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Abstracts of Scientific Documents Submitted to the Commission for the 2009 Annual Meeting

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Abstracts of Scientific Documents Submitted to the Commission for the 2009 Annual Meeting

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This document compiled abstracts of scientific research documents submitted to the Commission from the adjournment of the 2008 Annual Meeting to October 2009. A total of 40 documents (3 from Canada, 13 from Japan, 5 from Korea, 8 from Russia, 7 from the United States, and 4 from the Committee on Scientific Research and Statistics) was presented for the consideration of scientific research and statistics. Each abstract contained document number, title, and name of author(s) or agency (if available).

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Canada

1165 Proposed thermal marks for salmon from British Columbia for brood year 2009

J. Till

In British Columbia thermal marking continues to play an important role for both research and for fisheries management. For the 2009 brood year we expect to thermally mark approximately 63 million salmon. This will include 36 different thermal marks applied at 12 hatcheries and released from 45 locations. The plan is similar to that proposed in 2007 and to that carried out in 2008. British Columbia's main production releases remain unchanged while a few smaller programs have seen some changes to their marking.

1166 Canadian highseas salmon surveys in 2009-2010

M. Trudel, J.F.T. Morris, M.E. Thiess, T.B. Zubkowski, and Y. Jung

The Canadian Program on High Seas Salmon has been conducting integrated epipelagic ecosystem surveys from the west coast of British Columbia to Southeast Alaska since 1998 to assess the effects of ocean conditions and climate change on the distribution, migration, growth and survival of Pacific salmon, and to forecast salmon returns to British Columbia. Three surveys have been planned by the Canadian Program on High Seas Salmon for 2009-2010: a summer survey on June 18 - July 6, 2009, a fall survey on October 8 - November 17, 2009, and a winter survey on February 2 - March 2, 2010. The primary objectives of these surveys will be to (1) collect biological information on Pacific salmon (*Oncorhynchus* spp.) and associated epipelagic fish community using a rope trawl towed at the surface, (2) describe the ambient oceanographic conditions using CTD profiles and water samples collected with niskin bottles, and (3) quantify the biomass of zooplankton and describe zooplankton species community composition in coastal waters of British Columbia and Southeast Alaska using a bongo net.

1182 Canadian enhanced salmonid production during 1978-2008 (1977-2007 brood years)

R. Cook, J. MacDonald, and J. R. Irvine

The Salmonid Enhancement Program (SEP) in British Columbia, Canada was initiated in 1977 to rebuild stocks and increase catch through the expanded use of enhancement technology. The program comprises over 400 projects that produce Chinook, coho, chum, pink, and sockeye salmon, as well as small numbers of steelhead salmon and cutthroat trout. Projects include hatcheries, fishways, spawning and rearing channels, habitat improvements, flow control works, lake fertilization, and small classroom incubators, and range in size from spawning channels releasing nearly 100 million juveniles annually, to schools with classroom incubators that release fewer than one thousand. Data from facilities that operate outside the direction of SEP are not included in this report. Steelhead and cutthroat are a provincial government responsibility, but some enhancement takes place at SEP facilities under a cooperative arrangement. Steelhead and cutthroat numbers in this report do not include releases from facilities operated by the Freshwater Fisheries Society of British Columbia.

Japan

1157 Incidental catches of anadromous fish by Japanese research vessel in the North Pacific Ocean in 2008

T. Nagasawa

Some Japanese research vessels conducted the scientific fisheries operation with possibilities of the incidental catch of anadromous fish in 2008. The R/V *Tomi maru* No.58, which conducted the experimental towing of the surface and mid-water trawl gear to develop the commercial fishery on pacific saury (*Cololabis saira*) during a period from early June to late September in 2008, had caught a total of 7,564 pacific salmons incidentally. Total of 32 salmonids including 9 chum salmon, 12 pink salmon, 11 coho salmon, and 1 Chinook salmon were caught by gill net survey for Pacific saury in July 2008 (R/V *Hokushin maru*). Total of 197 salmonids including 81 chum, 114 pink, and 2 chinook salmon were caught by surface trawl net operations or Pacific sury (Cololabis saira) survey in June 2008 (R/V *Oumi maru*). Total of 105 salmonids including 51 pink salmon, 39 chum salmon, 9 coho salmon, 4 Chinook salmon, and 1 steal head trout were caught by surface trawl net operations for Pacific saury survey in June and July 2007 (R/V *Hokuho maru*). Total of 6 salmonids including 4 chum salmon, 1 Chinook salmon, and 1 steal head trout were caught by surface trawl net operations for Pacific saury survey in November 2008 (R/V *Kaiyo maru*). Total of 10 salmonids including 31 pink and 1 chum salmon were caught by dip-net operations for Pacific saury survey in June and July 2008 (R/V *Kouryou maru No 63*). Total of 9 salmonids including 8 pink and 1 chum salmon were caught by dip-net operations for Pacific saury survey in June and July 2008 (R/V *Eiku maru No 63*).

1158 2008 T/V *Oshoro maru* salmon research cruises

K. Sakaoka, Y. Kamei, S. Takagi, Y. Kajiwara, J. Kimura, and T. Meguro

In order to clarify the oceanic structure and marine ecosystem, oceanographic observations and fishing surveys (including for salmonids) were conducted in the Northwest Pacific Ocean (along 155°E), in the central North Pacific Ocean (along 170.3°E), around the Aleutian Islands, in the Bering Sea and in the Chukuchi Sea. Each survey was conducted during the Cruise #189 in May and the Cruise #190 from June to July, 2008. Sea surface temperature along 155°E in May, 2008 was about 1.0°C warmer than 2007. The Polar Front was located between 44°N and 43°N and the Subarctic Boundary was located between 40°N and 39°N which were similar to the location in previous years. Four drift gillnet surveys were conducted along 155°E in May during the Cruise #189. A total 268 chum and 641 pink salmon were caught by gillnet. Catch ratio of salmonids was decreasing to the south. CPUE value of chum salmon was the lowest at 42.5°N on the other hand, that of pink salmon was the highest at 42.5°N. One drift gillnet, one surface long-line and two hook-and-line gear samplings were conducted along the 170.3°E, four surface long-lines and 13 hook-and-line gear samplings were conducted around the Aleutian Islands in during the Cruise #190 -Leg 1. A total of 65 sockeye, 33 chum, 32 pink and nine coho salmon were collected by every sampling gear. Four surface long-line, five hook-and-line gear samplings and eight otter trawl surveys were conducted in the Bering Sea. A total of five sockeye, four chum and nine pink salmon were collected by surface long-line and hook-and-line gear surveys in the Bering Sea during the Cruise #190-Leg 2. All salmon were collected in the southeast Bering Sea area. No salmonids were collected by any and every sampling gear in the Chukuchi Sea during the Cruise #190-Leg 3.

