Emerging Baselines to Estimate the Migration Patterns of Dolly Varden Charr Nearshore and on the High-seas

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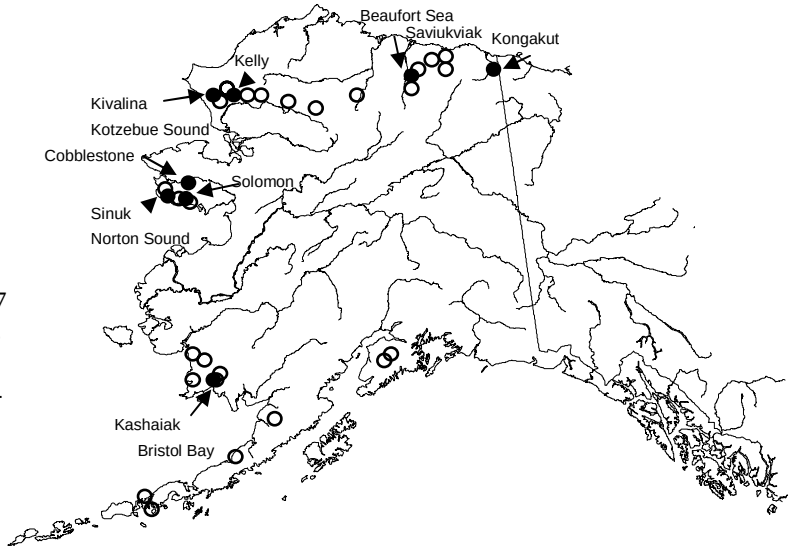
Dolly Varden (*Salvelinus malma*) is a dominant freshwater species in arctic and subarctic eastern Russia, Alaska, and western Canada and an important food source for indigenous people in these regions. Anadromous Dolly Varden are distributed throughout Alaska and occupy a wide variety of habitats, from coastal streams in the southeast panhandle to rivers draining the North Slope. Anadromous Dolly Varden show highly complex migration patterns. They typically feed in marine waters in the summer, home to spawn in their natal streams, and overwinter in natal and non-natal freshwater lakes and rivers in mixed aggregations.

Two subspecies have been described in North America. The northern form (*S. m. malma*) is distributed from the Mackenzie River to the north side of the Alaska Peninsula, while the southern form (*S. m. lordi)* is distributed from the south side of the Alaska Peninsula to Puget Sound. The forms appear to differ greatly in their marine migrations in Alaska. The median migration distance reported in studies of southern form Dolly Varden is less than 60 km with the longest documented migration of 250 km (Bernard et al. 1995). Longer migration distances have been reported for northern form Dolly Varden. Dolly Varden spawning and overwintering in Beaufort Sea drainages routinely travel distances of 100 to 350 km during summer feeding migrations (Krueger et al. 1999 and references therein). Dolly Varden tagged in the Wulik River north of Kotzebue Sound have been recovered not only in other rivers of Kotzebue Sound, but also in Norton Sound, St. Lawrence Island, and several locations in the Russian Far East, migrations ranging from 150 km to 1,690 km (DeCicco 1992, 1997). Differences in migration patterns between the forms may be due to frequency of spawning, reliance on lakes for overwintering, and other life history differences.

Migration patterns have typically been evaluated using tagging and radio telemetry studies. Our objectives are to develop datasets based on microsatellites and mitochondrial DNA markers to estimate population structure in Alaska and use mixed stock analysis (MSA) to identify the origin of Dolly Varden sampled from overwintering areas, coastal catches, and offshore locations to evaluate population specific migration patterns.

Dolly Varden have been collected from 37 locations in Alaska (Fig. 1). These collections are being assayed for genetic variation at seven microsatellite loci (*Sma-3, -5, -10,* -17, -*21*, -*22*, and -*24*). A subset of 20 populations (N = 10) is being assayed for genetic variation in three segments of the mitochondrial DNA mtDNA) genome (cytochrome b, ND1/2, and ND5/6) using 14 enzymes.

Fig. 1. Locations of Dolly Varden populations sampled for genetic analysis in Alaska.



