Essential Fish Habitat project status report

Reporting date: October 28, 2011

Project number: 2006-12, 2007-12, 2008-06

Title: **Habitat Influence on Rearing Condition and Overwinter Survival of Juvenile Capelin (*Mallotus villosus*)**

PIs: J. Vollenweider, R. Heintz

Funding year: FY 2008

Funding amount: $44,540

Status: ☐ Complete ☐ Incomplete, on schedule ☒ Incomplete, behind schedule

Planned completion date if incomplete: All field collections, chemical analyses, and data analyses are complete. Two manuscripts are currently in progress describing the overwinter energy allocation strategies of juvenile 1) eulachon and 2) capelin. The juvenile eulachon manuscript is under review and will be submitted to a journal this winter (FY12). The capelin paper, which is also in draft, will be submitted to a journal the following summer (FY12).

Reporting: The project has not yet been reported, however 2 manuscripts are in progress and are anticipated to be published in FY12. In FY11, results were presented at the AFS annual meeting in Seattle.

Results:

Winter starvation mediated by low-levels of foraging is likely an important mechanism structuring recruitment success of juvenile forage fish. Over the course of two winters, we observed size-selective mortality in juvenile eulachon and capelin stemming from starvation in the smallest individuals. Between the fall and subsequent spring sampling periods, length frequency distributions of juveniles shifted towards larger individuals, which could either be indicative of a loss of smaller fish or growth (Figure 1). Growth overwinter is highly unlikely, however, as fish lost energy during this period and therefore surplus energy would not have been available for growth.

Winter energy deficits resulted from the loss of both lipid and protein energy. The magnitude of the deficit and relative depletion of lipid and protein were size dependent (Figures 2 and 3). Larger juveniles began winter with greater lipid reserves than smaller fish. During winter, larger fish depleted more of their pre-winter lipid reserves than smaller fish, and as a consequence, the contribution of lipid catabolism to the winter energy deficit increased with body size (Figure 4). Although the relative proportion of protein loss was independent of body size, the smallest fish lost more energy in the form of protein than lipid. By the end of the winter, the energy content of the smallest surviving juveniles was very near the energetic threshold, below which mortality occurs (Figure 5). Thus, the smallest juveniles were under extreme nutritional stress and were forced to metabolize protein to meet most of their metabolic demands, apparently as a consequence of exhausting lipid reserves.

Comparisons from two bays (Fritz Cove and Berners Bay) indicate that prey availability plays an important role in survival of juvenile fish that are on the brink of starvation in winter. Despite a general scarcity of prey during winter, what little forage juvenile fish could consume appeared to help stave off starvation. Nearly half the juvenile eulachon were feeding during the winter, as evidenced from stomach contents. Zooplankton prey species, particularly copepods, were

more abundant in Fritz Cove than Berners Bay (Figure 6). Though juvenile eulachon in Fritz Cove were smaller and had lower energy reserves going into winter, they were in better condition than those from Berners Bay in the spring, suggesting that prey availability may help to preserve lipid reserves and thereby reduce starvation risk.

Collectively, these results indicate that the smallest eulachon and capelin do not store sufficient reserves of lipid for winter, are forced to metabolize protein, and may suffer a greater risk of winter mortality. Winter foraging, despite low prey abundance, may be crucial for survival. We suggest that disproportionately high rates of starvation among the smallest age-0 forage fish are important mechanisms influencing recruitment.