1159 Proposed cruise plans of Japanese research vessels for salmon in the North Pacific Ocean in 2009

M. Fukuwaka, K. Morita, and T. Nagasawa

Four Japanese salmon research vessels have been tentatively scheduled to conduct the following scientific research in the North Pacific and the Bering Sea in 2009. In case of gillnet operation, gillnets less than 2.5 km in length at sea will be used.

(1) The *Hokko maru* will conduct research with a surface/midwater trawl and hook-and-line to obtain information on the distribution, abundance and some biological characteristic of summering salmon in the Bering Sea and Chukchi Sea from early July to mid August.
(2) The *Oshoro maru* will conduct research with gillnets, longline, hook-and-line and surface/bottom trawl to obtain data on the distribution and ecology of salmon and other pelagic fishes in the western North Pacific in May, and in the central North Pacific and Bering Sea from early July to late August.
(3) The *Wakatake maru* will conduct research with gillnets and longlines to obtain data on the distribution and abundance of salmon along 180° longitude in the central North Pacific and Bering Sea from early June to late July.
(4) The *Kaiun maru* will conduct research with gillnets to obtain data on the distribution and ecology of neon flying squid, salmon and other pelagic fishes in the western and central North Pacific Ocean from early July to early August.

1160 The Cruise plans of Japanese research vessels involving incidental takes of anadromous fish in the North Pacific Ocean in 2009/2010 Fiscal Year

Fisheries Agency of Japan

Five Japanese research vessels are scheduled to conduct the following scientific research for pelagic fishes in the North Pacific in 2009/2010 fiscal year. There are some possibilities of incidental catch of salmon during these cruises. In case of gillnet operation, lengths of gillnets will be less than 2.5 km at sea.

1163 Proposed otolith marks for brood year 2009 salmon in Japan

M. Takahashi, and E. Suzuki

In Japan, otolith marks are used for migration, growth and survival surveys of juvenile salmon in the coastal waters, and for offshore migration surveys in the Okhotsk Sea, North Pacific Ocean, and Bering Sea. In addition, hatchery origins of maturing adults are determined using thermal marks to evaluate their homing migrations. The proposed otolith marks for the 2009 brood year salmon include 53 discrete thermal patterns and two ALC (alizarin complexone) patterns. We plan to mark approximately 155 million chum, 22.6 million pink, 3.2 million masu, and 30 thousand sockeye salmon at 18 hatcheries. The thermal marking pattern is presented as the Hatch code notation (Hagen et al. 2000; Josephson et al. 2006). As the base mark, two rings in the first band have been adopted to distinguish Japanese chum and pink salmon from other stocks since 1999 brood year stock . All thermal rings are induced by cooler temperature exposures. The ALC marks will be used for chum salmon surveys by Hokkaido Fish Hatchery.

1183 Japan salmon commercial catch statistics for 2008

Fisheries Agency of Japan

The Fisheries Agency of Japan reported preliminary total commercial catches of Pacific salmon in 2008 by weight. The total catches in coastal, and offshore areas of Japan in 2008 was 172.1 thousand tons. Species

specific statistics data may be available by the end of March 2010.

1184 Preliminary 2008 salmon enhancement production in Japan

Takahashi, M., and K. Sasaki

Four species of Pacific salmon (chum, pink, masu and sockeye salmon) are currently enhanced in Japan. A total of 2,046 million juveniles and smolts were released from Japanese hatcheries in 2008. Approximately 1,890 million chum salmon fry were released in the spring of 2008, the almost same level as in the previous year. Japanese hatcheries also released 142 million pink salmon fry, 13,721 thousand juveniles and smolts of masu salmon, and 371 thousand juveniles and smolts of sockeye salmon.

In 2008, a total of 4919 thousand adult salmon were captured in rivers along the Japanese coasts. Chum and pink salmon accounted for 80.8 % and 18.6 % of the total river catches, respectively. Within Hokkaido, the number of adult returns was 24,619 fishes for anadromous masu salmon, and 562 fishes for anadromous sockeye salmon.

1191 The summer 2009 Japanese salmon research cruise of the R/V *Hokko maru*: exploration of the northern limit of offshore distribution and annual survey in the Bering Sea

K. Morita, S. Sato, M. Kato, and J. Yamamoto

A summer high-seas research cruise to investigate the biology of Pacific salmon was conducted from July 9 to 25 in the northern Bering Sea and Chukuchi Sea (first leg) and from July 28 to August 14 in the southern Bering Sea (second leg), aboard the Japanese research vessel *Hokko maru*. Research cruise activities included the collection of data on oceanography, zooplankton, micronekton, salmonid fishes, and other organisms. A total of 4,932 salmonids were caught by trawls and angling: 1,289 fishes during the first leg and 3,643 fishes during the second leg. Chum salmon was the most abundant species (83.6%), followed by sockeye salmon (12.2%), chinook salmon (2.4%), pink salmon (1.7%), and coho salmon (0.1%). Four big chum salmon were caught in the offshore waters of the Chukuchi Sea in the Arctic Ocean (69°N, 168°W). Salmonids were measured with respect to fork length and body and gonad weights, they were sexed, and the scales were removed for age determination. Isotope, genetic, otolith, stomach content, and lipid samples were obtained for future study.

1192 Offshore distributions of anadromous lamprey and threespine stickleback

K. Morita, S. H. Morita, H., and M. Fukuwaka

Pacific lamprey (*Entosphenus tridentatus*), Arctic lamprey (*Lampetra japonica*) and threespine stickleback (*Gasterosteus aculeatus*) are anadromous fishes inhabiting the North Pacific Ocean. The analysis of by-catch data of Japanese offshore salmon monitoring suggested that both lamprey and threespine stickleback were distributed across a wide range in the offshore waters of Pacific Ocean.

