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# Russian Bibliography Publications Linked to the NPAFC Science Plan in 2016

by

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**Russian Bibliography Publications Linked to the Current NPAFC Science Plan in 2016**


## ABSTRACT

The current bibliography lists original papers published in 2016 by Russian scientists and their collaborators relevant to the 2016-2020 NPAFC Science Plan as well as other salmon studies. The bibliography lists 48 papers, corresponding mainly to the 3 key research components of the NPAFC Science Plan: 1) Status of Pacific Salmon and Steelhead Trout; 2) Pacific Salmon and Steelhead Trout in a Changing North Pacific Ocean; 3) New Technologies. Each publication is listed under one research component, although some of them are relevant to several components. The references are given with abstracts if papers included abstracts in English. Otherwise, they are listed without abstracts.

## BIBLIOGRAGHY

### Theme 1. Status of Pacific Salmon and Steelhead Trout

**Antonov, N.P., N.V. Klovatch, A.M. Orlov, A.V. Datsky, V.A. Lepskaya, V.V. Kuznetsov, A.A. Yarzhombek, A.A. Abramov, D.O. Alekseev, S.I. Moiseev, N.A. Evseeva, and D.O. Sologub. 2016. Fishing in the Russian Far East fishery basin in 2013 // VNIRO Proceedings. 160: 133-211. (In Russian with English abstract).** Long-term data on catch composition and status of fisheries of main aquatic biological resources in the Far Eastern fisheries basin are analyzed. Fisheries statistics of the industrial information system "Rybolovstvo" was used. Main fishing grounds (about 70% of the total Russian catch) are the Bering Sea, Sea of Okhotsk, Sea of Japan and adjacent waters of the Pacific Ocean. The analysis of the use of fishery resources showed that total fish catch in 2013 as compared to 2012 decreased from 2352.0 to 2268.4 thou. t. At the same time, harvest of herring, sculpins, rockfishes, halibuts, sand lance and thornyheads increased. Based on the recent data, walleye pollock, Pacific salmon, Pacific herring, Pacific saury, flatfishes, greenlings, Pacific cod, sculpins, and grenadiers remain the main commercial species in the Far Eastern Fisheries basin, which annual catch can attain over 50 thou. t. Maximum catch in 2013 was composed of walleye pollock (1558.7 thou. t) and Pacific herring (385.1 thou. t). The catch of Pacific salmon in territorial sea and inner waters of the Far East comprised 405.5 thou. t, or 129.3% of initially recommended amount. Non-fish targeted species are harvested in the Far Eastern basin in considerably lesser amounts as compared to fish resources. Nevertheless, high prices of products made from some non-fish resources (i. e. various crabs) and sustainable demand for such a products at the world fish markets make non-fish resources an important fisheries targets. Cephalopods (squids) are harvested in largest amounts, their total catch in 2013 was 93.6 thou. t. Considerably lesser catches were characteristic for various crabs (47.3 thou. t) and shrimps (9.8 thou. t). Data presented allow for judging of current potential of fisheries resources, effectiveness of fishery, level of exploitation of total allowable catch (TAC) and allowable (recommended) catch (RC) by domestic fleet during modern period.

**Barabanschikov, E.I., N.I. Krupyanko, and A.V. Lisenko. 2016. Results of salmon fishery season in the Primorye Territory in 2016. Bulletin of Pacific salmon studies in Far East 11: 45-53. (In Russian).**

**Bugaev, A.V., O.B. Tepnin, and K.W. Myers. 2016. Correlation between winter sea surface temperatures in the North Pacific Ocean and continental-scale commercial catches of Pacific salmon, 1983-2013. NPAFC Bull. №6: 189–205.**

Ocean conditions experienced by Pacific salmon (*Oncorhynchus* spp.) during the first winter at sea may affect the productivity of Asian and North American populations. We evaluated potential correlations between annual commercial catches of five species of Pacific salmon and sea surface temperature anomalies during winter in the Bering Sea and North Pacific Ocean (October–April 1982–2013). The strongest correlations were restricted to the region south of the Aleutians (40°–50°N latitude, 160°E–170°W longitude), and were generally stable over time for both Asian and North American salmon. In the Bering Sea, correlations were slightly negative or neutral (close to zero), as expected, given that most juvenile Pacific salmon leave the Bering Sea during winter. North. Pacific waters south of the Aleutians correspond to a known area of high abundance of juvenile salmon in winter. The direction of correlations in this region was generally positive for highly abundant species (pink, chum, and sockeye) and negative for low abundance species (coho and Chinook). These differences may reflect density effects between high and low abundance species during their first winter at sea.

**Esin E.V., and A. Fedosov. 2016. The effect of chronic volcanic pollution on the morphometric characteristics of juvenile Dolly Varden (*Salvelinus malma* W.) on the Kamchatka Peninsula // Hidrobiologia. 783(1): 295–307. (In English).**

Salmon rivers that flow from volcanoes on the Kamchatka Peninsula are subjected to chronic pollution by mineral suspensions and dissolved metals. We analyzed the impact of chronic pollution on the body morphology of Dolly Varden parr using linear measurements and geometric morphometrics. Populations from different rivers demonstrated differences in morphology, although our results suggest that contamination is not responsible for the formation of any specific morphological features. The anadromous juveniles from polluted streams are characterized by high variability in external morphology, expressed in the increased standard deviation and coefficient of variation in distributions of morphometric traits. Mean standard deviation of the trait distributions in the samples from polluted rivers is significantly higher than in samples from streams not subjected to volcanic pollution. The increase of morphometric variability occurs gradually with fish age and affects a complex of characters, including the position of fins and their length. Isolation of Dolly Varden in polluted streams has other consequences for external morphology. The landlocked populations are characterized by channelization of the development and acquire novel morphologic features, which are reflected in peculiar values of some morphometric traits (especially upper jaw length and position of dorsal fin) together with reduced dispersion in these traits.

