

Seasonal variation in the metabolic performance of walleye pollock and the influence of
water temperature

Interim progress report for the period of June-December, 2004:

Prepared For:

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Synopsis of Progress: Initial funding for year 1 of the project was received in June 2004. The majority of our efforts and budgetary expenditures were initially committed to enhancements to the wet laboratory space within the Kodiak Fisheries Research Center. Four, 5700 L, fiberglass tanks were assembled and installed within the facility. A new water chiller and plumbing materials were purchased to complete this re-circulating system designed to maintain two tanks of fish at water temperatures of 3° and 8° C ($\pm 1^\circ\text{C}$). Following completion of these improvements we developed experimental protocols for determining metabolic rates, critical swimming speeds, and analytical assays of plasma constituents of walleye pollock and Pacific cod. To date we have performed one trial examining the swimming and metabolic performance of pollock that were collected during the fall of the year. We have begun assaying plasma samples gathered over the course of this trial in order to characterize condition of animals before and after exhaustive swimming. Additionally, we continue to develop and enhance our techniques for determining metabolic rate and swimming performance using Pacific cod. Our goals for the spring of 2005 include chartering a commercial fishing vessel to collect pollock for tests evaluating impacts of temperature and seasonality on the metabolic performance of this species. Collection of pollock for these studies continues to provide challenges and the most successful technique for collection of laboratory animals used to date is capture with hook and line. We have attempted to collect live pollock on two research cruises little success. However, we continue to evaluate other techniques using chartered fishing vessels that will provide a more efficient approach to capture.

Completion of tasks by objective

Objective 1. Determine how the metabolic scope of walleye pollock is altered by seasonal physiological changes.

Progress to date: We have performed one seasonal test evaluating the metabolic scope of walleye pollock collected from the wild in the late summer/fall. We performed these tests before water temperature control had been fully optimized in our wet laboratory and water temperatures were higher than desirable (10-11°C). Critical swimming speeds (N=5) and oxygen consumption rates (N=4) of walleye pollock over a range of swimming speeds were determined. The highest oxygen consumption rate during exhaustive swimming represented a fourfold increase from the lowest values observed. The range of values for the critical swimming speed was 46 to 73 cm/s (0.9 to 1.8 body lengths/sec). These data were not corrected for the effects of solid blocking, which may account for the large range of values reported here. We have completed an additional test with Pacific cod captured during the summer months. Resting and maximal metabolic rates were determined for 5 fish. A 2 to 3-fold increase between cod at rest and at exhaustion was observed (Figure 1).

Tasks Ahead: Over the course of the next 12 months we will capture groups of pollock and transport them to tanks on Kodiak Island. Three groups of fish will be captured in

order to determine if season of the year influences the metabolic rates of walleye pollock. These groups of fish will be collected in spring (Mar-Apr), summer (Jun-Jul), and fall (Sep-Oct). These fish will be maintained in tanks at ambient water temperatures and acclimated for two weeks before commencing any trial.

Metabolic Rate
(mg O₂/kg/hr)

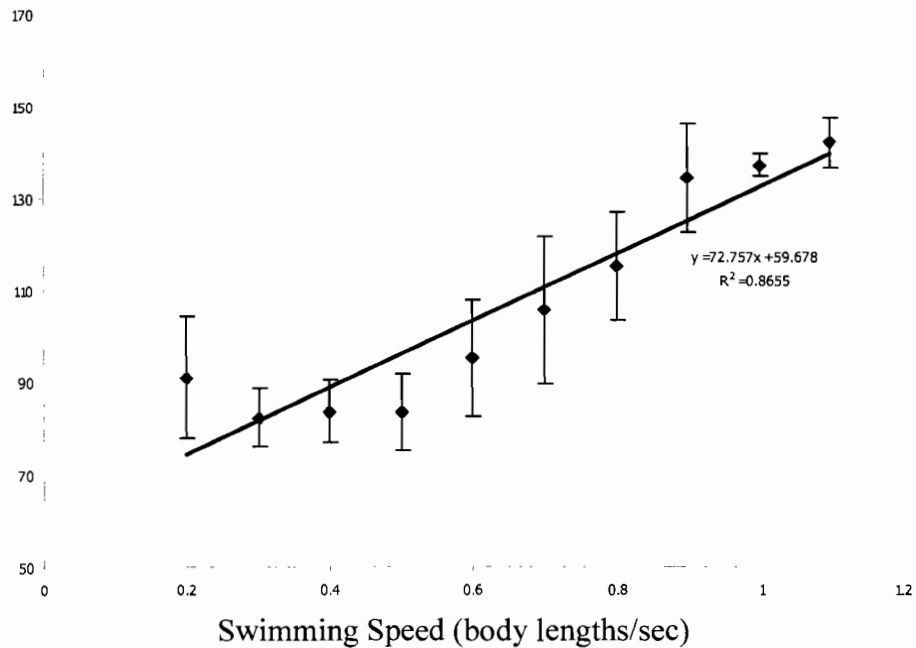


Figure 1. The mean metabolic rates (\pm SEM) for Pacific cod over a range of swimming speeds versus swimming speed.