1193 Salmon stock assessment in the North Pacific Ocean, 2009

M. Fukuwaka, T. Kaga, M. Sakai, and Y. Kamei

Results of annual research cruises on salmon stock assessment conducted by Japan in the summer of 2009 were summarized. Three Japanese salmon research vessels (*Oshoro maru*, *Kaiun maru* and *Wakatake maru*) conducted oceanographic observations, 45 gillnet (2,220 tans), 28 longline (800 hachi) and 26 hook-and-line fishing operations in the North Pacific and the Bering Sea from May to early August. Mean sea surface

temperature and abundance of salmonids in 2009 were compared to those from 1992 to 2008. Mean sea surface temperature at gillnet research stations in 2009 were lower than the mean of 1992-2008 in the central North Pacific and Bering Sea. A total of 18,833 salmonids was caught during fishing operations including 15,782 pink (83.8%), 2,019 chum (10.7%), 602 sockeye (3.2%), 308 coho (1.6%), 86 chinook salmon (0.5%), and 36 steelhead trout (0.2%). Mean CPUEs of sockeye and chum salmon in the summer of 2009 were the lowest among recent years, while mean CPUE of pink salmon was the highest in the Bering Sea. Mean CPUEs of other salmonids including coho, chinook salmon and steelhead trout were at a low level in 2009.

1194 International salmon research aboard the R/V *Wakatake maru* in the central North Pacific Ocean and Bering Sea during the summer of 2009

T. Kaga, and N.D. Davis

An annual high-seas salmonid research cruise was conducted in the central North Pacific Ocean and Bering Sea from June 4 to July 17, 2009 onboard the Japanese research vessel, *Wakatake maru*, to investigate salmon stock condition. Research cruise activities included collection of data on oceanography, primary production, zooplankton, salmonids, and other organisms. Average sea surface temperature in the central North Pacific Ocean in 2009 was 9.3°C, which was slightly warmer by 0.1°C than the average temperature in 2008. The Subarctic Boundary was located between 42°N and 43°N, which was further north of its position in 17 of the previous 18 years. In the central Bering Sea, sea surface temperature in 2009 was 6.4°C, which was 0.2°C cooler than in 2008. At 27 experimental fishing stations, a total of 13,968 salmonids was caught by longline and gillnet: 620 fish in the central North Pacific and 13,348 fish in the central Bering Sea. In the central North Pacific, chum salmon was the most abundant species (48.5% of the salmonid catch), followed by coho (40.8%), pink (5.0%), steelhead (4.2%), sockeye (1.0%), and Chinook salmon (0.5%). In the Bering Sea, pink salmon was the most abundant species (88.2% of the salmonid catch), followed by chum (8.2%), sockeye (3.1%), Chinook (0.6%), and coho salmon(0.02%). A total of 1,499 salmonids was disk tagged during the survey, which included three sockeye, 80 chum, 17 pink, 51 coho, and two Chinook salmon, and 11 steelhead released in the central North Pacific. Seventy-eight sockeye, 207 chum, 1,046 pink, and four Chinook salmon were released in the Bering Sea. A total of 64 passive integrated transponder (PIT) tags were placed on disk-tagged fish in the central North Pacific Ocean including 51 coho and two Chinook salmon, and 11 steelhead. A total of six Chinook salmon were released with water temperature and depth recording data storage tags. Snouts from ten adipose fin-clipped steelhead were collected for later potential recovery of coded-wire tags. Other salmonid research activities included sampling for total lipid content, RNA/DNA analysis, food habits analysis, and collection of steelhead and Chinook salmon genetics samples.

1195 Proposed cruise plans of Japanese research vessels for salmon in the North Pacific Ocean in 2010

M. Fukuwaka, and K. Morita

Four Japanese salmon research vessels have been tentatively scheduled to conduct the following scientific research in the North Pacific, Bering Sea, and Chukchi Sea in 2010. In case of gillnet operation, gillnets less than 2.5 km in length at sea will be used.

(1) The *Hokko maru* will conduct research with a surface/midwater trawl and hook-and-line to obtain information on the distribution, abundance and some biological characteristic of summering salmon in the Bering Sea, Chukchi Sea, eastern and western North Pacific from mid July to late August.

(2) The *Oshoro maru* will conduct research with gillnets, longline, hook-and-line and surface/bottom trawl to obtain data on the distribution and ecology of salmon and other pelagic fishes in the western North Pacific in May, and in the North Pacific and Bering Sea from June to July.
(3) The *Wakatake maru* will conduct research with gillnets and longlines to obtain data on the distribution and abundance of salmon along 180° longitude in the central North Pacific and Bering Sea from early June to late July.
(4) The *Kaiun maru* will conduct research with gillnets to obtain data on the distribution and ecology of neon flying squid, salmon and other pelagic fishes in the western and central North Pacific Ocean from July to August.

1205 Releases of otolith marked salmon from Japan in the fall of 2008 and spring of 2009

M. Takahashi, M. Iida, K. Kusumo, H. Ikka, Y. Katayama, K. Ohmoto, M. Fukuhara, T. Chiba and Y. Miyauchi

This document provided information of Japanese otolith mark releases, including release site, date, number, and mark patterns with images. In the spring of 2009, approximately 172.9 million chum, 25.0 million pink, 2.2 million masu, and 77 thousand sockeye salmon fry (2008 brood year) with thermal marks or ALC (alizarin complexone) patterns were released from 20 hatcheries in Japan. In addition, 477 thousand masu salmon smolts and 62 thousand sockeye salmon smolts (2007 brood year) were released in the spring of 2009 after thermally marked. In the fall of 2008, 641 thousand juveniles of otolith-marked masu salmon (2007 brood year) were also released. Two thermal rings as base mark were adopted to distinguish Japanese salmon from other stocks. ALC marks were used for chum salmon surveys by the Hokkaido Fish Hatchery. These data are uploaded to the database on the website of NPAFC Working Group on Salmon Marking (http://npafc.taglab.org).

Republic of Korea

1175 Korean chum salmon catch statistics and hatchery releases in 2008

K.B. Seong, J.H. Park, K.E. Hong, and C.H. Lee

The total catch of chum salmon in Korea was 82,553 fish or 217.0 metric tons in 2008. The total fries of chum salmon released was 5,785 thousand fish in 2009 (2008 brood year). Eighteen thousand cherry salmon smolts were released to Namdae-cheon (stream) in April.

1176 Recoveries of coded wire tag for chum salmon in Korea in 2008

K.B. Seong

Korea has released CWT tagged juvenile chum salmon since 2003, and 67 CWT chum salmon were recovered at Namdae-cheon and harbor of coastal area (set net) during the spawning seasons in 2008. Among 67 chum salmon, 39 salmon were female and 28 were male. Most salmon sampled were age 3 (40.3 %) and age 4 (44.8%), which were released in 2006 and 2005, respectively.

1177 Otolith thermal mark for brood year 2008 and proposed thermal marks for brood year 2009 chum salmon in Korea

K.B. Seong, J.H. Park, K.E. Hong and S. Kang

Korea released 5.0 million and 1.2 million thermal marked chum salmon in March 2008 and 2009, respectively. The marks were 3,2,1H for 2008 and 3,3nH for 2009. Korea will mark approximately 3.0 million chum salmon in brood year 2009, which cover about 50% of release of chum salmon at Namdae-cheon (river). Chum salmon will be marked at Cold -water Fish Research Center using only 1 thermal mark (3,1,2H).