**Feldman, M.G., E.A. Shevlyakov, and N.B. Artukhina. 2016. An assessment of the Pacific salmon adult escapement parameters for the river basins on east and south-east Kamchatka. The researches of the aquatic biological resources of Kamchatka and of the north-west part of the Pacific Ocean. Collection of scientific papers. Vol. 41: 51-80. (In Russian with English abstract).**

The current strategy of management of Pacific salmon resource in Kamchatka has in its basis the idea, that a certain optimal part of parental salmon (stock) should enter rivers within extensive area in commercial fishery districts as an escapement. Meantime, if there were commercial interests of several countries, the control of fishery should be based on certain volumes of the catch and the escapement into each particular stream. In this article we make the escapement to fit the maximal sustainable catch, for the most important streams within the Petropavlovsk-Commander fisheries subzone. In view of precautionary approach to evaluation and in regard to uncertainties the escapement is given in the form of interval. Two methodical approaches are demonstrated. The method of data stratification for the maximal, minimal and intermediate levels of reproduction, relevant to changes in environmental conditions, was used for the river Kamchatka, where series of observations is long. In accordance with this, the escapement estimates are given in the form of interval (average and extremes). As for the other rivers, where the series of observations over the escapement is shorter or fragmental and the fishing normally operates in the coastal zone (where origin of the fish returned hardly can be identified), the data pools were analyzed in geographic clusters of several rivers. As a rule the cluster mentioned consisted of one big river and several minor rivers around. The parameters of the corporate “stock–recruitment” model for all rivers of South-East Kamchatka (except Kamchatka River) used for estimation of the escapement, can be split into the parameters of models for particular clusters depending on the average long-term annual parental stock and progeny (recruitment) in every cluster. The article is the first in a series addressed to the theme, where similar work is planned to carry out for the rivers of Northeast and West Kamchatka.

**Golub’, E.V., and A.P. Golub’. 2016. The research and harvest of the Pacific salmon in Chukotka in 2016 // Bulletin of Pacific salmon studies in Far East 11: 30-36.**

**Gorodovskaya, S.B., and A.S. Sushkevich. 2016. The state of the oocytes in the gonads of juvenile Pacific salmon within Kamchatsky Gulf (Pacific Ocean) in summer of 2010 and 2013. The researches of the aquatic biological resources of Kamchatka and of the north-west part of the Pacific Ocean. Collection of scientific papers. Vol. 40: 24-31. (In Russian with English abstract).**

The data to figure out specifics of gonad structure of juvenile Pacific salmon sampled in summer in the Pacific Ocean waters off Kamchatka were obtained first time based on histological analysis. Differences in the ovary development rate were demonstrated for the young fish with different strategies during their early period of feeding at sea. Copmarative analysis was made for the development rate of ovaries in juvenile fish from Kamchatsky Gulf (East Kamchatka) and in the costal waters of the Okhotsk Sea (West Kamchatka) in July–August in 2010 and 2013.

**Ignatov, N.N., and B.P. Safronenkov. 2016. Estimation of carrying capacity of small salmon streams of the Northern part of Kony Peninsula (Odyan Bay of the Tauyskaya Bay of the Sea of Okhotsk) for artificial reproduction. Bulletin of Pacific salmon studies in Far East 11: 106-119. (In Russian).**

The coastal water area of a Southern part of Odyan Bay is studied; the data on forage biomass for juvenile salmon, hydrochemical condition of water are obtained. Approximate carrying capacity for chum salmon hatchery juveniles is calculated for four small streams. About 37 million of juvenile chum salmon is possible to release from hatcheries in the coastal part of the Sea of Odyan Bay.

**Kaev, A.M. 2016. Development of the pink salmon fishery in its main reproduction ranges within the Sakhalin area in 2016. Bulletin of Pacific salmon studies in Far East 11: 68-76. (In Russian).**

**Kaev, A.M., and A.A. Pulkina. 2016. On the method of detection the number and size of circuli on scales of pink salmon *Oncorhynchus gorbuscha.* Izv. TINRO 185: 95-101. (In Russian with English abstract).**

Numbers of scale circuli are calculated and intercirculi spacings are measured along 3 radii (the longest one and two lateral ones deviated by 15° from the longest) for pink salmon *Oncorhynchus gorbuscha* from the Kurilsky Bay (Iturup Island, southern Kuril Islands) and the Ostrovka and Kura Rivers (southern Sakhalin Island). The difference of the circuli numbers along different radii was twice lower in comparison with the difference of their number between fish, but the differences of intercirculi spacing were similar between the radii and between fish in each area. Variability of these parameters was significantly higher between the areas; the differences were statistically significant for both in this case. The feature of low variability of the circuli number and intrecirculi spacing allows to pick a proper radius for measuring the circuli to avoid over- or underestimation of their number in cases of local deformation of scale (merging or splitting of some circuli).

