

## Preliminary Genetic Analysis of Juvenile Chum Salmon from the Chukchi Sea and Bering Strait

Christine Kondzela<sup>1</sup>, Michael Garvin<sup>2</sup>, Rachel Riley<sup>2</sup>, James Murphy<sup>1</sup>, Jamal Moss<sup>1</sup>,  
S. Adam Fuller<sup>2</sup>, and Anthony Gharrett<sup>2</sup>

<sup>1</sup>U.S. Department of Commerce, NOAA, NMFS,  
Alaska Fisheries Science Center, Ted Stevens Marine Research Institute,  
17109 Point Lena Loop Road, Juneau, Alaska 99801, USA

<sup>2</sup>University of Alaska Fairbanks, School of Fisheries and Ocean Sciences,  
17101 Point Lena Loop Road, Juneau, Alaska 99801, USA

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**Abstract:** The arctic region has experienced warming in recent years, resulting in decreased summer sea ice cover and increased sea surface temperatures. In September 2007, the U.S. BASIS survey extended surface trawling into the Chukchi Sea. Juvenile (young-of-the-year) chum salmon were collected at most stations. Genetic methods using microsatellite and SNP loci were applied to identify the origin of a subset of juvenile chum salmon collected in the Chukchi Sea and Bering Strait. Most of the juvenile chum salmon caught in the Bering Strait were from populations of the Anadyr-Kanchalan river system of northeastern Russia and the majority of fish collected in the Chukchi Sea site were from populations of northwestern Alaska.

**Keywords:** genetic stock identification, juvenile chum salmon, Bering Sea, Chukchi Sea

### INTRODUCTION

The sea surface temperature in the arctic marginal seas has increased since the mid-1960s. The extent of arctic summer sea ice cover has decreased dramatically in recent years (Steele et al. 2008). In 2007, the NOAA ship *Oscar Dyson* was used for the U.S. BASIS survey of the eastern Bering Sea, which extended northward for the first time into the Chukchi Sea. Along with juvenile Chinook (*Oncorhynchus tshawytscha*), pink (*O. gorbuscha*) and sockeye salmon (*O. nerka*) and various forage fish species, juvenile (young-of-the-year) chum salmon (*O. keta*) were caught in most of the trawl hauls in the surface waters of the Chukchi Sea (Moss et al. 2009). The objective of this study was to identify the populations or regional groupings of populations that contribute to the juvenile chum salmon collected in this northern region.

### MATERIALS AND METHODS

Genetic methods were applied to identify the origin of the juvenile chum salmon collected from two locations, the Bering Strait (three trawl hauls pooled; n = 185) on September 13, 2007, and the eastern Chukchi Sea (one trawl haul; n = 186) on September 7, 2007 (Fig. 1). A microsatellite baseline that is compatible with data assembled by Fisheries and

Oceans Canada (Beacham et al. 2008) is being developed and will be coupled with data from single-nucleotide-polymorphism (SNP) markers from nuclear and mitochondrial loci (M.R. Garvin, unpub. data; Garvin and Gharrett 2007). For our study, nine microsatellite loci (Oki100, Omy1011, One101, One102, One104, One114, Ots103, Ots68, and Ssa419) and 21 SNPs representing one mitochondrial and nine nuclear loci were used (M.R. Garvin, unpub. data). A preliminary 89-population genetic baseline currently incorporates sufficient genetic information of western Alaskan and Asian populations for stock identification analysis of chum salmon caught in the Bering and Chukchi seas. Eight regional groupings were used for this analysis. Baseline simulations for the eight regional groupings and estimates of stock proportions present in the juvenile chum salmon from Bering Strait and Chukchi Sea were made using the program SPAM 3.7b (Debevec et al. 2000).

