Fatty Acid Analysis as Evidence for Winter Migration of Age-0 Herring

Principal Investigators: Ron Heintz and Johanna Vollenweider, NOAA

Ron Heintz and Johanna Vollenweider

PROBLEM: Monitoring of age-0 herring has been suggested as an important component of the Trustee herring program, but the appropriate spatial scale over which they should be monitored is unknown. The current program assumes age-0 herring remain in their nursery bays over winter. If true, then age-0 monitoring can use a series index bays to evaluate the relative health of herring cohorts. Observations of differences among bays in terms of age-0 condition and marine conditions can provide a basis for identifying conditions which lead to improved recruitment to age-1. However, if if age-0 fish move about Prince William Sound in winter, then measurements of fish condition are limited to inter annual variation, severely constraining our ability to identify the conditions leading to the recruitment of large year classes. Thus the current herring monitoring program requires validation of the assumption that age-0 herring remain in their nursery bays over winter.

We propose to test the assumption by monitoring the fatty acid composition of age-0 herring over winter. Herring foraging on different prey fields likely have different fatty acid compositions because the fatty acid composition of depot lipids derives from diets (Budge et al. 2006). Differences in the prey fields in different bays should produce differences in the fatty acid compositions of herring in those bays (Otis et al. 2009). During periods of food deprivation, fish fatty acid compositions are conserved (Figure 1). Therefore, the fatty acid composition of age-0 herring in fall can act as a natural tag for identifying migration. We hypothesize that migration of herring will result in increasing similarity of herring fatty acid compositions. Changes in fatty acid composition due to winter feeding are likely to be minimal because age-0 herring experience energy deficits in winter, proscribing lipid storage. We plan to test this assumption in a laboratory study. Consequently, if the fatty acid composition of age-0 herring in given bays is constant over winter then migration must be limited.

STUDY DESIGN: We propose to repeatedly sample herring from different bays in eastern and western Prince William Sound at the beginning and end of winter. These samples will be collected as part of the current herring monitoring program. Costs for this project are incurred from expanding the analysis of samples we will already be processing.

Ideally our collection will include samples from at least one bay in Port Fidalgo, two bays in Port Gravina, and both arms of Whale Bay. However, we will design the study based on the samples we receive while aiming to maximize our ability to understand the spatial scales for migration. Fatty acids will be analyzed by GC/MS and differences among fish from different locations will be identified by non-parametric multidimensional scaling (Heintz et al. 2010). Field sampling will identify the spatial scale of winter movement by answering the following questions:

1. Do fatty acid compositions differ between bays at the beginning of winter?

2. Are compositional differences between fish from eastern and western PWS conserved over winter?
3. Are compositional differences between fish in two adjacent conserved over winter?
4. Are compositional differences between two adjacent fjord systems (Gravina and Fidalgo) conserved over winter?
5. Are compositional differences between separate bays within a fjord system conserved over winter?

At the same time the assumptions underlying the fatty acid approach will be examined under laboratory conditions by maintaining two populations with distinct fatty acid compositions and fasting them over winter. Each of the populations will have a fasted component and a second component that is periodically offered some prey, but still maintained at an energy deficit. At the end of the lab study it will be possible to determine

1. Are the fatty acid compositions of starving herring conserved over winter?
2. Does winter feeding alter the fatty acid composition of starving herring ?

LOGISTICS: We anticipate that this study can be completely integrated into the existing herring growth study. Samples collected for the herring growth project can be used for the initial and final observations of fish from different bays. For the laboratory study, we propose to use fish collected near our lab in Auke Bay. Fish will be collected by beach seine in late summer, transferred to our lab and divided into two groups. The groups will be fed different diets to create two groups with distinct fatty acid compositions. Fatty acid analysis will take place at the Auke Bay Lab, following established protocols (Heintz et al. 2010).

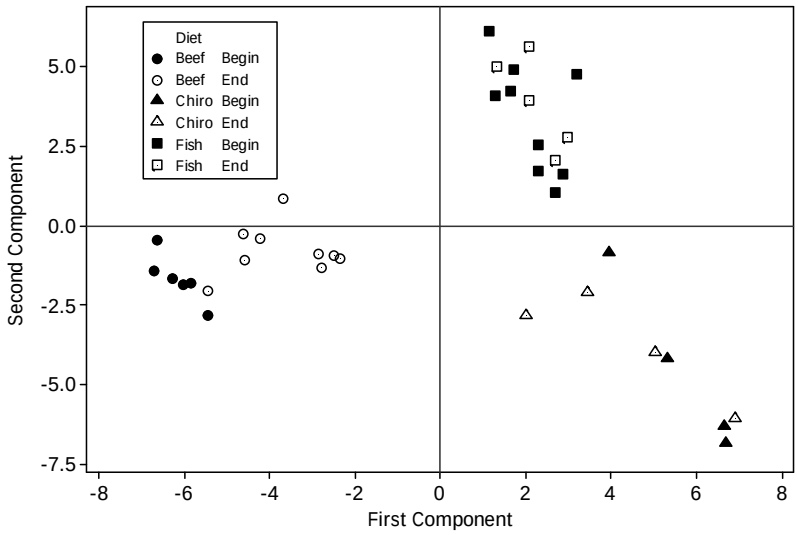

Figure 1. Principle components analysis of the fatty acid composition of coho salmon fed three different diets and fasted under the same conditions for 60 days. All fish came from the same wild population and were fed the different diets for 100 days before fasting commenced. Symbols show component scores for the fatty acid compositions of fish before and after fasting.