**Kaev, A.M., and L.A. Zhivotovsky. 2016. New findings to discussion on local versus fluctuating stocks of pink salmon *Oncorhynchus gorbuscha.* Izv. TINRO 187: 122-144. (In Russian with English abstract).**

Some patterns in dynamics of catch and biological parameters of pink salmon *Oncorhynchus gorbuscha* returned to the southeastern coast of Sakhalin Island and the Aniva Bay in 2014 (additional peak in the return abundance and unusual increase in relative fecundity of females in the second half of the return) could be interpreted as presence of the fish from Kuril Islands. This hypothesis was proven by the scale structure analysis, using the known difference between the pink salmon from southern Sakhalin and Iturup Island by the total number of

sclerites and the depth of the local minimum in the first eight intersclerite distances caused by different environments. The fish of Kuril origin was found in all samples collected on the southeastern coast of Sakhalin on August 6, 7, 14, and 18, with its portion increasing in later catches, and in the sample collected in the Ostrovka River on the eastern shore of the Aniva Bay on August 18, but wasn't found in the sample collected in the same site on August 25, and only a small portion of the fish of Kuril origin was found in the marine sample taken at the Busse Lagoon. The pink salmon in the Kura River on the western shore of the Aniva Bay had mixed origin, too, but without signs of the Kuril origin. This is the first real evidence of the salmon straying and the hypothesis of fluctuating stocks of pink salmon obtained with the ichthyological methods, though possibility of the straying is debating many years. This phenomenon has high theoretical and practical importance. The new findings show that mass movement of pink salmon between different reproduction regions is quite real, though maybe it happens rarely, presumably during the shift of domination between the odd- and even-year broodlines. The straying of low intensity may be invisible with routine methods, that is why thorough monitoring of pink salmon stocks in different areas of its reproduction is necessary for understanding its population structure and dynamics, including detailed environmental, ichthyology and genetic studies.

**Kozlova, T.V., and O.A. Schweiger. 2016. Pink salmon fishery 2016 in Primorye area (Tatarsky Strait, Sea of Japan). Bulletin of Pacific salmon studies in Far East 11: 41-44. (In Russian).**

In 2016, pink salmon run timing was differed from the average; a delay was 10-12 days for all local rivers. The highest catch over a 100-year period of observation was recorded for this fishery area. Total catch was more than 14 thousand metric tons. High survival rate of juveniles during the marine period could be a reason for such great abundance. Significance in the Pacific salmon reproduction of mainland coast area within the Tatar Strait from the Cape of Red Partisans to the Gold Cape is increasing. Among all pink salmon spawner abundance, 75 % enter into the Tatar Strait rivers to the north from the Cape of Red Partisans, and 25 % – in rivers to the south from this cape.

**Kuznetsova, N.A., and M.A. Shebanova. 2016. Status of the plankton community and trophic relationships among fish in the north-western part of the Pacific Ocean and the southern part of the Okhotsk Sea in July-August 2015. Bulletin of Pacific salmon studies in Far East 11: 163-182. (In Russian).**

**Markovtsev, V.G., and G.N. Kurganskiy. 2016. Masou salmon artificial reproduction in the State salmon plants of Primorye area. Bulletin of Pacific salmon studies in Far East 11: 140-143. (In Russian).**

**Markovtsev, V.G., V.N. Valova, A.N. Bashtovoy, G.N. Tymchyshyna, E.V. Yakush, A.P. Yarochkin, and V.A. Marchenko. 2016. Testing of the new chum salmon juveniles feed composition. Bulletin of Pacific salmon studies in Far East 11: 144-149. (In Russian).**

**Nagornov, A.A., M.N. Kovalenko and A.A. Adamov. 2016. Modern state of trap-net fishing of pacific salmon in Kamchatka. The researches of the aquatic biological resources of Kamchatka and of the north-west part of the Pacific Ocean. Collection of scientific papers. Vol. 40: 32-41. (In Russian with English abstract).**

An estimation of the modern state of trap-net fishing of Pacific salmon species in Kamchatka for the period from 2006 for 2015 is made. Data characterizing this type of fishing for recent 10 years are provided. General challenges, including organizational ones, typical for the trap-net fishing of salmons in Kamchatkan waters, and possible ways of their solution are discussed.

**Naydenko, S.V., and O.S. Temnykh. 2016. Survival of pacific salmons in the North Pacific winter-spring season. Izv. TINRO 185: 67-94. (In Russian with English abstract).**

Influence of several factors (water temperature, food supply, predatory, size of juveniles) on Pacific salmon survival during wintering is considered on the data collected from the upper pelagic layer in surveys conducted by Pacific Fisheries Research Center (TINRO) in the North-West Pacific. There is highly unlikely that the temperature influences on fish mortality directly. There is no obvious proof of negative influence of the low temperature on food base of salmons, as well. The lowering of forage zooplankton biomass in the Subarctic Front zone in February-March is insufficient for the salmons starvation taking into account that the total abundance of planktivorous nekton is also lowered in this area and generally in the Subarctic waters in winter-spring, so the food supply cannot be considered as a crucial factor of the salmon survival. Seasonal changes with lowering of feeding intensity, lipid accumulation, and somatic growth in winter known for Pacific salmon are not forced by poor food base but are a feature of their species-specific life strategy with cyclic changes of metabolism. Predators are not abundant in the Subarctic zone in winter, so the predation also cannot cause the high mortality of salmons. Relationship between the size of juveniles and their mortality in winter is considered in detail for the Okhotsk Sea stocks of pink salmon and there is concluded that the size of juveniles cannot be a predictor of their year-classes return for spawning. Thus, any single factor does not determine winter mortality of pacific salmons but their survival is likely determined by a complex interaction of abiotic and biotic factors.