1178 Korean research plan for salmon in 2009

K.B. Seong, J.H. Park, K.E. Hong, and C.H. Lee

Salmon are political resources due to the characteristics of transboundary distribution and economic importance. The interest in chum salmon biology in Korea was much increased since the establishment of the Cold-water Fish Research Center (formerly Yangyang Inland Hatchery) of National Fisheries Research and Development Institute during mid 1980s. The enhancement program of chum salmon has been expanded thereafter, so that chum salmon were transplanted 18 streams in the coast of the Korean Peninsula. On the other hand, however, the ecological research on salmon species was very limited until recently due to the lack of research program. Though the involvement to the North Pacific Anadromous Fisheries Commission (NPAFC) requires scientific investigation on salmon research of each member nation, the conspicuous increase in research funding was not achieved. Oceanic environments have been rapidly altered by climate change during the last a few decades and ocean ecosystems including salmon populations will be modified under the global warming situation. Especially, a special intention is needed for stocks in southern boundary of distribution such as Korean chum salmon.

1. Adult salmon attached to disc tag will be carried out to investigate the coastal migration route and timing of Korean chum salmon. Salmon will catch from set net fisheries at eastern coastal areas of Korea.
2. To reveal the mechanisms of mass mortality of chum salmon during their early life in rivers and coastal areas in conjunction with the fluctuation of return rates, we will carry out the researches as follows:

(1) Identification of prey and predator species for juvenile salmon in the rivers and coastal areas,
(2) Stage-by-stage estimation of survival rate after releasing in the rivers and coastal areas,
(3) Monitoring of environmental factors in the river and coastal areas,
(4) Examination of growth rate during the early life history using otolith and compare the growth rate between released juvenile salmon and wild juvenile salmon, and
(5) Investigation on the optimal releasing period for juvenile salmon.

3. Climate change effects on salmon distribution, migration route, and abundance will be investigated. This research includes:
   (1) Continuous monitoring activities on environmental conditions in the Korean waters and the western Pacific Ocean, and
   (2) Climate change effects on the biological characteristics of chum salmon returned to the Korean waters.

4. Otolith thermal marking on Korea chum salmon will be carried out to provide information about growth, survival during the early ocean life stage, and hatchery origins from 2009 release (2008 brood).
5. For the stock identification, we will study on the parasitic fauna as a biological tag for the returned chum salmon to Namdae-cheon(stream). Also, genetic variations through mitochondrial DNA control region sequence analysis and microsatellite DNA analysis will be continued to reveal the relationship between Korean and other countries chum salmon.
6. We plan to expand cherry salmon releasing program, and as the first step of cherry salmon research, we will examine stomach contents to know the prey items of cherry salmon and the competitions for preys with other fish species in the coastal area and ocean.
7. International cooperative research (eg., Republic of Korea and U.S. Panel Conference on Fisheries Sciences) in the North Pacific will be continued.

1200 *Anisakis simplex* (Nematode : Anisakidae) larvae infection in chum salmon (*Oncorhynchus keta*) from Namdae River, Korea in 2008

E. Setyobudi, K.B. Seong, C.H. Lee, and J.H. Kim

The prevalence and intensity of *Anisakis simplex* larvae in chum salmon (*Oncorhynchus keta*) from the Namdae River, Korea in 2008 were investigated. 120 fish samples in total were collected during October~November 2008. All of chum salmon samples caught in the Namdae River were infected with *A. simplex* larvae (100 %) and the average intensity of infection was 69.65±48.58 (larvae/host). Based on the morphological analysis, this nematode was considered as *A. simplex* third stage larvae (L-3 larvae). The nematodes were found mostly in muscle (98.00 %). Intensity of infection and the length of larvae tended to increase with the increase of host body length.

Russia

1161 Trawl survey plans for Pacific salmon marine life period studies in the Far Eastern seas in 2009 by Russia

Anonymous

The document summarizes trawl survey plans for Pacific salmon marine life period studies in the Far Eastern Seas in 2009 by Russia (TINRO-Centre). The outline of materials, methods, surveys timing and theoretical background are provided.

1185 Spatial distribution and abundance of Pacific salmon in southern Okhotsk Sea during autumn of 2008 (results of 2008 research cruise of R/V *Professor Kaganovsky*)

A.Y Befimkin, E.V. Kurenkova, V.V. Lipinsky, A.E. Lazhentsev, and Y.V. Novikov

The document provides results of ecosystem survey of upper epipelagic layer of southern Okhotsk Sea in 2008. These studies provide extention for established long-term time-series on postcatadromous juvenile Pacific salmon abundance and distribution in this area during autumn period. The survey took place during October 13 - November 5 period being traditionally temporally linked to active offshore migration of juvenile Pacific salmon into central and southern basin areas. Data on oceanological conditions, distribution and abundance of major zooplankton groups. Estimates of nekton and jellyfish species abundance and biomass are provided. The distributions, biological parameters of different species of Pacific salmon are described in detail. Foods habits are examined for different size groups of pink and chum salmon.

1186 Trawl survey results for Pacific Salmon Marine Life Period Studies in the western Bering Sea during autumn period of 2008 (results of 2008 research survey by R/V *TINRO*)

I.I. Glebov, E.V. Kurenkova, A.M. Slabinskii, and S.P. Dudkov

The document summarizes results of R/V *TINRO* trawl survey of upper epipelagic layer of the western Pacific Bering Sea during September- October 2008. Similar to surveys during previous years, this survey was carried out within framework of TINRO-Center's long-term program of fisheries research of the Bering Sea and within framework of BASIS program. One of the major research goals of this survey was the estimation of juvenile Pacific salmon, pink salmon in particular, abundance during early marine period of life. Data on oceanological conditions, distribution and abundance of major zooplankton groups were provided. Estimates of nekton and jellyfish species abundance and biomass are provided. The distributions, biological parameters, feeding behavior of different species of Pacific salmon are described in detail.

