Oral-1

Applications of the Pacific Ocean Shelf Tracking System (POST): A Permanent Continental-Scale Acoustic Tracking Array for Fisheries Research and Ocean Observation

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The Census of Marine Life is helping to develop POST, a permanent continental-scale tracking array for the west coast of North America. 2004–05 was a two year field demonstration, and used six 20 km long listening lines and several thousand acoustically tagged juvenile salmon (12–15 cm long) to test the concept. Detection rates for individual fish crossing 20 km long acoustic lines was approximately 95% in both years, meaning that only one fish in 20 was not detected as they crossed each listening line. As a consequence, very precise measurements of salmon biology (including survival) are now feasible.

The results demonstrate striking differences in marine migration pathways and survival even between different populations of the same fish species, as well as between species—and that these differences are measurable. Even during the shelf migration there is evidence for stock specific migration pathways, with clear differences evident between two stocks of endangered sockeye salmon from southern British Columbia. Freshwater and early marine survival of most stocks studied was generally high, and indicates that substantial mortality must occur beyond the geographic range and period of time that the current POST array measures. Although survival rates generally seem to be stable between years, we observed a six-fold drop in the freshwater survival of Cultus Lake sockeye in 2005. Other stocks of salmon that also migrate out of the Fraser R showed no decline in 2005, and subsequent survival in the ocean of Cultus Lake sockeye was similar to that measured in 2004. Although the reason for the poor survival in 2005 is unclear, the key point is that it is now possible to measure these changes and isolate the parts of the life history affecting salmon conservation.

The development of POST promises a radical change in how scientific research can be conducted on salmon in freshwater or continental shelf waters. For example, it is now possible to contemplate direct experiments in the ocean of how different groups of marine fish respond (movement rates, survival) after “treatment” (e.g. sea lice burden or El Nino) or to measure seasonal movements of individual stocks of fish—of all species, not just salmon. This will change marine salmon research from a discipline based on a very limited observational capacity to one based on direct experiment.

Oral-2

Results of Pioneering Studies of Pacific Salmon Early Marine Life on the Sakhalin Island Shelf

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The early marine life of Pacific salmon is considered as critical period for their numbers formation but it was not investigated for a long time. In 2002, SakhNIRO began juvenile salmon biology and distribution studies in the Sakhalin- Kurile region with pelagic trawl 54.4/192 m. In 2005, survey was conducted into three stages in the Aniva Bay. During first stage (July 6–10), pink salmon catches varied from 5 to 2867, average 278 fish per half-hour haul. In total, 3617 juveniles were caught, mostly in the western Aniva Bay above 34–36 m depths. Chum salmon occurred at five stations in the eastern Aniva Bay (7 fish) and the La Perouse Strait (133 fish), above 30 m depth and deeper, from one to 133 fish per haul. During second stage (July 20–25), seven pink salmon juveniles were caught in the eastern Aniva Bay and 151 juveniles in the La Perouse Strait above 51–100 m depths, and single chum salmon specimen. During third stage (11–18 August), juvenile salmon did not meet.

During first stage, total numbers of pink salmon juveniles was estimated at 51.6 millions fish, the distribution density - 16 353 fish/km^2. During downstream migrations, total pink salmon brood numbers were estimated at 219.3 millions from the Aniva Bay rivers in 2005. According to calculations, pink salmon mortality totaled at 76.5% of abundance during 1.5 months in the sea. Estimation appears the overstated because of underestimation of juvenile pink salmon abundance in the Aniva Bay. Pink salmon body length differed little between stations of first survey stage and averaged 7.3 cm, weight – 2.94 g. Chum salmon length and weight varied in 5.8–13.1 cm and 1.54–18.91 g, average 7.9 cm and 4.07 g. During second stage, the body length varied in 7.6–9.7 cm, weight – 3.3–7.03 g, on the average – 8.8 cm and 4.9 g in the Aniva Bay. Year-to-year comparisons reveal size indices stability. Size range supports assumption that investigated pink salmon juveniles originate from local rivers.

In the Aniva Bay, juvenile pink salmon dwell namely coastal zone until 30 m depth and do not leave its limits in abundance from the late April to early July, from 2.5 to 0.8 months depending on the time of marine environment entering. Mass migration occurred not gradually, in correspondence to juveniles' growth, but simultaneously during several days. It was possibly related with SST increase up to 14–15°C, upper limit of pink salmon optimum at sea.

Oral-3

Distribution and Growth of Juvenile Chum Salmon in the Abashiri Bay, Eastern Hokkaido, in Relation to Sea Surface Temperature

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We have conducted a research project to determine the optimal timing to stock hatchery-reared juvenile chum salmon (*Oncorhynchus keta*) along the Abashiri coast of the Okhotsk Sea since 2002. Some of 32 million juveniles annually stocked in the Abashiri River were otolith-marked with alizarine complexone (ALC) before hatching and were stocked in April or May 2002–2005. Several marked groups were stocked at different timings to examine the effects of stocking timing on distribution and growth of juveniles after ocean entry. Subsequently, marked juveniles were captured by a surface trawl net in a coastal area (within 7 km from the shore) from May to July 2002–2005 and by a beach seine in a littoral area (within ~100 m from the shore) from May to June 2003–2005. While relatively high juvenile abundances were observed in coastal area from late May to mid-June in 2002 and 2004 when sea surface temperature (SST) ranged from 8 to 13°C, this temperature occurred only in June in 2003 and 2005 in the coastal area. When SST was below 8°C, marked juvenile chum salmon stocked earlier (late April) were not distributed in the coastal area, and they dispersed themselves widely in the coastal area along with the other marked group stocked later (mid-May) when SST exceeded 8°C in June. When SST was less than 8 °C in the coastal area, juvenile chum salmon were abundant in the littoral area where SST was relatively higher. These differences indicated that spatial distribution of juvenile chum salmon immediately after ocean entry was strongly affected by seawater temperature. Number of juvenile chum salmon in the coastal area began to decrease when SST exceeded 13°C. The timing and duration of SST within the range from 8°C to 13°C fluctuated year by year in the Abashiri Bay, and it may affect the growth and survival of juvenile chum salmon stocked from hatcheries.