**Naydenko, S.V., O.S. Temnykh, and A.L. Figurkin. 2016. Is winter the critical period in the marine life history of Pacific salmon? N. Pac. Anadr. Fish Comm. Bull. 6: 139–152. doi:10.23849/npafcb6/139.152.**

Winter conditions experienced by Pacific salmon in the North Pacific Ocean have been investigated based on data collected in winter–spring, 1986–1992 and 2009–2011, and in summer, 2004–2014. Although forage zooplankton biomass in the western Subarctic Frontal Zone was 40–70% lower in February–March than in April and June–July, the availability of preferred prey items was likely sufficient to satisfy the trophic demands of wintering salmon. Pink, chum, and coho salmon 10–30 and 30–50 cm in fork length foraged intensively in winter. While feeding intensity was higher in autumn than in winter, it was not significantly different among seasons. Distinctions in the seasonal dynamics of feeding rates for different salmon species and sizes seem to provide evidence for a species-specific life strategy rather than to signal the onset of poor food conditions. The rare occurrence of predatory fish in salmon winter habitat also suggests a low rate of salmon mortality. Estimated ocean winter mortality of pink salmon was 36–80% from September–November to June-early-July, which is not higher than mortality experienced during the freshwater, estuarine, or early marine phases of their life history. We conclude that winter is an important period in salmon marine life history, but may not be more critical than earlier life-history periods in fresh water and the ocean.

**Ostrovsky, V.I., O.V. Vershinina, and A.P. Shmigirilov. 2016. Dependence of progeny abundance for summer chum salmon (Oncorhynchus keta) in the Amur River on the parents abundance. Izv. TINRO 184: 70-81. (In Russian with English abstract).**

For almost the century the landings of summer chum salmon in the Amur were approximately in 5 times lower that the landings of fall chum salmon, in spite on almost the same fishing efforts. However, its catches were very high in the 1990–2000s, even higher that for the fall chum salmon, that contradicts to conceptions on its lower absolute fecundity, smaller spawning grounds, and higher vulnerability of its reproduction on unfavorable external factors. Relationship of mature progeny abundance for summer chum salmon with number of their parents is analyzed. The data on the parents and progeny abundance were calculated from fishery statistics, including cited data, considering annual catch as 50 % of the stock. The highest

recruitment of summer chum salmon is estimated as 19.08 $10^6$ fish that is comparable with the strength of the fall chum salmon year-classes. The spawning stock of 1.94 $10^6$ fish is enough to produce this progeny, but the population growth is much lower with the lower spawning stock, that is a real reason for slow recovery of the summer chum salmon stock, though potentially both races could be equally abundant. To maintain the stock of summer chum salmon at the highest level, an optimal number of parents should be passed to the spawning grounds, within rather narrow range, that is difficult to control in conditions of the big river.

**Ostrovsky, V.I. 2016. Pathways of the Amur pink salmon Oncorhynchus gorbuscha to the areas of reproduction. Izv. TINRO 186: 121-134. (In Russian with English abstract).**

Biannual sequence of high-numerous and low-numerous year-classes of pink salmon (Oncorhynchus gorbuscha) is disturbed rarely in the areas close to its spawning grounds where mostly local groupings are landed, as it is shown on the data of fishery statistics in many areas of Russian Far East for 1907-1986. The disturbances are related usually with by-catch of transitory fish, in particular for the Sakhalin-Kuril region. Dynamics of the pink salmon annual landings in the Amur correlates with its dynamics at northwestern Sakhalin, that allows to suppose the species migration from the Okhotsk Sea to its spawning grounds via northwestern Sakhalin. Besides, a part of the Amur pink is caught at the mainland coast of the Gulf of Sakhalin, but the landings in the Amur correlate well with this transitory area in even years only, when the run is stronger. The highest catches of pink salmon on the mainland coast of the Gulf of Sakhalin in 2015 could be ensured neither the Amur nor the Sakhalin groupings; a hypothesis on the Shantar groupings contribution is discussed. In general, high catches of pink salmon in Khabarovsk Region in 2015-2016 are possibly reasoned by its good survival and lowered fishery in the Sakhalin-Kuril region.

**Ostrovsky, V.I. 2016. Problems of pink salmon forecasting in the Khabarovsk Territory under conditions of information deficit. Bulletin of Pacific salmon studies in Far East 11: 54-67. (In Russian).**

The questions of pink salmon stock forecasts development are discussed under condition of information losses. In particular, the desirability of consolidation for forecasted areas in the Khabarovsk area and the increase use of fishing statistics in forecasts are considered. Problems and criteria for forecasts estimating the quality under growing stock conditions, as well as questions related to the optimum of spawner abundance estimation are discussed.

**Shuntov, V.P. 2016. A significant achievement in research on the Pacific salmon stock differentiation during marine period of their life histories (Book Review A.V. Bugaev "Pre-spawning migrations of the Pacific salmon in the Russian economic zone" Petropavlovsk-Kamchatsky: KamchatNIRO, 2015, 416 pp.). Problems of Fisheries. 17 (3): 379-384. (In Russian with English abstract).**

**Shuntov, V.P. 2016. Why do we need integrated marine surveys for biological resources study? Bulletin of Pacific salmon studies in Far East 11: 129-132. (In Russian).**

**Shuntov, V.P., and O.S. Temnykh. 2016. Russian Far Eastern salmon fishery season - 2016: good results, successes and errors in the forecasts, and the traditional VNIRO failure in the ways along announced innovative breakthroughs in abundance and catch forecasts. Bulletin of Pacific salmon studies in Far East 11: 3-13. (In Russian).**

**Shuntov, V.P., O.S. Temnykh, and O.A. Ivanov. 2017. On stability of stereotypes in ideas of marine ecology of the Pacific Salmon (Oncorhynchus spp.). Izv. TINRO 188: 3-36. (In Russian with English abstract).**