1187 Results of Pacific salmon trawl surveys by R/V TINRO and R/V *Professor Kaganovskii* during summer of 2008 in the upper epipelagic layer of northwestern Pacific and Kuril Islands coastal waters of Okhotsk Sea

I.I. Glebov, E.V. Kurenkova, A.M. Slabinskii, and S.P. Dudkov

The document describes results of Pacific salmon trawl surveys by R/V *TINRO* and R/V *Professor Kaganovskii* during the summer of 2008 in the upper epipelagic layer of northwestern Pacific and Kuril Islands coastal waters of Okhotsk Sea. This survey was one in the row of north-west Pacific epipelagic community state observations during early summer period. Its main goal was total registration of pink salmon on its early preanadromous migration ways. The research results provided data on oceanological conditions, distribution and abundance of

major zooplankton groups. Estimates of nekton and jellyfish species abundance and biomass are provided. The distributions, biological parameters of different species of Pacific salmon are described in detail. Foods habits are examined for different size groups of pink and chum salmon.

1188 Composition and structure of epipelagic nekton communities in the central and western parts of subarctic frontal zone in winter and spring of 2009 (result of 2009 research cruise of R/V *TINRO*)

A.N. Starovoytov, S.V. Naydenko, E.V. Kurenkova, M.A. Ocheretyany, and N.S. Vanin

The document summarizes results of at R/V *TINRO* trawl surveys of upper epipelagic layer in the central (Region "B") and western (Region "A") part of Subarctic frontal zone in the February-March 2009 are analyzed. New information on nekton (and Pacific salmon, in particular) composition, distribution, biological parameters, feeding of salmon, forage base and oceanographic environment is reviewed. Estimates of nekton abundance and biomass, vertical distribution of Pacific salmon and salmon biomass evaluation on 0 to 90–120 m depth are provided.

1189 Marked salmon production by the hatcheries of Russia in 2009

E. Akinicheva and V. Volobuev

The main goal of salmon marking at Russian hatcheries is the assessment of returns of Pacific salmon released from each hatchery. Additional investigations are performed in Magadan region where survival of wild and hatchery-reared juvenile chum salmon in the early sea life period is evaluated based on the otolith marks differentiation. About 50 million juvenile salmon with marks on otoliths are annually released from four Magadan hatcheries, six Kamchatka hatcheries, and one hatchery of Khabarovsky region. In 2009 (brood year 2008), besides these hatcheries, salmon marking was performed at Sakhalin and Kuril hatcheries. As a result, there was a significant increase in released marked juveniles, which composed 211 million. On the whole, salmon marking was performed at 18 Russian hatcheries. Of them, 6 hatcheries are located on Sakhalin Island, 2 on the Kuril Islands (Iturup Island), 4 in Magadan, 5 in Kamchatka, and 1 in Khabarovsky regions.

1190 Proposed otolith marks for brood year 2009 salmon in Russia

E. Akinicheva and V. Volobuev

The main goal of salmon marking at Russian hatcheries is the assessment of Pacific salmon returns. Besides, differentiation of wild and hatchery-reared salmon is used for studies according to the regional programs. For instance, in Magadan region the wild and hatchery-reared juvenile chum salmon survival in the early sea life period is evaluated based on the otolith marks differentiation. A complex population structure of pink salmon returns is noted for Sakhalin-Kuril region where they spawn in great numbers. In this connection, the important trend of studies is to determine timing of pink approaches and abundance of their different populations and groupings. The straying assessment of the hatchery-reared pink spawners to the neighbour rivers is of great interest for fish culturists.

1201 Results of trawl count surveys on juvenile salmon and attendant fish species along southern Sakhalin Island (southwestern Sea of Okhotsk) performed by RV *Dmitry Peskov* in July 2006–2008

A.O. Subin, M.V. Kovtun, I.N. Moukhametov, D.R. Faizulin, O.V. Kusailo, V.N. Chastikov, and A.T. Tsoy

The results of oceanographic and trawl count surveys in Aniva Bay and along southeastern Sakhalin Island (southwestern Sea of Okhotsk) in July 2006–2008 are considered. A total of 280 oceanographic and 263 trawl stations were performed, and 2834 juvenile pink and chum salmon and 846047 fish of other species were sampled. Profiles of temperature distribution along standard transects in Aniva Bay, graphic data of horizontal temperature distribution over the sea surface and at 10- and 20-m horizons in the study areas, maps of catch distribution patterns for juvenile salmon and attendant fish species and their size-weight characteristics are given in this report. It is mentioned that in Aniva Bay juvenile pink and chum salmon stay for a long time (to 1.5-2.5 months) in a coastal zone after their appearing in sea waters. Juveniles' migration from a shore to the open waters of the bay takes place independently of the dates when specimens enter sea waters. This migration is brief and usually happens in the first half of July. As a rule, by the 20s of July, all juvenile pink and chum salmon leave the bay area. Then they concentrate along southeastern Sakhalin and stay there up to the end of July. The results of studies of juvenile salmon migration from southern Sakhalin in 2004–2008 are summed up. Besides salmonids, a total of 47 fish species from 22 families enter the ichthyocenoses composition of the upper epipelagial of Aniva Bay and shelf area of southeastern Sakhalin. Juvenile pink and chum salmon make up only 0.02-0.76% of the total fish sampled. Attendant fish species were represented mainly by fry, underyearlings and immature small specimens. The predatory fish that could consume salmon juveniles were either absent or not abundant in the ichthyocenoses composition.

United States

1153 Southeast Alaska Coastal Monitoring (SECM) Survey Plan for 2009

J.A. Orsi, M.V. Sturdevant, E.A. Fergusson, A.C. Wertheimer, B.L. Wing, and W.R. Heard

ABSTRACT NOT AVAILABLE

1156 United States cruise plan for BASIS, September, 2009

Anonymous

Scientists from the National Marine Fisheries Service (NMFS), Marine Ecosystem and Stock Assessment (MESA) Program, BASIS group will conduct a survey during fall 2009 within the eastern Bering Sea to provide key ecological data on the pelagic ecosystem. Primary objectives of the survey will be to: 1) collect biological information on ecologically important fish species and to 2) describe the physical and biological oceanographic conditions of the eastern Bering Sea waters. A survey of epi-pelagic fish species, zooplankton, ichthyoplankton, and oceanographic measurements will be conducted at stations within the eastern Bering Sea aboard the NOAA Ship Oscar Dyson. The survey will begin 2 September 2009 in Dutch Harbor, Alaska and end on 30 September 2009 in Dutch Harbor, Alaska, for a total of 27 sea days. The cruise will be conducted aboard the NOAA ship Oscar Dyson. Fish samples will be collected using a midwater rope trawl. At each station, the net will be towed at or near the surface for 30 minutes at speeds between 3.5 and 5 kts. All fish species will be counted and standard biological measurements including length and weight will be taken from subsamples of each species. Diets of subsamples of marine fish will be examined onboard. Biological and physical oceanographic data will be collected at each trawl station as well as opportunistically during the survey.

