Origins and Biological Status of Chum Salmon Wintering in the Central Gulf of Alaska

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INTRODUCTION

Winter is believed to be a crucial period for marine salmon survival, but little biological data exists to support this hypothesis. In mid February 2006, a winter research cruise was conducted to examine the spatial distribution and biological status of chum salmon in the central Gulf of Alaska.

METHODS

Fish Samples

Fish were caught at 7 stations (48-54ºN, 145ºW; **Fig. 1**) by a surface trawl (net mouth: approximately 50 m x 50 m) at 5 knots for 1 hour on February 15-18, 2006. Pectoral fin and sagittal otoliths were collected from all chum salmon caught by trawl.

Genetic Stock Identification (GSI)

DNA was extracted from the fin samples. Variations at 14 microsatellite loci (*Ots3, Oke3, Oki2, Oki100, Omm1070, Omy 1011, One101, One102, One104, One111, One114, Ots103, Ssa419,* and *OtsG68*) were surveyed, and genotypes were determined for each locus in each sample. The statistical software program (SPAM version 3.7) was used to estimate stock composition of mixture samples. The baseline data set included 354 populations, covering major spawning stocks in North America and Asia. The reporting regions are: Fall Yukon, Western Alaska/Alaska Peninsula, Southeast Alaska (SEAK), Kodiak, Prince William Sound (PWS), Northern British Columbia (BC), Southern BC, Washington, Japan, Russia, and Korea. Simulation studies indicated that all reporting regions showed greater than 90% accurate when true group contributions were 100%.

Detection of Thermal Otolith Marks

The sagittal otoliths were observed under the microscope after being ground, and the microstructure patterns were compared to mark patterns deposited in the database of mark releases (http://npafc.taglab.org) to determine hatchery origins.

RESULTS

Distribution

- A total of 535 chum salmon was caught at 7 stations (48-54ºN, 145ºW), where the water temperature ranged from 4.5ºC to 6.5ºC (**Fig. 1**). The temperature of their winter habitat was apparently lower than that of the summer habitat.
- Ocean age 2 and 3 fish were dominant at all sampling stations, and young fish (ocean age 1) were distributed in the southern water (**Fig. 2**).

Origins and Abundance Estimated by GSI

- All young fish (ocean age 1) were North American origin (mostly PWS, southeast Alaska and southern BC), while the proportion of Asian (Japan and Russia) stocks increased with the ocean ages (**Fig. 3**).
- North American stocks were dominant in the northern water, and Asian stocks were dominant in the southern water (**Fig. 4**).
- Asian and Alaskan chum salmon were relatively abundant between 48ºN and 51ºN, while BC stocks were abundant in the northern water (50-53ºN) (**Fig. 5**).
- The estimated stock composition of chum salmon biomass in the survey area was 11.1% western Alaska/Peninsula, 10.9% PWS, 15.9% southeast Alaska, 5.6% northern BC, 16.7% southern BC, 1.7% Washington, 17.5% Russian, and 19.8% Japanese stocks.

Thermal Otolith Marks

- The samples included 46 otolith-marked chum salmon released from hatcheries in PWS (n=7), southeast Alaska (n=37), BC (n=1), and Japan (n=1).
- A comparison of CPUE estimated by genetic stock identification and otolith mark recoveries suggested that the contributions of hatchery fish to PWS and southeast Alaskan chum salmon in the Gulf of Alaska were variable (0-87%) among age groups (**Fig. 6**).

CONCLUSIONS

The present microsatellite and otolith mark analyses confirmed that various stocks of North American and Asian chum salmon inhabit the central Gulf of Alaska during winter. Their ocean distribution pattern is slightly different among regional stocks and among age groups, maybe reflecting stock- or age-preferable water temperatures, which are lower than in summer season. Our trophic analysis (not present in this poster) suggests that young fish are extremely undernourished during winter. Further surveys are required to evaluate their winter mortalities in the Gulf of Alaska.

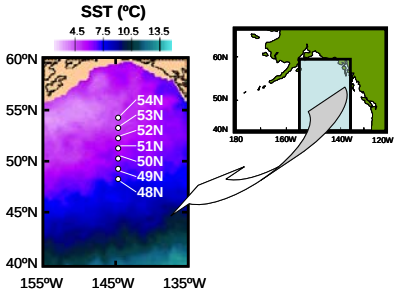


Fig. 1. Maps showing sampling locations in the central Gulf of Alaska with a satellite image of sea surface temperature (SST) on February 15-18, 2006 (http://www7320.nrlssc.navy.mil/global_nlom/globalnlom/westc.html). SST in the survey area ranged from 4.5ºC (54ºN) to 6.5ºC (48Nº).