Some ideas on marine ecology of the Pacific salmons (Oncorhynchus spp.), which were provided in the modern publications in the second half of last century, are considered from critical positions. They concern absolute priority given to sea surface temperature influence on salmon distribution and formation of their generations yield, conclusions about deficiency of food (especially during the winter period) and fierce competition for it, "suppression" by pink salmon of other salmons species and their own adjacent generations, limited carrying capacity of the ocean subarctic pelagic zone for salmon, violations of epipelagic communities structure in the North Pacific ecosystems due to artificial reproduction of chum salmon, etc. Most of these ideas have not confirmed by results of long-term complex expeditions of the TINRO-Center into the Far East seas and adjacent waters of the North Pacific in the 1980s and continue now. They showed that compared to previous ideas the Pacific salmon is very ecologically plastic species with a wider temperature range of habitat. Salmon can make significant vertical migrations in which they freely cross the temperature jumps and heterogeneous water masses. Having wide food ranges and dwelling in the dispersed state during marine and oceanic feeding migrations, salmon successfully fill their diet in the vast waters, even with relatively low concentrations of food organisms (macroplankton and small nekton). Biomass of all species of the Pacific salmons in the North Pacific is not more than 4-5 million tonnes (in the Russian waters no more than 1.5-2.0 million tons). At the same time, biomass of other nekton is several first hundreds of millions of tons. The share of salmon in total food consumption by all nekton in different years is 1-5% in the western Bering Sea epipelagic, 0.5-1.0 % in the Sea of Okhotsk, less than 1 % in adjacent ocean waters of the Kuril Islands, 5-15 % in the East Kamchatka oceanic waters.

**Starovoytov, A.N., and P.O. Emelin. 2016. Nekton community composition during Pacific salmon early marine migrations in the Sea of Okhotsk in 2016. Bulletin of Pacific salmon studies in Far East 11: 158-162. (In Russian).**

**Temnykh, O.S., and V.V. Kulik. 2016. To the method of the determination of pink salmon abundance approaches into the Okhotsk Sea basin based on trawl salmon surveys during their late marine migration in northwestern part of the Pacific Ocean. Bulletin of Pacific salmon studies in Far East 11: 133-139. (In Russian).**

**Temnykh, O.S., A.N. Kanzeparova, and V.A. Shevlyakov. 2016. Current pink salmon stock status in the Russian Far East. Bulletin of Pacific salmon studies in Far East 11: 183-192. (In Russian).**

This report provides information on the Russian Far East pink salmon stock dynamics status for 2000s. This period is characterized by noticeable changes in climatic and oceanographic conditions that will undoubtedly affect the salmon population dynamics. At the same time, since 2009 the fishing rules for Pacific salmon in the Russian Far East basin (replacement of TAC salmon on Recommended Catch with the possibility for fast quota additions during the fishing season) has changed. These changes have affected dynamics of the fishery and pink salmon escapement in some regions. Thus, the Pacific salmons take rather modest place in trophic networks of subarctic waters. Therefore, neither the pink salmon, nor a chum salmon can be considered responsible for large ecosystem reorganizations and abundance wave in abundance dynamic of other mass nekton species.

**Volobuev, V.V., and V.V. Ovchinnikov. 2016. On forms of life strategy realization in the Pacific salmon genus *Oncorhynchus*. Bulletin of the North-East Scientific center, Russian Academy of Sciences 2: 50-63. (In Russian with English abstract).** Based on authors' observations and published data, the intraspecific variety of the Pacific salmon life forms is analyzed. The Pacific salmon have temporal groupings differentiated by spawning time and location, as well as duration of freshwater residence including anadromous, semi-

anadromous, and resident life forms of living; rheophilic and limnophilic ecotypes; seasonal races; and epigenetic variations. The diversity of life forms in salmonids is interpreted as a result of the species interaction with the environment and development of stock adaptations to various environmental conditions. Based on the analysis conducted, fifteen variations of life strategy are distinguished.

**Volobuev, V.V., V.V. Ovchinnikov, and I.S. Golovanov. 2016. Abundance of spawning pink salmon *Oncorhynchus gorbuscha* (Walbaum) and topography of its spawning areas in the Magadan Region in 1966-2015. Bulletin of the North-East Scientific center, Russian Academy of Sciences 3: 73-82. (In Russian with English abstract).**

The database of aviation accounts of spawning pink salmon in the Magadan Region is analyzed. The maximum and minimum sizes of returns and escapes of pink salmon on the spawning ground are defined. The data on localization of its spawning areas in the basic spawning reservoirs of region are presented. The significance and contribution to natural pink salmon reproduction in rivers of different sizes are discussed.

**Volobuev, V.V., V.V. Ovchinnikov, I.S. Golovanov, A.M. Korshukova, and A.I. Mordovin. 2016. Salmon fishing season in 2016 in the Magadan region. Bulletin of Pacific salmon studies in Far East 11: 25-29. (In Russian).**

Article involves some data about Pacific salmon: pink salmon, chum salmon, coho salmon, sockeye salmon, and Dolly Varden trout catches in fishery season of 2016. Number of their escapement on spawning grounds within Magadan area and some data on escapement biological structure are shown.

**Volobuev, V.V., V.V. Ovchinnikov, and M.V. Volobuev. 2016. Reproductive peculiarities of Pacific Salmon genus *Oncorhynchus* of the continental coast of the Okhotsk Sea. Problems of Fisheries. 17 (2): 1-21. (In Russian with English abstract).**

Data on features of reproductive ecology of four species of the Pacific salmon which are reproduced in reservoirs of continental coast of the Sea of Okhotsk are presented. Their preferences concerning terms and choice of places for spawning are shown. The data about the basic characteristics of water currents in spawning and incubation embryos of salmons is cited.