1162 (Rev 1) Proposed thermal marks for brood year 2009 salmon in Alaska

R. Josephson, and D.S. Oxman

In Alaska, mass-marking of salmon using otolith thermal marking is an effective research and management tool applicable to a variety of situations. For brood year 2009, approximately 57 million sockeye, 700 million pink salmon, 591 million chum, 4 million coho, and 8 million Chinook salmon will be marked at 21 different hatcheries using 62 thermal marks.

1174 Incidental catches of salmonids by U.S. groundfish fisheries in the Bering Sea/Aleutian Islands and the Gulf of Alaska, 1990-2009

J.D. Berger

Incidental catches of Pacific salmonids in U.S. groundfish fisheries off Alaska are presented for 1977 through August 22, 2009. Estimated numbers of salmonids caught incidentally in these fisheries in the Bering Sea/Aleutian Islands were 30,501 in 1990; 79,142 in 1991; 83,405 in 1992; 289,284 in 1993; 138,369 in 1994; 45,311 in 1995; 141,265 in 1996; 117,524 in 1997; 121,128 in 1998; 61,731 in 1999; 67,550 in 2000; 101,278 in 2001; 122,167 in 2002; 250,682 in 2003: 511,030 in 2004; 783,667 in 2005; 412,261 in 2006; 226,758 in 2007 and 40,125 in 2008. In the Gulf of Alaska, incidental catches were 21,085 in 1990; 53,848 in 1991; 28,010 in 1992; 80,853 in 1993; 50,839 in 1994; 79,439 in 1995; 19,937 in 1996; 18,539 in 1997; 30,528 in 1998; 38,129 in 1999; 37,700 in 2000; 21,167 in 2001; 16,139 in 2002; 24,926 in 2003; 28,551 in 2004; 37,878 in 2005; 23,229 in 2006; 43,777 in 2007 and 18,095 in 2008. Through August 22, 2009, the incidental catches were 42,701 salmon in the Bering Sea/Aleutian Islands and 6,138 salmon in the Gulf of Alaska. The last joint

venture operations took place in 1990 in the Bering Sea/Aleutian Islands, with an incidental catch of 152 salmon.

1196 Releases of otolith marked salmon from Alaska in 2008

D.S. Oxman, and R.P. Josephson

In Alaska, mass-marking of salmon using otolith thermal marking is an effective research and management tool for a variety of situations. This document reports the thermal mark patterns applied to hatchery-raised salmon stocks released in Alaska during 2008. It includes five species of salmon from brood years 2006 through 2008. Release numbers, mark patterns, and release locations are summarized.

1198 Alaska salmon hatchery releases, commercial fishery catch statistics, and sport fishery catch statistics for 2008 season

E. Volk, and R.P. Josephson

In 2008 there were 27 private nonprofit, 2 federal, and 2 state hatcheries operating in Alaska. Most of these facilities (18) are located in southeast Alaska. The Cook Inlet and Prince William Sound region has 11 hatcheries and the Kodiak region has 2 hatcheries. Alaskan hatcheries released approximately 1.49 billion fish. Of the fish released 55% were pink salmon and 38% were chum salmon. Hatcheries in Prince William Sound contributed 52% and hatcheries in Southeast Alaska contributed 35% of the fish released.

The Alaska salmon harvest of all species combined for 2008 totaled 146.3 million fish, which was about 9.3 million fish greater than the preseason forecast of 137 million and the 16th largest salmon harvest since 1960. In 2008, the overall catch of pink salmon was 84 million compared to the preseason projection of 66 million. Prince William Sound harvested 42 million fish, almost twice the 22 million forecast for that area, however the catch of 15.9 million in Southeast Alaska was below the 20.7 million forecast. Combined chum harvests of 18.3 million approached the projection of 18.7 million. Coho catches were right on forecast at 4.4 million. The biggest shortfall was sockeye salmon, where the harvest of 39 million fish was well below the expected yield of 47 million fish. The Chinook catch of 351,000 was about half the forecast of 672,000. The preliminary estimate for the total value of Alaska's 2008 salmon harvest is $452 million, well above the $417 million in 2007. While this is below record highs, it is the greatest since $487 million in 1995.

1202 Forecasting pink salmon harvest in Southeast Alaska from juvenile salmon abundance and associated environmental parameters: 2008 returns and 2009 forecast

A.C. Wertheimer, J.A. Orsi, E.A. Fergusson, and M.V. Sturdevant

The Southeast Alaska Coastal Monitoring (SECM) project has been sampling juvenile salmon (*Oncorhynchus* spp.) and associated environmental parameters in northern Southeast Alaska (SEAK) since 1997 to better understand effects of environmental change on salmon production. A pragmatic application of this effort is to forecast the abundance of adult salmon returns in subsequent years. Since 2004, juvenile peak salmon catch per unit effort (CPUE) from SECM, modified by other environmental parameters as appropriate, has been used to forecast harvest of adult pink salmon (*O. gorbuscha*) in SEAK. The forecast of 16.1 million fish for 2008 was within 2% of the actual harvest of 15.9 million fish. This represents the fourth forecast over the period 2004-2008 which was within 11% of the actual harvest. In 2006, however, the harvest was substantially different from the forecast. Although a simple CPUE model did indicate a downturn in harvest for 2006, the forecast was nonetheless 200% higher than the actual 2006 harvest. These results show that the CPUE information has great utility for forecasting year class strength of SEAK pink salmon, but additional

environmental data are needed to avoid “misses” such as the 2006 return. Since 2007, the forecast model was developed using stepwise multiple regression, jackknife hindcast analysis, and bootstrap confidence intervals. A four-parameter model was selected as the “best” forecast model for 2009. Juvenile pink salmon CPUE in northern SEAK accounted for 82% of the variability in annual harvest of SEAK pink salmon over the 1997-2008 time period. The amount of variability explained was improved to 99% when the May 20-m integrated sea water temperatures and mixed-layer depths (from the SECM strait habitat) and the El Niño Southern Oscillation (ENSO) Index were included in the four-parameter multiple regression model. The 2009 forecast from the four-parameter model, using data collected in 2008, is 44.4 million fish, with an 80% bootstrap confidence interval of 37-52 million fish. Juvenile pink salmon peak CPUE collected in southern SEAK from 2005-2007 was highly correlated ($r = 0.99$) with the peak CPUE from northern SEAK in those years, and was not correlated ($r < 0.01$) with the residuals from the forecast model. Because the pattern of juvenile abundance was similar for the two areas, no additional variation in the harvest was explained by including the southern region data. However, that time series includes only three years of data; more years may provide additional information on regional variation in pink salmon year-class strength, especially for years when the two areas have distinctly different environmental conditions.

