctic slope water had completely replaced the Atlantic temperate slope water in the deep basins of the Gulf of Maine (GoM), as a result of the shift. This scenario, known as a minimal modal state, dramatically affected the plankton communities in the GoM. For example, autumn phytoplankton and small copepod abundances increased dramatically (Pershing *et al.* 2001). Within the next few years, the NAO returned to positive values. By 1999, the Slope Sea had returned to its previous condition of a maximal modal state (Green and Pershing 2003).

While physically the GoM returned to its pre-shift state ecologically the impacts were longer lasting. Atlantic herring exhibit density-dependent growth (Jennings and Beverton 1991, Rochet 2000, Lorenzen and Enberg 2001, Stevenson and Scott 2005). As microzooplankton increased in the early 1990s, herring populations also began to increase. With the upswing in population, individual growth rates began to drop, resulting in large numbers of small herring (Green and Pershing 2003, Pershing *et al.* 2005).

*Calanus finmarchicus* were also impacted by the minimal modal state. The abundance of younger calanus increased, however larger adult stages steeply declined, possibly due to increased selective feeding pressure from growing herring populations (Green and Pershing 2003).

A decline in bluefin tuna condition and abundance coincided with the changes in herring size and abundance; several hypotheses have been proposed to explain the decline in bluefin tuna condition. The foraging hypothesis suggests that the decline in tuna condition could be explained by reduced herring condition or decreased capture efficiency. The junk food hypothesis suggests that consuming low-lipid prey will not satisfy the energetic demands of a predator regardless of prey abundance (Rosen and Trites 2000).

Atlantic herring is the dominant fish species in the North Atlantic. They have top down impacts on zooplankton and bottom up influence on piscivorous fishes. Understanding shifts in the condition and abundance the herring, and other forage fish, populations is crucial in predicting the flux of other ocean species.

Bioenergetics models use the basic mass balance equation where energy in equals energy used and excreted, Consumption = Respiration + Growth + Egestion + Excretion. These models are useful in tracking the energy allocation of herring and how changing temperatures, food supplies or densities might alter growth and consumption. Bioenergetics models have been used to inform stocking and catch quotas for some species. Unfortunately, the traditional Wisconsin bioenergetics model has several shortcomings. The model relies on temperature, weight, age and a variety of lab or literature derived constants to estimate consumption and respiration. Wisconsin models use an activity multiplier to balance the equation by scaling respiration. This scaling has been questioned in the literature and several methods have been derived to avoid the issue.

Mercury mass balance models (MMBM) use bioaccumulation of methylmercury (MeHg) in predators and prey to directly estimate consumption rates for predators. When herring consume prey MeHg from their tissues is assimilated into the herrings body at a given rate, by measuring MeHg in both organisms we are able to determine a consumption rate for each individual herring.

We have built both a Wisconsin model (Kitchell et al 1977) and a MMBM (Trudel et al 2001) to compare the differences between the two. We suspect that the Wisconsin model underestimates consumption and respiration rates. A direct comparison of both models on the same fish shows directly measured consumption rates derived using the MMBM to be significantly higher than those values estimated in the Wisconsin model. Respiration rates were also found to be significantly higher in the MMBM than the Wisconsin model.