**Volobuyev, V.V., and V.V. Ovchinnikov. 2016. The continental coast of the Sea of Okhotsk as the large complex of Pacific Salmon reproduction and fishery in the Russian Far East. Bulletin of Pacific salmon studies in Far East 11: 77-85. (In Russian).**

There are four salmonid species: pink salmon, chum salmon, coho salmon, and sockeye salmon spawn and are fished by Russian fisheries in this area. Pink and chum salmon are dominating species; their portion is up to 90 % of total catch. Total number of all Pacific salmon species reaches 50 million fish; their catch sometimes exceeds 35 thousand metric tons. The continental coast of the Sea of Okhotsk extends about 3,500 km from the Gulf of Sakhalin in the southwest to the Penzhina Bay in the northeast, including east coast of the Taigonos Peninsula.

**Voronova, E.S., V.G. Yerokhin, E.A. Shevlyakov, and M.G. Feldman. 2016. Analysis of the use of autumn trawl survey data on juvenile chum salmon *Oncorhynchus keta* in the assessment of adult returns to the northeast of Kamchatka. The researches of the aquatic biological resources of Kamchatka and of the north-west part of the Pacific Ocean. Collection of scientific papers. Vol. 42: 44-57. (In Russian with English abstract).**

The number of underyearlings in 16 generations of chum salmon (*Oncorhynchus keta*) was calculated from results of juvenile salmon trawl surveys in the southwestern Bering Sea. Correlation between the number of the under yearlings and the mature stocks was evaluated from regression analysis. The model used for description of the correlation between observed juvenile

chum salmon escapements and adult returns demonstrated satisfactory results about generation abundance in eight of 13 returns observed.

**Zaporozhets, O.M., G.V. Zaporozhets, and Zh.H. Zorbidi. 2016. Dynamics of biological parameters of spawners of pacific salmons returned to the rivers of the Avachinsky Bay (south-eastern Kamchatka) in 1989-2014. Izvestiya TINRO. Vol. 184: 23-40. (In Russian with English abstract).**

Analysis of the dynamics of biological characteristics of chum, sockeye, pink, coho, and Chinook salmon in the basins of Avachinsky Gulf was carried out. It was demonstrated for three sockeye salmon populations, that the average age at return most likely can positively correlate with the length of freshwater period, and negatively correlate with the time of spawning run. Consequent decrease in female body weight (vs. different trend in males) was demonstrated for Chinook salmon in Avacha River. The time of spawning run and the trends of body length dynamics were different in pink salmon (and chum salmon) from Avacha River and Nalycheva River. The age at return and fecundity of coho salmon are more or less close to the average, the body length has the trend to decrease.

**Zikunova, O.V. 2016.The dynamics of the Chinook salmon stock in Kamchatka River with regard to the fishery dynamics. The researches of the aquatic biological resources of Kamchatka and of the north-west part of the Pacific Ocean. Collection of scientific papers. Vol. 42: 58-70. (In Russian with English abstract).**

Current specifics of the condition of the stock of Chinook salmon in Kamchatka River can be characterized by increased spawning runs, which demonstrate significant structural transformations; the age composition has changed toward younger groups, and the percent of females has decreased. In the river basins where the fishery management is well organized, including the Kamchatka River watershed, fishery is the main factor limiting the stock abundance and forming biological indexes of salmons. An important instrument in interpreting the mechanisms of the influence of the fishery onto the condition of the Chinook salmon stock is the analysis of archive and current extensive data pools. The basis data pool consisted of Russian official commercial fishery statistics of Chinook salmon catches on drift-net fishing at sea from 1952, drift-net fishing near shore in Kamchatsky Gulf and in the Kamchatka River watershed from 1934. Today, 80% of Chinook salmon stock in Kamchatka River are harvested by fixed nets set within Kamchatsky Gulf southward from the river mouth. The most impressive effects on the character and scale of the commercial use of chinook salmon are strongly depend on existing multispecies fishery of Pacific salmon in the basin, where the main target species is sockeye salmon. Aside of the nearshore fishery, not the last role in revealed transformation of the structure of the Chinook salmon parental stocks and in the size-age composition and sex range, was played by the drift net fishing at sea.

**Zolotukhin, S.F., A.N. Kanzeparova, and T.V. Kozlova. 2016. Features of the pink salmon run 2016 in Khabarovsk area. Bulletin of Pacific salmon studies in Far East 11: 37-40. (In Russian).**

In 2016, unusually high pink salmon abundance was observed in the Tartarsky Strait of the Sea of Japan and in some parts of the Okhotsk Sea. Fishing companies, which harvest pink salmon in the Amur River in 2016, reached a historical record catch of pink salmon – 23,100 tons. These fish likely belonged to two population groups: Sea of Japan and Sea of Okhotsk. There was 7-12-day delay of pink salmon run for all fishing areas: in the Sea of Japan and the mainland coast of the Okhotsk Sea, including Magadan and West Kamchatka coast in 2016, and the low maturity of individuals as well. This might be due to the very cold winter-spring season in the Subarctic front area in February-May, 2016. No pink salmon aggregations have been observed in the Tatar Strait northward from the Tumnin River mouth that were able to contribute

significantly to the stock ensured fishery harvest in the Amur River. Therefore, the Amur River pink salmon stock does not migrate through the Tatar Strait and the Amur Estuary area before entering the Amur River in 2016. There are no data on abundant pink salmon migration from the Sea of Japan through the La Perouse Strait. Probably, the Amur River pink salmon consisted mainly of individuals that overwintered in the Pacific Ocean.