The Committee on Scientific Research and Statistics (CSRS)

1164 Plan for NPAFC Bering-Aleutian Salmon International Survey (BASIS) Phase II 2009-2013

NPAFC Committee on Scientific Research and Statistics

Research Questions

Climate change, and its impact on salmon carrying capacity in the Bering Sea was discussed at the November, 2008, NPAFC, BASIS Symposium, held in Seattle, WA. A current overarching hypothesis suggests that climate change will alter the current geographic distributions and behaviors of humans, marine mammals, seabirds, and fish by restructuring their habitats within the Bering Sea ecosystem (NPRB 2007). Oral presentations at the symposium highlighted evidence that increased levels of atmospheric carbon dioxide are linked to warming air and sea temperatures, reduced sea ice extent during winter, and melting of the polar cap in the Arctic region (Bond et al. 2008). However, the effect of climate change on the Bering Sea ecosystem is still debatable, with studies indicating no direct effect on the ecosystem (Shuntov and Temnykh in review) to studies that indicate the possibility of reduced ecosystem productivity with increasing sea surface temperatures (Coyle et al. 2008). BASIS Phase II will address the following research questions:

1) How will climate change and climate cycles affect anadromous stocks, ecologically related species, and the Bering Sea ecosystems?

Within the broad, shallow shelf region of the eastern Bering Sea, there is evidence that increased warming will reduce sea ice extent during winter and spring, favoring pelagic productivity (Hunt et al. 2002). However, recent research suggests that climate change will reduce summer storm activity and increase water column stability. The greater water column stability is believed to reduce post-bloom production, altering the size and composition of zooplankton taxa and shifting trophic relationships among zooplankton and consumers, with the potential to impact fish, birds and mammals on the eastern Bering Sea shelf (Coyle et al. 2008). For example, juvenile pink salmon energy density was significantly lower during years with warm sea temperatures than during years with cold sea temperatures (Andrews et al. in review). Thus increased water column stability during summer due to climate change may reduce energy reserves of pelagic juvenile fish, increasing over-winter mortality.

2) What are the key climatic factors affecting cyclical changes in Bering Sea food production and pelagic fish communities?

In the deeper waters of the western Bering Sea, results suggest that climate change has not affected primary and secondary productivity or fish biomass (Shuntov and Temnykh in review). Instead, the evidence suggests that cyclic climate events restructure zooplankton and fish communities, but do not alter the overall biomass of these communities within the western Bering Sea ecosystem. However, predicting community structure in the wake of shifting climate regimes is difficult, due to the lack of thorough investigations on the structure and function of whole ecosystems.

3) How will climate change and climate cycles impact the available salmon habitat in the Bering Sea?

In the offshore waters of the Bering Sea, immature salmon abundance during summer is predicted to increase as climate change forces Pacific salmon further north in search of preferred sea temperatures. Recent bioenergetics models suggest that the carrying capacity of offshore Bering Sea ecosystem was sufficient for immature chum salmon growth during years with high abundance levels (Azumaya et al. 2008). However, if

more immature salmon enter the Bering Sea during summer, inter and intra-specific competition could increase leading to density-dependent growth and mortality.

4) How will climate change and climate cycles affect Pacific salmon carrying capacity within the Bering Sea? At the close of the BASIS Symposium, discussion turned to future Bering Sea pelagic ecosystem research. The general opinion was that BASIS research strengthened our knowledge of the effects of climate change and cylces on pelagic ecosystems of the Bering Sea. During the symposium we learned that cyclic patterns of warm and cold spring sea temperatures had positive and negative effects, respectively on salmon carrying capacity within the eastern Bering Sea shelf (Farley and Moss in review). Future salmon carrying capacity modeling efforts must account for cyclic patterns in climate, the potential of increased sea temperature warming, and density-dependent processes that effect salmon growth and survival.

The BASIS research fostered unprecedented cooperation among NPAFC Parties and is now considered a model for future collaborative international research efforts in the North Pacific Ocean. At the end of the BASIS Symposium, there was overwhelming opinion to continue BASIS research into Phase II, building on the knowledge gained during Phase I. This document discusses the research plan for BASIS phase II.

Survey Plan Elements

The BASIS Phase II plan calls for surveys of salmon and associated pelagic nekton within three regions that include the eastern Bering Sea shelf, the Russian EEZ, and the Bering Sea basin. Each region will have a set of survey stations where trawl fishing operations will occur. Sampling will consist of surface trawls to capture salmon and other fish, plankton tows, and sampling of ocean conditions (e.g., salinity, temperature, currents). Coordination of sampling by vessels of NPAFC member nations would be through the NPAFC.

As in BASIS phase I, in-depth biological and stock identification analyses will determine growth and life history characteristics of regional stock groups. BASIS data will be used in spatially-explicit models incorporating oceanographic data and salmon migration, growth, and mortality processes to advance our understanding of the causes of changes in productivity of salmon populations.

Survey Plan Benefits

- BASIS phase II continues much needed pelagic ecosystem research in the Bering Sea to determine the impact of climate cycles and climate change on ecosystem function and structure.
- BASIS phase II enables research to continue on all aspects of the effects of abiotic and hydrobiological factors on the marine period of life of Pacific salmon.
- BASIS phase II directly addresses the key elements of the 2006-2010 NPAFC Science Plan and is a component of one of NPAFC's scientific research themes
- BASIS phase II complements long-term climate, ocean, and ecosystem research and monitoring activities carried out within the framework of national and other international programs (PICES, NPRB, and GLOBEC).

1167 Report of the Research Planning and Coordinating Meeting, Sakhalin, Russia, April 21-23, 2009

NPAFC Committee on Scientific Research and Statistics

The NPAFC Committee on Scientific Research and Statistics (CSRS) held its annual Research Planning and

Coordinating Meeting (RPCM) at Sakhalin Convention Center and SakhNIRO in Yuzhno-Sakhalinsk, Russia, from April 21-23, 2009. The group including 27 participants from five member countries.

The primary purpose of the RPCM is to discuss the 2009 national research plans and cruise activities, and to review the exchange of biological samples, data, and personnel, and the activities of subcommittee and working groups after the last Annual Meeting. The Parties presented 2009 national research and cruise plans. Canada provided three cruise plans in summer, fall and winter to collect biological information on Pacific salmon and their ecological communities. Japan will conduct three research cruises in the North Pacific Ocean, Bering Sea and Chukchi Sea. Russia described three research cruise plans for Pacific salmon marine life period studies in the salmon wintering area, during their migrations. The United States presented cruise plans for Southeast Alaska coastal monitoring (SECM) in the northern region from late May to late August and in the southern region in late June and late July. The NOAA ship Oscar Dyson will be also used to collect biological information on ecologically important fish species in the eastern Bering Sea during the fall.

