Energetics of Overwintering Juvenile Eulachon (*Thaleichthys pacificus*) in Two Southeastern Alaska Bays

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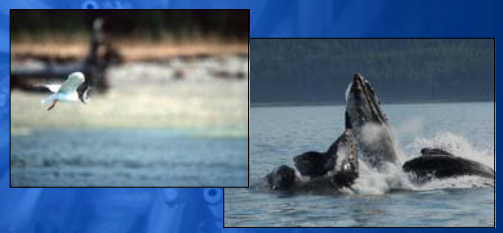
Background



Forage fish play an important role in marine food webs, yet the factors that influence their populations in Alaska are poorly understood.

Size-selective winter mortality is a common phenomenon among temperate forage fishes and can influence their recruitment success and, ultimately, abundance. Winter mortality may result from the depletion of lipid reserves.

Relative to older/larger individuals, higher metabolic rates and lower lipid reserves in juvenile fish make them more vulnerable to winter mortality.

Forage fish winter energy dynamics and mortality rates may vary among wintering habitats.

Approach

We measured overwinter (Jan-Apr) changes in the primary energy constituents of juvenile eulachon in Fritz Cove and Berners Bay in southeastern Alaska.

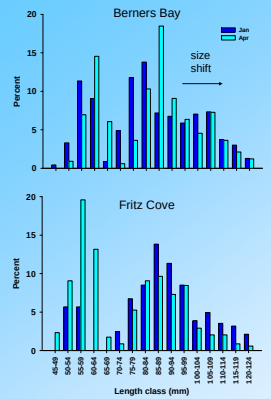
Zooplankton and temperature data were collected throughout the water column at multiple fixed stations in each bay.

Eulachon were analyzed for protein and lipid content from which total energy content was calculated.

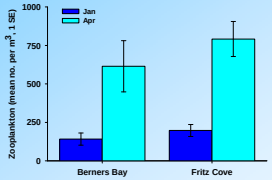
Overwinter energy dynamics were assessed by comparing (ANCOVA) January and April protein, lipid, and energy content allometries for 42-77 mm (mostly age YOY) and 78-124 mm size groups.

Results presented here are based on length-adjusted means for small (64 mm) and large (102 mm) eulachon.

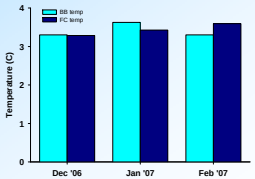
Findings



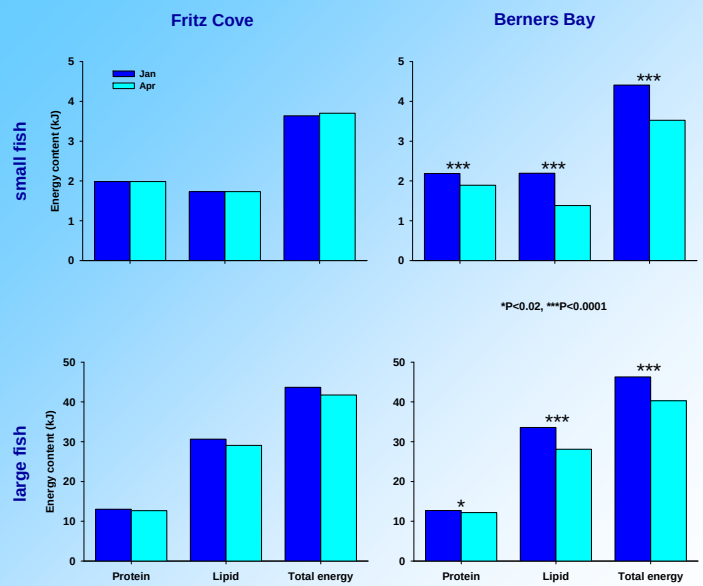
An overwinter shift in the size distribution of eulachon was evident in Berners Bay and absent in Fritz Cove. This phenomenon is commonly attributed to size-selective mortality of small individuals.



Prey are more abundant in Fritz Cove, but not statistically.



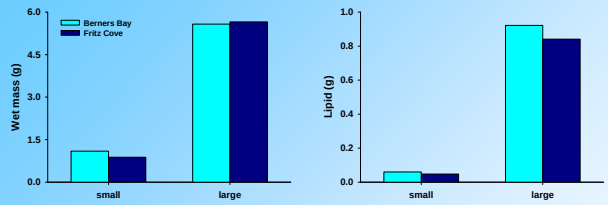
Average water column temperature varied little between bays.



Fritz Cove eulachon maintained energy levels during winter suggesting that prey consumption offset metabolic costs.

Berners Bay eulachon metabolized significant amounts of both protein and lipid during winter indicating that lipid reserves alone were not sufficient to meet metabolic demand.

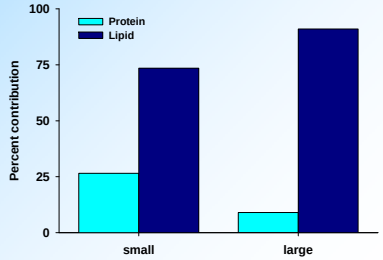
Going into winter – January body size and lipid reserve



Small (64 mm) eulachon in Berners Bay entered winter heavier and with more lipid reserves than their Fritz Cove counterparts. Although large (102 mm) eulachon were similar in mass between bays, eulachon from Fritz Cove had less lipid at the onset of winter.

What fuels winter metabolism in Berners Bay?

Although lipid is the primary winter energy source for both small and large eulachon, protein is also metabolized, and more so in small than in large eulachon.



Summary & Conclusions

Large eulachon began winter with disproportionately (relative to mass) larger (15X) reserves of lipid compared to small eulachon. In Berners Bay these reserves enabled large eulachon to minimize protein metabolism, an inefficient energy source with potential negative consequences for swimming performance.

Small eulachon in Berners Bay consumed considerable protein during winter (~30%) despite their larger pre-winter body size and lipid content compared to Fritz Cove eulachon.

Considering that water temperature and prey abundance were similar between bays, the post-winter energy deficit observed in Berners Bay eulachon may have resulted from reduced foraging success.

Assuming that lipid is preferentially metabolized when consumption does not satisfy metabolic demand, protein loss during winter may signal energetic stress. This stress may account for higher mortality rates among the smallest eulachon in Berners Bay resulting in the observed shift in size distributions.

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