**Theme 2.Pacific Salmon and Steelhead Trout in a Changing North Pacific Ocean Pacific**

**Krovnin, A.S., B.N. Kotenev, and N.V. Klovach 2016. Association of «salmon epochs» in the Far East region with the large-scale climate variations in the North Pacific // VNIRO Proceedings. 164: 22-40. (In Russian with English abstract).**

Based on the analysis of climatic data and data on Far East salmon catches for 1911–2016, two types of the large-scale climatic variability creating favorable conditions for growth of salmon stocks have been revealed. «The salmon epoch» in the first half of the XX century was associated with warming of surface water in the Northeast Pacific and its propagation into the northwestern ocean. On the contrary, the favorable conditions for growth of Asian salmon stocks since the end of the 1980s were resulted from a sharp warming of surface water in the western half of the ocean. The cooling of Northwest Pacific surface water in 2012–2014 led to decrease in salmon catches in 2012–2015. However, a sharp warming off the western North American coast began in autumn, 2013 and continued also in 2014–2016. Advection of this warm water into the Northwest Pacific resulted in formation of favorable conditions for survival of the 2014–2016 salmon generations, first of all in the area of West and East Kamchatka. In general, the character of sea surface temperature anomalies distribution in the northern part of the North Pacific in 2015–2016 is very similar to their distribution during the «salmon epoch» of the first half of the XX century. Thus, it may be supposed that the present period of high Far East salmon abundance has not come to its end yet. Time of its ending remains uncertain and depends on how long the anomalously warm state of surface water in the Northeast Pacific will continue. It is expected that the next «salmon epoch» will begin in the 2030s.

**Myers, K.W., J.R. Irvine, E.A. Logerwell, S. Urawa, S.V. Naydenko, A.V. Zavolokin, and N.D. Davis. 2016. Pacific salmon and steelhead: life in a changing winter ocean. N. Pac. Anadr. Fish Comm. Bull. 6: 113–138. doi:10.23849/npafcb6/113–138.**

How Pacific salmon and steelhead (Oncorhynchus spp.) respond to climate-driven changes in their oceanic environment is highly uncertain, in part due to limited information on winter distribution in international waters (high seas) of the North Pacific Ocean and Bering Sea. We review what is known and summarize what should be known to properly address the question: Where do Pacific salmon go in the high seas during winter and why, and how might this be affected by climate change? Historical high-seas research (1950s–1970s, all seasons) discovered that there are species and stock-specific distributions in the high seas; winter survey results provided some clues as to important winter locations and dominant oceanographic features of winter habitat. In succeeding decades (1980–2015), new fisheries-oceanographic survey methods, stock-identification techniques, remote-sensing technologies, and analytical approaches have enabled us to expand our knowledge of the winter distribution and ecology of salmon, although empirical data are still very limited. In general, we learned that the “why” of ocean distribution of salmon is complex and variable, depending on spatio-temporal scale and synergies among heredity, environment, population dynamics, and phenotypic plasticity. The development of quantitative multispecies, multistage models of salmon ocean distribution linked to oceanographic features would help to identify key factors influencing winter distribution and improve understanding of potential climate change effects.

**Urawa, S., and 25 co-authors (including Alexander V. Zavolokin, Alexander V. Bugaev, Nataliya V. Klovach, Maxim V. Koval , Svetlana V. Naydenko, Olga S. Temnykh, Vladimir V. Volobuev ). 2016. Forecasting Pacific salmon production in a changing climate: a review of the 2011–2015 NPAFC Science Plan. N. Pac. Anadr. Fish Comm. Bull. 6: 501–534. doi:10.23849/npafcb6/501.534.**

In recent decades, the marine production of Asian and North American Pacific salmon and steelhead populations has undergone significant variability linked to climate change. Improved forecasts of the abundance and distribution of salmon are needed that will benefit stock management in all salmon producing countries around the North Pacific Rim. The North Pacific Anadromous Fish Commission (NPAFC) Science Plan is a long-term comprehensive strategy for international cooperative research. The primary goal of the 2011–2015 Science Plan was to explain and forecast annual variations in Pacific salmon production. The plan was developed with an overarching research theme "Forecast of Pacific Salmon Production in the Ocean Ecosystems under Changing Climate" and five research topics. This paper describes progress made on each research topic and the overarching theme, much of which was assessed at an international symposium in Kobe, Japan, on May 17–19, 2015. In summary, the reliability of stock identification methods including genetic and otolith mark analyses has improved, enabling better monitoring of stock-specific ocean distribution and abundance. Salmon marine survival depends on early marine coastal environments but also on conditions later in life, including winter. Models incorporating fish mortality and various environmental factors improve our ability to forecast returns of specific salmon stocks. However, limitations on our ability to accurately explain and forecast annual variations in Pacific salmon production remain, in part because of uncertainty in the factors responsible for salmon mortality and from the effects of climate warming on the marine distribution and abundance of salmon. It is more important than ever to promote cooperative and innovative international research to identify and better understand the ecological mechanisms regulating the distribution and abundance of salmon populations for sustainable salmon and steelhead management.

**Zavolokin, A.V., V.I. Radchenko, and S.V. Naydenko. 2016. Changes in the trophic structure of an epipelagic community in the western Bering Sea and western North Pacific Ocean with an emphasis on Pacific salmon (Oncorhynchus spp.). N. Pac. Anadr. Fish Comm. Bull. 6: 259–278. doi:10.23849/npafcb6/259.278.**