Oral-4

A Summary of Juvenile Salmon Research along the Eastern Bering Sea Shelf by the Ocean Carrying Capacity Program, August–October (2000–2005)

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The goal of the Ocean Carrying Capacity program's juvenile salmon research along the eastern Bering Sea shelf is to understand mechanisms underlying the effects of environment on the distribution, migration, and growth of juvenile salmon in the eastern Bering Sea. Primary objectives of this work are: 1) determine the extent of offshore migrations of juvenile salmon from rivers draining into the eastern Bering Sea, 2) describe the physical environment of the eastern and northeastern Bering Sea shelf waters occupied by juvenile salmon, and 3) collect biological information on other ecologically important species. We will summarize the results of these surveys (August–October 2000–2005) with emphasis on annual variability in juvenile salmon biological characteristics (i.e. distribution, migration, size, diet). We will also describe the annual variability in oceanographic conditions (habitat) along the eastern Bering Sea shelf and identify habitat associations of juvenile salmon using our survey data.

Oral-5

Seasonal Distribution and Migration of Juvenile Chum Salmon in the Western Bering Sea and the Okhotsk Sea

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Data from complex epipelagic research surveys by TINRO-Centre in the southern Okhotsk Sea and western Bering Sea during autumn of 1991–2005 is utilized to analyze quantitative distribution, abundance and migrations of the juvenile chum salmon. The biological characteristics of the juvenile chum salmon in the Okhotsk and Bering Sea, as well as seasonal and interannual dynamics of growth are considered. The oceanological conditions are reviewed along with the analysis of their influence upon redistribution and marine environment adaptations of juvenile chum salmon. Juvenile chum salmon's seasonal migration pathways and factors influencing them are determined. The complex analysis of the hydrobiological factors (i.e. presence and abundance of accessible prey items, quantitative estimates of juvenile chum salmon's potential competitors and predators' abundance) influence upon juvenile chum salmon are provided.

Oral-6

Distribution of Chum Salmon during the First Winter of Ocean Life in the Western North Pacific

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Some researchers considered that the critical period determining year class strength of Pacific salmon may be either/both at the early ocean life or/and at the first winter of ocean life. The early ocean mortality of chum salmon in coastal waters was very high. On the other hand, the mortality during the first winter might also be high because chum salmon was starving in winter. In the western North Pacific, Asian chum salmon distribute during the first winter of ocean life. We are planning a winter research cruise of R/V *Kaiyo maru* from January 25 to March 6, 2006, which is targeting on 1) to estimate spatial distribution and biomass of salmon by species, stocks or developmental stages, 2) to clarify the ocean environments of their winter habitats, 3) to evaluate the winter mortality, trophic condition, and growth rate, and 4) to compare physical and biological environments for salmon during winter and summer seasons. We summarize research results of *Kaiyo maru* winter cruises in the western North Pacific.

Oral-7

Origins of Juvenile Chum Salmon Inhabited in the North Pacific Ocean during the Winter: Rapid Estimates by SNP Markers

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Currently the stock-specific distribution of chum salmon in the North Pacific Ocean during the winter is uncertain. Our objective was to examine the population origins of juvenile chum salmon caught on the 2006 winter cruise of the research vessel *Kaiyo maru* in the North Pacific Ocean. We first created a baseline by sampling about 95 individuals each from 86 populations from throughout the range of chum salmon in Asia and North America. These populations represent all of the major lineages detected in the larger allozyme baseline used in previous NPAFC studies. Individuals were assayed for 30 nuclear single nucleotide polymorphisms (SNPs) and six mitochondrial SNPs using the 5' nuclease reaction previously reported by the U.S. and Japanese parties. The Kaiyo maru is at sea at this time; upon return, juvenile chum salmon will be rapidly analyzed and assigned to population of origin using conditional maximum likelihood and Baysian methods.

Oral-8

Time and Spatial Distributions by Age Classes of Chum Salmon in the Central North Pacific and the Bering Sea.

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Chum salmon is widely distributed in the North Pacific and the Bering Sea from spring to autumn. It was known that the distribution for maturing chum salmon was father north than that of immature chum salmon in spring, because of their return migration to the spawning area. However, why immature and maturing chum salmon did not migrate in the North Pacific and the Bering Sea together? We examined the time and spatial distribution of chum salmon by each age class in the central North Pacific and the Bering Sea using the data on chum salmon collected from Japanese salmon research vessels. Age 0.1 class of chum salmon was distributed around 45N of the North Pacific in June, and they was distributed at 55 N to 60 N of the Bering Sea in August. On the other hand, age 0.3 class was distributed in the Bering Sea in June. The speed of northward migration by year class seems to correspond to the swimming speed based on the fork length. Chum salmon of older year class experienced relatively lower water temperature, so that this is advantageous for maturation. Because the advantage in the cold water is that the energy output is low due to low metabolism.