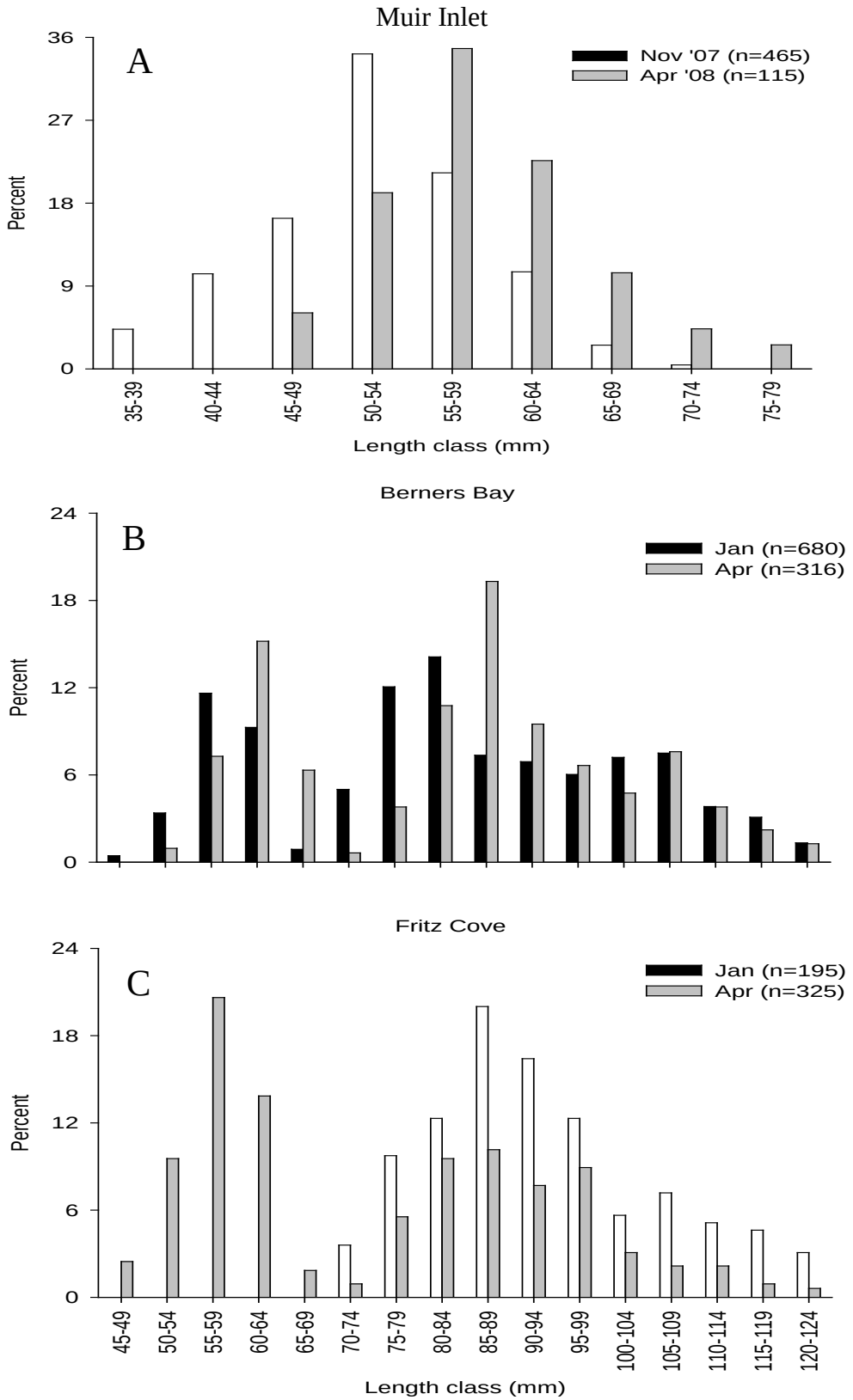

Figure 1. Shi[redacted] in siz[redacted] distri[redacted]tion of juvenile capelin (A) and eulachon (B & C).