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Preliminary results are presented for eight populations analyzed for both marker types: Kongakut River, Saviukviak River, Kivalina River, Kelly River, Cobblestone River, Sinuk River, Solomon River, and Kashaiak River (Fig. 1, closed circles). Microsatellite loci were highly polymorphic; average observed heterozygosity was 0.684 and the average number of alleles per locus was 20. Fourteen mtDNA haplotypes were observed. Haplotype diversity was 0.532 and nucleotide diversity was 0.002. In a multidimensional scaling of genetic distances calculated from microsatellite data, four population clusters were apparent: the North Slope (Kongakut and Saviukviak Rivers), Kotzebue Sound (Kivalina and Kelly Rivers), Norton Sound and Imuruk Basin (Cobblestone, Sinuk, and Snake rivers), and Bristol Bay (Kashaiak River) (Fig. 2), indicating that genetic relationships follow geographic proximity as well as life history variation. Dolly Varden in Norton Sound drainages south to the Alaska Peninsula are smaller than those found in Kotzebue Sound and Beaufort Sea drainages, and their movement patterns for feeding follow the movements of Pacific salmon (DeCicco and Reist 1999). Few differences in haplotype frequencies were detected among the northern form populations though large differences between southern and northern form populations were observed. MtDNA data collected in this study can be merged with mtDNA survey for Asian Dolly Varden (Oleynik et al. in press).

A simulation analysis was conducted in SPAM version 3.7 (Debevec et al. 2000) to test whether allele frequency differences among collections were large enough for MSA. Rare alleles were pooled and a Bayesian estimator of baseline allele frequencies was used to account for sampling error. Conditional maximum likelihood estimates of populations contributions were made for 1,000 artificial mixes (n = 400) from a single population so that mean contribution estimates should equal 100%. Mean contribution estimates approximated 90% for all populations (Fig. 3). Individual assignment tests were conducted using the direct classification method in Geneclass (Cornuet et al. 1999) because incidence of Dolly Varden in coastal waters is likely to be low. The percent of individuals classified to the correct region was approximately 80% for individuals from the North Slope, Kotzebue Sound, and Norton Sound and 70% for the Kashaiak River.

Significant global warming is predicted in this century; the greatest warming is expected at high latitudes. Warming may cause profound changes in Dolly Varden life history phases including changes in movement patterns in marine waters as ocean productivity and fish metabolism alter and location and stock composition in overwintering areas as stream discharge and freeze cycles alter. Genetic methods will provide stock-specific information to aid in assessing predicted changes in marine and freshwater habitat use.

Fig. 2. Multidimensional scaling analysis of genetic distances calculated from allele frequencies for seven microsatellite loci for eight populations of Dolly Varden in Alaska.

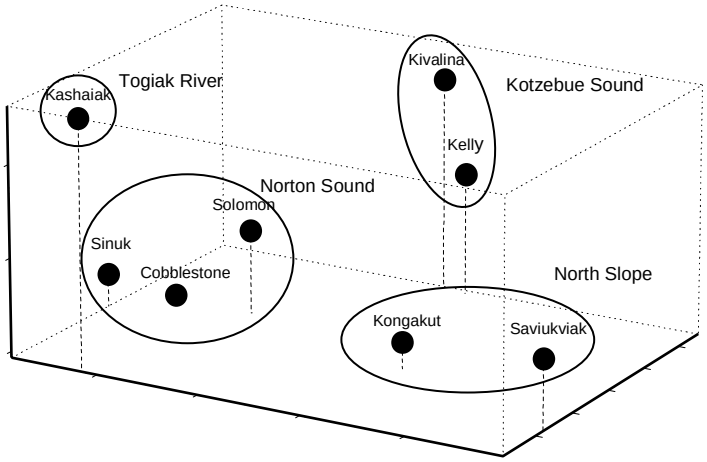
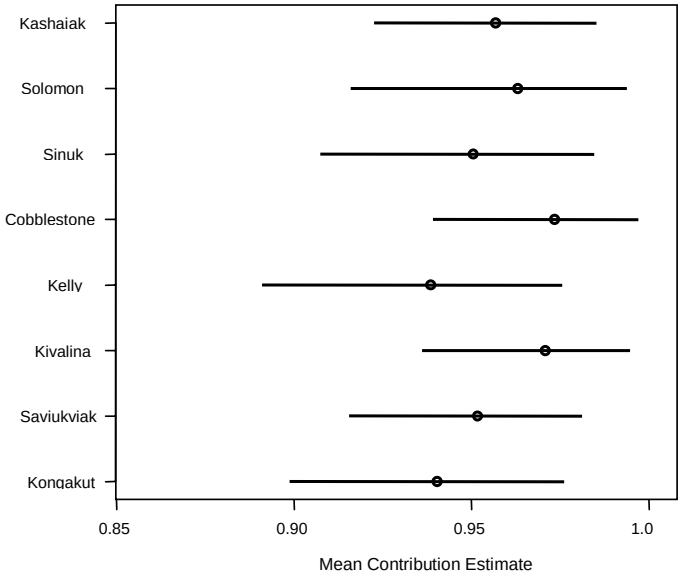


Fig. 3. Mean contribution estimates for 1000 artificial mixtures created from individual populations of Dolly Varden.



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