hour anabolic phase when GBF increased by 75–100%. No significant difference existed for GBF among the three diets during this phase. There was a subsequent catabolic phase for the final 60 hours of the study in which GBF varied according to diet (NSERC).

A4.12
A swimmer's diet: Substituting dietary lipids and the resulting effects on swimming performance in Chinook salmon (*Oncorhynchus tshawytscha*)

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Temperate-water marine fish provide the best dietary source for omega-3 (n-3) highly unsaturated fatty acids (HUFAs). Wild marine fish stocks are drastically declining worldwide; aquaculture industries are expanding, but because wild marine fish oil is still the primary lipid component of commercial feed, efforts to find alternate lipid sources (e.g. plant source HUFAs) are becoming increasingly important. Canola oil (n-6 HUFA) was chosen for this investigation. Six experimental diets were developed and tested on juvenile Chinook salmon (Oncorhynchus tshawytscha), wet weight ranging 11 g start to 70 g finish, over a 20-week period. Proximate composition of each diet was maintained, but various ratios (50, 40, 30, 20, 10, and 0%) of anchovy oil were substituted with canola oil. Every four weeks, maximal aerobic swimming velocity (Ucrit) was determined and repeated after a one hour recovery, as an overall indicator of physical status. Ucrits, recovery ratios, and hematalogical parameters were calculated but not found to significantly differ in fish between diet types, across all four months, and between freshwater and seawater swims. These data indicate that supplemental dietary lipid sources may consist of up to 50% canola oil without affecting swimming performance in juvenile Chinook salmon. The lack of difference is interesting in light of recent studies demonstrating effects of supplemental lipids on respiratory and cardiac physiology in other species. Our observations may indicate that altering 50% of the total dietary lipid is not enough to alter physical performance; additionally, our results may be species-specific or coupled to the developmental stage of the organism.

A4.13
Swimming capacity and energetics of migrating and non-migrating morphs of Threespined Stickleback (*Gasterosteus aculeatus*) and ecological implication

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Threespined Stickleback (*Gasterosteus aculeatus*) shows two distinct morphs, a migrating morph (Trachurus) and a non-migrating morph (Leiurus). To test if the two morphs show also physiological differences associated with migration, we investigated swimming capacity as critical swimming speed, maximal swimming speed, gait transition speed and optimal swimming speed. Energetic features as oxygen uptake and energy stores like proteins, fats and sugars in liver and white muscle were measured and compared between the two morphs.
The results clearly show a better adaptation of Trachurus to migration and long distance swims. The critical swimming speed, maximal speed and gait transition speed are significantly higher than in Leiurus and the optimal swimming speed also shows higher values. Energetic values show significant differences between the morphs as well. Standard metabolic rate and active metabolic rate are significantly higher in Trachurus. The metabolic scope also is increased. Amounts of energy stores are significantly higher in Trachurus for fat in the liver only. Generally, Trachurus is better adapted to migration and long term swimming than Leiurus. The higher swimming performance can be explained by the effective migration behaviour of Trachurus. This study gives a good general view of adaptation to migration in the same species and in the same temporal frame.

A4.14
Effects of dietary lipid substitution on swimming performance during the early developmental stages of Chinook salmon (*Oncorhynchus tshawytscha*)

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The marine fish oils present in farm feed not only comprise a substantial proportion of the cost of aquacultural salmon production, they are also responsible for the accumulation of anthropogenic contaminants in the fish, such as PCBs and dioxins. Our study looks to assess the practicality of substituting these marine fish oils with canola oil, a vegetable-derivative which has the potential to decrease feed costs in salmon production, as well as reduce levels of harmful contaminants present in the fish. Over seven months, four groups of Chinook salmon (*Oncorhynchus tshawytscha*) were fed one of four diets differing in their respective canola oil/anchovy oil ratios (0/100, 25/75, 50/50, and 75/25 total lipid content). These ratios, as well as the feeding of the fish earlier in development, was to supplement a previous study investigating the effects of dietary lipids on fish physiology so as to further investigate the effects of canola oil replacement. Swimming performance was measured for the fish of each group through the determination of their critical swimming velocity (Ucrit), and from these values the overall physical condition of the fish could be inferred. Upon fatiguing, other indicators of osmoregulatory stress were measured in the fish, including gill Na+/K+ ATPase activity and morphology, plasma osmolarity, Na+, Cl, and muscle water content. No significant differences between the diets have been found regarding the fishes' swimming performance or muscle water content, suggesting canola oil as a viable substitute for anchovy oil in Chinook salmon.

A4.15
Flyway-scale variation in plasma triglyceride levels as an index of fattening in migrating shorebirds

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We combined radio-telemetry and plasma metabolite analyses to investigate variation in putative fattening rates (estimated as plasma triglyceride levels) at the flyway-scale in Western Sandpipers (*Calidris mauri*) migrating between Punta Banda, Mexico (31°N) and Hartney Bay, Alaska (61°N), a distance of 4240 km. Birds were caught at a wintering site (San Francisco Bay) and eight stopover sites along this Pacific Flyway. Plasma triglyceride levels were dependent on body mass, handling time and time of day so we corrected for these variables in our analysis. Body mass was highly variable among sites but did not vary systematically with latitude for either sex. Similarly, change in