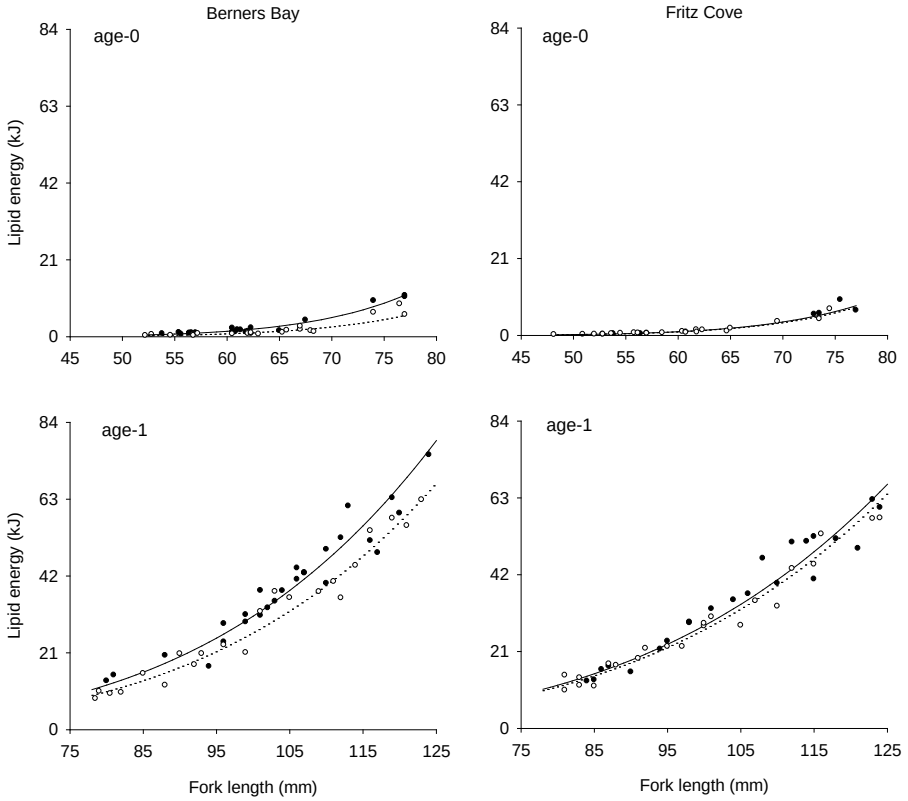

Figure 2. Energy allocated to lipid in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