Objective 2. Determine the extent that shifts in water temperature influence routine metabolic rate and swimming performance of walleye pollock.

Progress to date: We have performed preliminary tests and are at present evaluating data gathered on a surrogate species, Pacific cod, acclimated to two different temperatures. Pacific cod were swum to exhaustion over a range of temperatures and preliminary analyses of these data suggest a trend for an increased critical swimming speed with increased water temperature.

Tasks Ahead: In the coming months we anticipate capturing groups of pollock (see Obj. 1). During these cruises we will capture a larger numbers of fish to be divided amongst 4 tanks within the Kodiak Fisheries Research Center maintained at either 3 or 8°C. The fish will be fed identical diets consisting of herring and held long term at these conditions. At three points over the course of 12 months we will determine resting and active metabolic rates as well as critical swimming speeds to determine if long term

changes in water temperature influence performance. In February 2005 we intend to repeat the preliminary swimming performance tests with cod over two temperatures in order to validate preliminary results that suggest a relationship between swimming performance and water temperature.

Objective 3&4. Correlate organosomatic indices of walleye pollock with changes in aerobic capacity & assess the use of organismal and plasma indices as bioindicators of fish condition in walleye pollock.

Progress to date: Analytical procedures for the measurement of glucose, lactate, sodium, chloride, potassium, and the hormone cortisol have been established at laboratory facilities in Kodiak. Preliminary data gathered from walleye pollock used in swimming performance studies demonstrate the presence of osmoregulatory upset associated with animals stressed to exhaustion at the end of performance testing with larger amounts of sodium and chloride in the serum of exhausted animals (Figure 2).

Tasks ahead: Laboratory analyses of all of the plasma samples gathered to date in preliminary studies will be completed over the next 6 months. These data will include samples collected from fish acclimated at 3 and 8° C We are proceeding with further analyses to further characterize the physiological response to exhaustive swimming and identify any potential correlate with swimming performance. For the seasonal tests and the long term holding tests described above we will be collecting blood samples and data to determine organosomatic indices to determine if water temperature and/or season of the year influence the basal body condition, the capacity to recover from exhaustive swimming, and if there are body or plasma indices that are able to predict the outcomes of swimming performance trials.

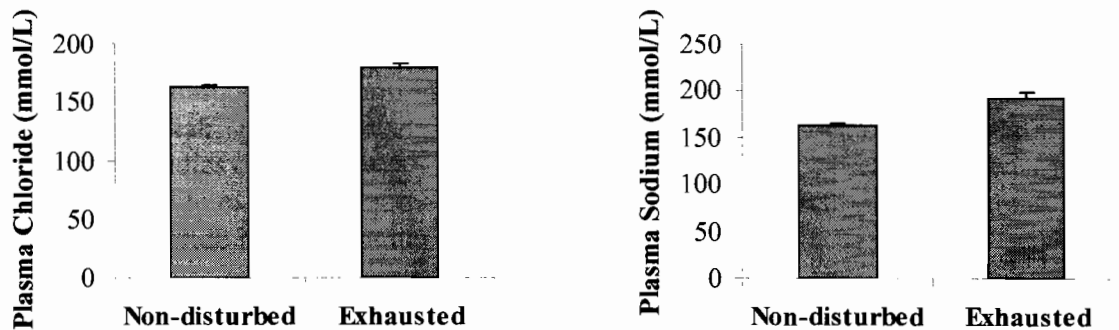


Figure 2. The mean concentrations (mmol/L \pm SEM) of sodium and chloride ions in the serum from walleye pollock sampled before and after exhaustive exercise.

Table 1. Budget summary for year 1 of “Seasonal Variation in the Metabolic Performance of Walleye Pollock and the Influence of Water Temperature”

Budget Category	Budgeted	Spent	Available
Salaries and Benefits	37,903	18,181	19,722
Travel	2,100	430	1,670
Contractual Services	15,500	0	15,500
Commodities	12,100	10,378	1,722
Total			38,614