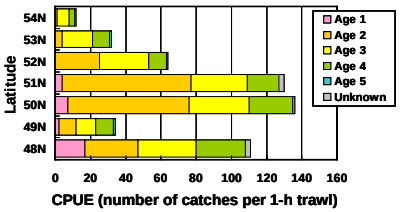


Fig. 2. CPUE (number of catches per 1-h trawl) of chum salmon by ocean age. Ocean age 2 and 3 fish were dominant, and young fish (ocean age 1) were distributed in the southern water.

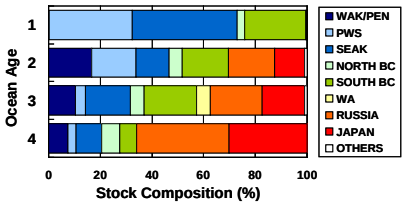


Fig. 3. Stock compositions of chum salmon by ocean age. Microsatellite mixture estimates indicated that young fish (ocean age 1) were 100% North American origin, while the portion of Asian stocks was high in older fish.

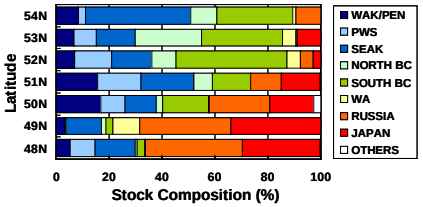


Fig. 4. Stock compositions of chum salmon caught at each sampling station. There was a latitudinal shift in the composition of Asian and North American stocks estimated by microsatellite analysis.

Winter chum salmon caught in the Gulf of Alaska

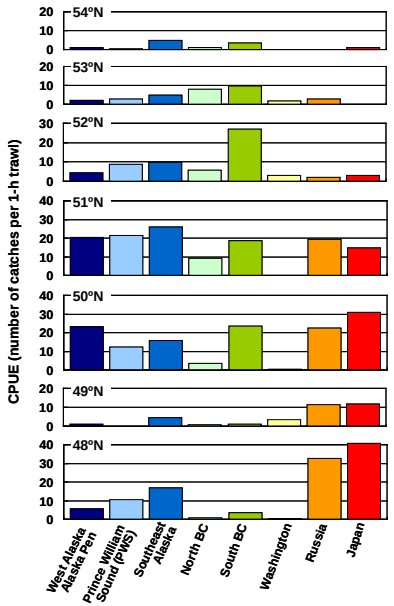
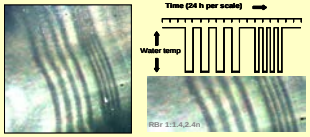
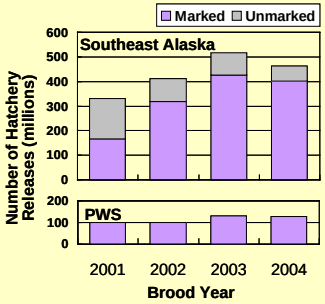


Fig. 5. Stock-specific CPUE of chum salmon at each sampling station, estimated by microsatellite analysis. Asian chum salmon were abundant in the southern water.

Thermal Otolith Marking …

Exposing a fish to different temperature regimes causes distinct rings to appear in the otolith microstructure. By manipulating temperature profiles during early incubation at hatchery, unique mark patterns can be created to identify the hatchery of origin. About 1.6 billion otolith-marked salmon are annually released from hatcheries in the North Pacific rim countries. Visit the website (http://npafc.taglab.org) for details.





Number of otolith-marked and unmarked chum salmon fry released from hatcheries in southeast Alaska and Prince William Sound (PWS).

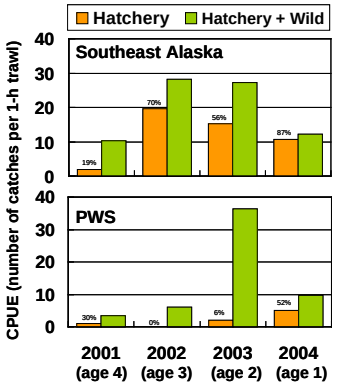


Fig. 6. Estimated contributions of hatchery fish to southeast Alaska and Prince William Sound (PWS) chum salmon in the Gulf of Alaska were variable (0-87%) among age groups. CPUE of hatchery fish was determined by otolith mark recoveries, and that of hatchery + wild fish was by microsatellite analysis.