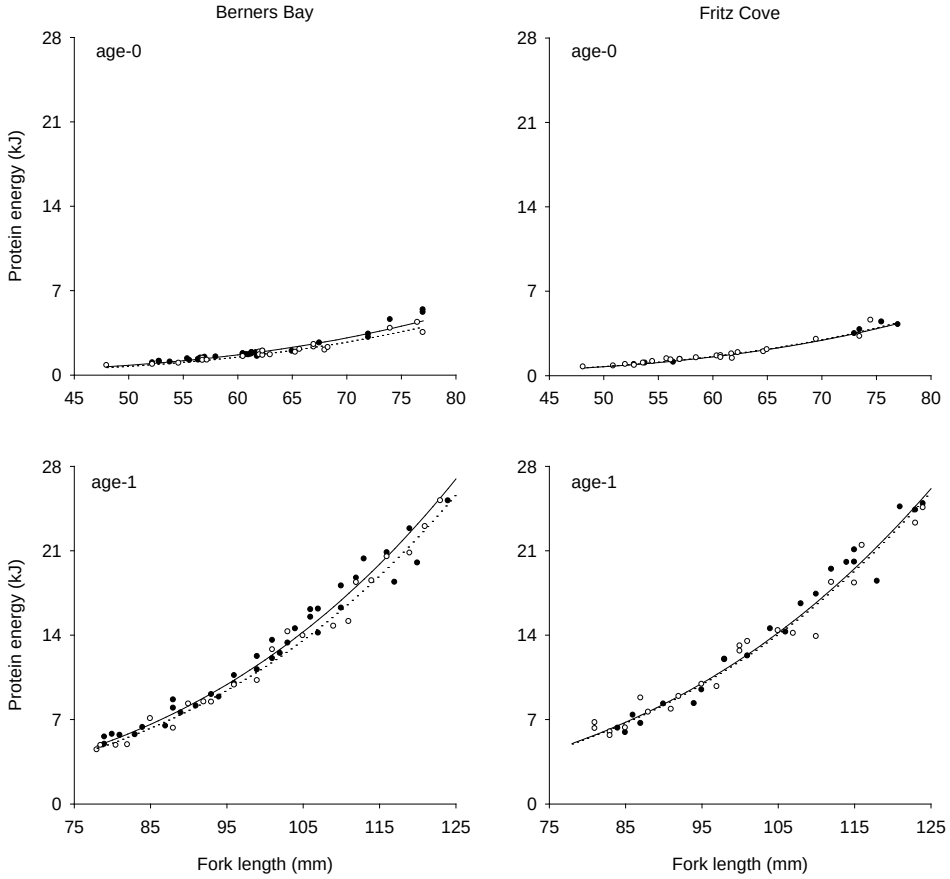

Figure 3. Energy allocated to protein in age-0 and age-1 eulachon in January (solid circles and lines) and April (open circles and dashed lines) in Berners Bay and Fritz Cove.

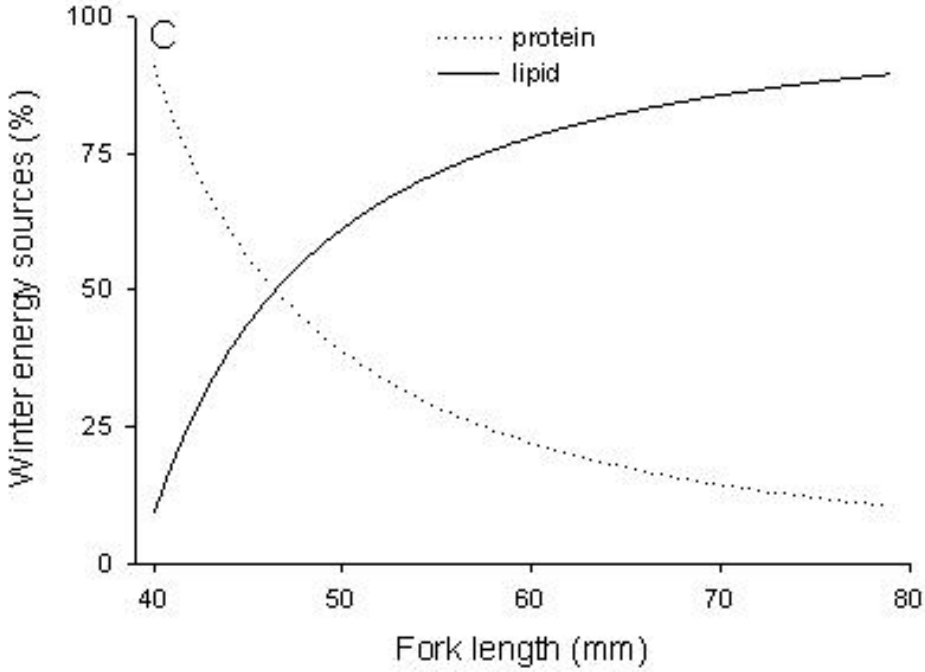

Figure 4. Modeled relationships between capelin fork length and the relative contribution of lipid and protein energy to the winter energy deficit.