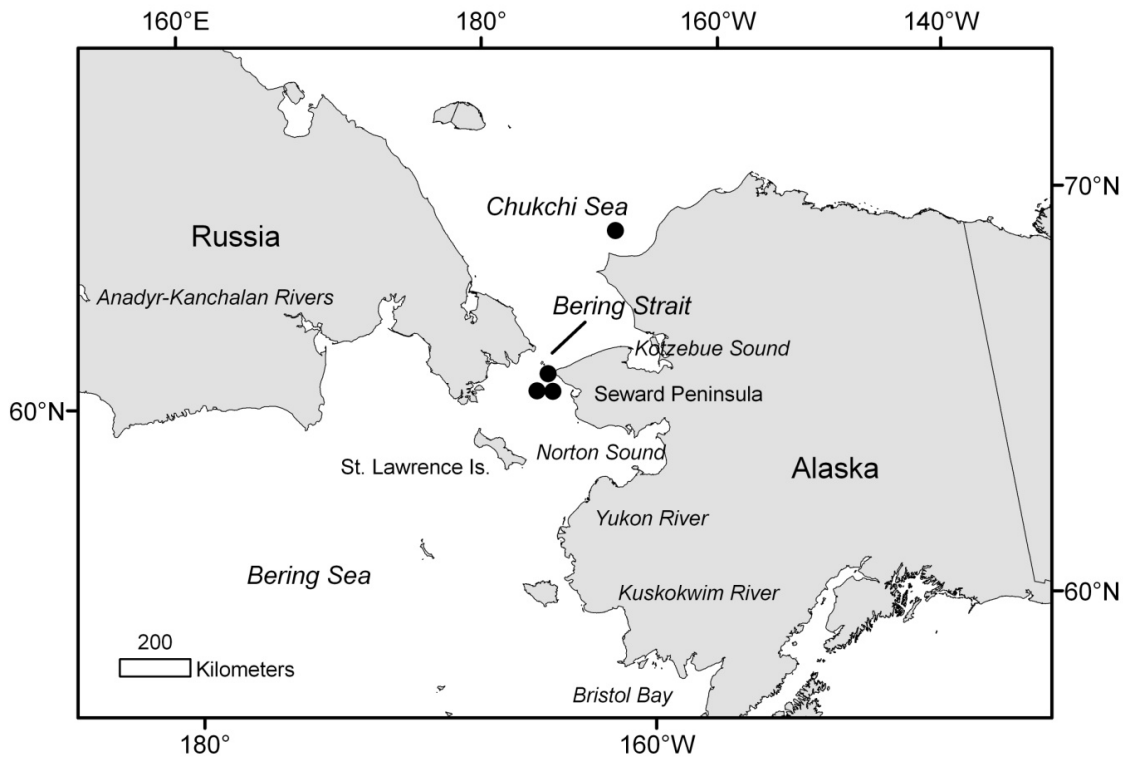
### RESULTS AND DISCUSSION

Regional estimates of origin of the juvenile chum salmon caught in the Bering Strait and Chukchi Sea indicate an eastward, then northward migration route used by northeastern Russian populations (Anadyr-Kanchalan rivers) and a westward, then northward route used by western Alaskan populations from coastal waters in late summer-early fall

(Table 1). Most of the juvenile chum salmon caught at the Bering Strait location were from the Anadyr-Kanchalan rivers of northeastern Russia with small contributions from the Kamchatka Peninsula and northwestern Alaska. Approximately two-thirds of the juvenile chum salmon caught in the Chukchi Sea location were from Kotzebue Sound, with lesser contributions from populations on the Seward Peninsula and in Norton Sound. It would be necessary to process additional samples to determine whether juvenile chum salmon from these northernmost populations also have a southward

migration component. A previous study suggests that the movement of juvenile chum salmon in this region may be more complex: juvenile chum salmon from northeastern Russia populations were caught in the fall of 2002 south of St. Lawrence Island (Farley et al. 2004), indicating a southeasterly component in their migration route, at least in some years. It is not known if northeastern Russian fish continue through the Bering Strait and into the Chukchi Sea.

The Chukchi Sea lies over the shallow continental shelf in the Arctic Ocean—and is unique among the arctic margin-



**Fig. 1.** Location (solid circles) of juvenile chum salmon samples genetically analyzed in this study from the Chukchi Sea and Bering Strait, collected during the 2007 fall U.S. BASIS survey using the NOAA ship *Oscar Dyson*.

**Table 1.** Estimates and standard errors of regional proportions assigned to juvenile chum salmon samples from the Bering Strait (n = 184) and Chukchi Sea (n = 183) using genetic methods based on nine microsatellite and 10 SNP loci. Number of populations in each grouping is given in parentheses after the region name.

Region <sup>1</sup>	Bering Strait		Chukchi Sea	
	Estimate	SE	Estimate	SE
Western Asia (19)	0	0	0	0
Kamchatka Peninsula (6)	0.0600	0.0044	0.0030	0.0002
Northeastern Russia (3)	0.7650	0.0563	0	0
Kotzebue Sound (4)	0	0	0.6915	0.0511
Seward Peninsula–Norton Sound (9)	0.0925	0.0068	0.2710	0.0200
Yukon River (11)	0.0443	0.0033	0.0304	0.0022
Kuskokwim (6)	0.0349	0.0026	0.0040	0.0003
Bristol Bay–Washington (31)	0.0033	0.0002	0	0

<sup>1</sup>Baseline simulations of these eight groupings indicated at least 80% correct assignment for simulation allocations set to 100%, except for the Kuskokwim grouping, which was 67%, with mis-allocation primarily to the Yukon and Seward-Norton regions.

al seas in that waters are transported from the North Pacific via the Bering Sea into the Chukchi Sea (Weingartner 1997). While movement of juvenile chum salmon from northeastern Russian and northwestern Alaska populations coincides with the northward flow of water from the Bering Sea shelf into the Bering Strait and Chukchi Sea, juvenile chum salmon from the Yukon River do not appear to follow this northward flow. For the locations sampled in this study there is little contribution from Yukon River populations. The winter habitat of juvenile chum salmon that utilize the northern Bering and Chukchi seas is unknown.

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