The Science Sub-Committee reported the progress of the Long-term Research and Monitoring Plan (LRMP). The LRMP Steering Committee members plan to meet in Shiogama, Japan in mid June 2009 to review and finalize the report. It was agreed on a process to review the results of the current 2006-2010 NPAFC Science Plan by the next RPCM in spring 2010 and begin to draft the next 5-year Science Plan. The Working Group on Stock Assessment had a one day meeting at SakhNIRO on April 21. The group agreed that the salmon status report will be completed on time for the next Annual Meeting in Niigata, Japan. Assembling these data by the end of May should also satisfy the request by PICES to provide catch data. The Working Group on Salmon Marking discussed via email the status of the NPAFC otolith mark database, marking plans for brood year 2009 salmon, and the success of designating thermal mark patterns for specific countries. The ad hoc Working Group on Stock Identification (WGSI) updated country reports of current genetic population studies through correspondence. The BASIS Working Group discussed the BASIS Phase II Plan and BASIS Symposium Proceedings. The BASIS Phase II plan summarized proposed research by Parties in the Bering Sea during 2009 to 2013. BASIS will address the following four key questions: (1) How will climate change and climate cycles affect anadromous stocks, ecologically related species, and the Bering Sea ecosystems? (2) What are the key climatic factors affecting cyclical changes in the Bering Sea food production and pelagic fish communities? (3) How will climate change and climate cycles impact the available salmon habitat in the Bering Sea? (4) How will climate change and climate cycles affect Pacific salmon carrying capacity within the Bering Sea?
As proceedings of 2008 BASIS Symposium held in Seattle, a total of 35 manuscripts were submitted for consideration to be published in the NPAFC Bulletin No. 5. The Working Group on Salmon Tagging had discussed by email communication on the tagging plans in 2009, format for tagging database, and other items. The Secretariat noted that 1,000 disc tags are stocked for future tagging experiments.

1197 Recoveries of high-seas tags in 2007-2008 and tag releases in 2008 from high-seas research vessel surveys in the North Pacific Ocean

Working Group on Salmon Tagging, Committee on Scientific Research and Statistics

In 2008 and 2009, high seas tags were recovered from 71 chum salmon in Japan, one Chinook salmon in the US, and two pink and two chum salmon in Russia. The Chinook salmon recaptured in the US also carried a data storage tag. From June to July 2009, a Japanese research vessel, *Wakatake maru*, conducted 24 longline (720 hachi) operations with the purposes of tagging salmonids with disk tags, data storage tags, and passive integrated transponder (PIT) tags. A total of 164 salmonids (three sockeye, 80 chum, 17 pink, 51 coho, and two Chinook

salmon, and 11 steelhead trout) in the central North Pacific and 1,335 salmonids (78 sockeye, 207 chum, 1,046 pink, and four Chinook salmon) in the Bering Sea were disk-tagged and released. These releases included six Chinook salmon tagged with data storage tags and 51 coho, two Chinook salmon, and 11 steelhead trout tagged with PIT tags.

1199 Status of North Pacific salmon

J.R. Irvine, M. Fukuwaka, T. Kaga, J.H. Park, K.B. Seong, S. Kang, V. Karpenko, N. Klovach, H. Bartlett, and E. Volk.

The Working Group on Stock Assessment (WGSA) assembled updated time series of data for salmon abundances, hatchery releases, and survivals and interpreted these to assess the biological status of Pacific salmon at various scales. Commercial catch data, documented in detail, provided reasonably consistent abundance indices, useful for examining status at the scale of the North Pacific and Asia and North America. WGSA reviewed information on illegal catches from the high seas and concluded these catches were a relatively insignificant component of the total catch. Hatchery release, exploitation and survival rate, and spawner escapement estimates assisted in understanding status, especially when considering units within large geographic groupings.

Aggregate North Pacific commercial catch estimates generally increased until the early to mid 1990's and since then remained relatively stable. The highest catches on record occurred during 2007 when >1 million tonnes of salmon (500 million fish) were caught. Catches in odd years tend to exceed those of even years because of differences in abundance between odd and even years of the most abundant species in the catch, pink salmon. The ranking of the species in the aggregate catch did not change during the time series, which began in 1937. Catches of pink salmon were always the highest, followed by chum, sockeye, coho, Chinook, and masu salmon. The North Pacific continues to produce large quantities of salmon, but there are differences among species. Pink and chum salmon are doing well, while many populations of sockeye, coho, and Chinook salmon are not.

Chum and pink salmon dominate Asian catches; recent catches have been at all time highs. In recent years Russia caught the largest and an increasing proportion of the total catch although in earlier years, Japan often caught the largest proportion; catches in the Republic of Korea are relatively minor. Increasing catches are the result of multiple factors. Expanding hatchery operations and improved hatchery technologies are responsible for some of these increases, but climate change, shifting fisheries, and habitat perturbations all have played a role.

Pink and sockeye salmon dominate North American catches, including those in Alaska and Canada. In Washington, Oregon, and California, Chinook and coho salmon were the most important species historically although during the last two decades, chum salmon replaced coho salmon as the second most important species. The relative importance of chum salmon has also increased in Alaska and Canada.

Reduced North American catches during the most recent decade resulted from declining catches outside of Alaska. Alaskan catches of chum and pink salmon were highest during the most recent decade; chinook and coho salmon catches were relatively stable and sockeye salmon numbers declined. Shifts in the importance of particular stocks contributing to sockeye fisheries in Alaska have been reported. Total catches in Canada were variable but without trend until the most recent decade when they experienced 2 major declines. South of the Canadian border, catches declined throughout the time series and are now only 25% of what they were 70 years

ago.

Declining coho salmon catches in and south of Canada are partly the consequence of reduced fishing effort due to conservations concerns, but status is also much reduced, as evidenced by declining or low marine survivals. Temporal abundance patterns for Chinook salmon, as represented by spawner escapement estimates, were positively associated with changes in survival and in some areas, changing patterns of exploitation. Northern Canadian sockeye salmon populations are generally doing better than those in the south; several major populations in the Fraser River (BC) watershed had extremely poor returns in 2009. Interestingly, high numbers of sockeye salmon returned to the Columbia River (USA) in 2008 and 2009.

Future NPAFC assessments will try to include more detailed examinations of survival information, consider changes to biological characteristics of salmon, and identify benchmarks so that status can be categorized at various scales.