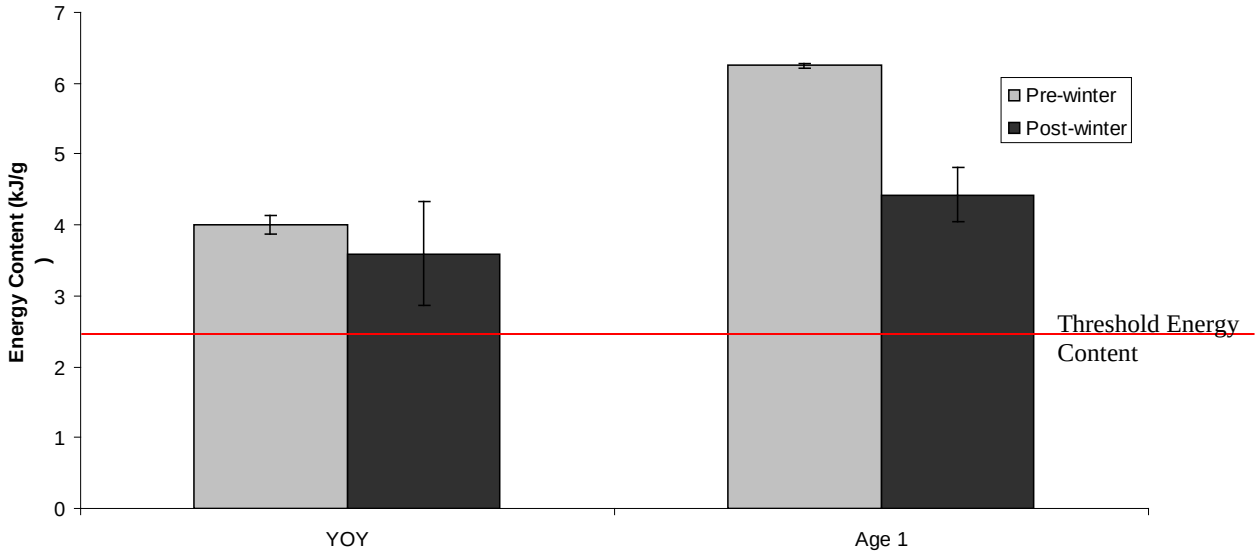

Figure 5. Overwinter energy loss (kJ g^{-1}) of juvenile capelin. Red line denotes the threshold energy content below which mortality occurs.

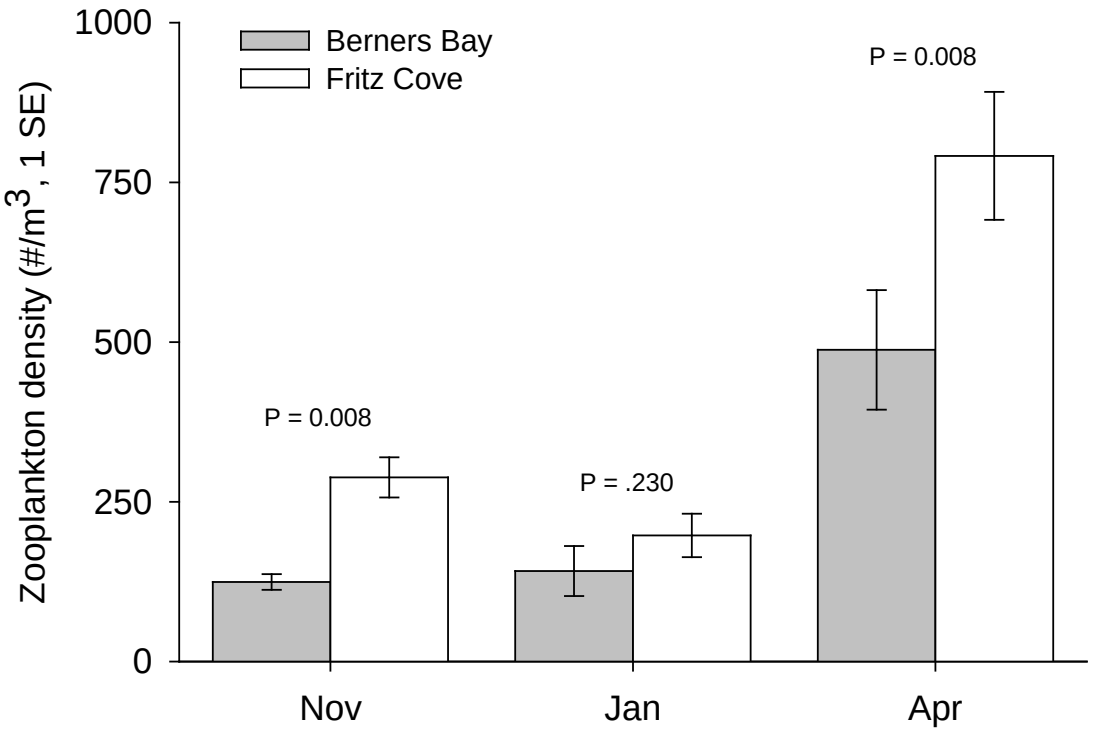

Figure 6. Zooplankton abundance in Berners Bay and Fritz Cove during winter 2006/2007. P-values are from Mann-Whitney U tests.