A comparative analysis of the trophic structure and interactions between Pacific salmon (Oncorhynchus spp.) and epipelagic communities in the western Bering Sea and Pacific waters off the Kuril Islands was conducted using the Ecopath modeling approach. In recent decades, the nekton communities in the Bering Sea and western North Pacific Ocean have changed greatly. For each region, we built two models describing the trophic structure of communities (1) in a period of relatively low salmon biomass and high biomass of other nekton species (walleye pollock, *Theragra chalcogramma*, and/or Pacific sardine, *Sardinops melanostictus*) characteristic of the 1980s and early 1990s, and (2) in a period of high salmon biomass and greatly decreased biomass of walleye pollock and/or sardine characteristic of the 2000s. To evaluate possible changes in trophic flows, we also examined hypothetical scenarios in which Pacific salmon biomass was multiplied by 1.5 relative to their highest level in the 2000s. Despite drastic changes in the biomass of several abundant species, the overall trophic structure of epipelagic nekton communities in both the western Bering Sea and Pacific waters off the Kuril Islands has not changed appreciably during the last 30 years. Between the 1980s and 2000s, Pacific salmon biomass increased greatly in the western Bering Sea and Pacific waters off the Kuril Islands resulting in increased food consumption. The increase in total food consumption appears to be associated with decreases in their diet composition from groups occupying relatively high trophic levels (e.g., amphipods and squids) and a rise in prey groups occupying relatively low trophic levels (e.g., euphausiids, copepods, and pteropods). As a result of this diet shift, the estimated

trophic level of Pacific salmon in the food web declined between the 1980s and 2000s. In the simulation with salmon biomass expanded 1.5 times relative to the 2000s estimate, the abundance of forage species was sufficient to maintain higher salmon consumption. The ability of Pacific salmon to access a variety of prey species at a variety of trophic levels appears to give them the capacity to satisfy their food requirements even during periods of extremely high biomass.

**Theme 3. New Technologies**

**Chistyakova, A.I., and A.V. Bugaev. 2016. An assessment of the origin and migration routes of juvenile hatchery pink and chum salmon in the basin of the Okhotsk Sea in autumn in 2011-2014. The researches of the aquatic biological resources of Kamchatka and of the north-west part of the Pacific Ocean. Collection of scientific papers. Vol. 40: 5-23. (In Russian with English abstract).**

The research was made to study structure of otoliths of juvenile pink and chum salmon from trawl catches of complex survey on the R/V "Professor Kaganovsky" in September–November in 2011–2014. The otoliths were collected from 3721 pink and 6389 chum salmon individuals. Results allow to identify hatchery marked individuals in mixed samples. There were 81 pink salmon (2.2%) and 339 chum salmon (5.3%) otolith marked individuals revealed from salmon hatcheries of Russian Far East and Japan. Juvenile pink salmon had marks of 7 Russian hatcheries (5 from Sakhalin and 2 from Iturup) and 3 hatcheries of Japan. Juvenile chum salmon had marks of 18 Russian (10 from Sakhalin, 4 from Iturup, 1 from the basin of Amur, 2 from the Northern Okhotsk Sea coast, 1 from West Kamchatka) and 25 Japanese (15 from Hokkaido, 10 from Honshu). The structure of the hatchery releases in the basin of the Okhotsk Sea was analyzed. The maximal number of juvenile pink salmon was released from the hatcheries of Sakhalin. The hatcheries of Iturup demonstrated the top position in the releases of marked pink salmon. It was found that the ratio between the fish from different regions in the catches is generally similar to the structure of the hatchery releases of juvenile pink salmon in Russian Far East and Japan. The maximal number of chum salmon was released from the hatcheries of Japan. Sakhalin is the region number one to release marked chum salmon. The ratio between marked Russian and Japan chum salmon in the catches was not similar to the structure of releases of marked hatchery fish, we think due to a higher survival of Japanese chum salmon comparing to Russian chum, as Japanese chum salmon demonstrate higher quality at release. Analysis of spatial distribution of marked juvenile salmons in the Okhotsk Sea made it possible to figure out migration routes of juvenile hatchery stocks of pink and chum salmon. Results of observations indicate of similar trend in the migration cycles of two species. Juvenile pink and chum salmon from the "Southern Okhotsk Sea" group of stocks (Sakhalin, Kuril Islands, Hokkaido and Honshu) migrate in the northeast direction to the coast of West Kamchatka up to 55–56° N. That maybe can be affected by the system of large-scale water circulation in the Okhotsk Sea basin.

**Khrustaleva, A.M. 2016. The Phylogeography of the Asian Sockeye Salmon *Oncorhynchus nerka,* Inferred from the Data on the Variability of Mitochondrial SNP Loci: Analysis of Scenarios for Post-Glacial Expansion of the Species over the Asian Coast of the Pacific Ocean // Russian Journal of Marine Biology. 42(7): 517-526. (In English).**

The variability of three single nucleotide polymorphism (SNP) loci in the mitochondrial DNA (mtSNP) is analyzed for sockeye salmon populations over a major part of the species range, from Chukotka to the Kuril Islands. Two basic mtSNP haplotypes, GCC and GTT, have been revealed in 20 sockeye samples from 15 lake–river systems on the Asian coast of the Pacific Ocean. In most of the samples, the ratio of the haplotypes is approximately equal. The GTT haplotype dominates the populations from the Kuril Islands (except Shumshu Island); only the GCC haplotype has been found in the sample from the Commander Islands. This geographic

pattern of haplotype distribution was presumably caused by the historico-demographic events related to the formation of the Asian sockeye range in the Middle–Late Pleistocene, viz., fragmentation of the species range and subsequent secondary contact between previously diverged populations. These data provide a basis to consider different scenarios for the formation of the modern diversity of sockeye mtSNP haplotypes, all of which suggest multiple expansions of the species to Asian waters during the periods of oceanic transgression after the Pleistocene glaciations.

**Khrustaleva, A.M., and N.V. Klovach. 2016. Variability of mitochondrial SNP loci in sockeye salmon Oncorhynchus nerka populations from Asia and North America // Conservation of biodiversity of Kamchatka and coastal waters. Materials of XVII international scientific conference. Petropavlovsk-Kamchatsky: Kamchatpress. P. 130-133. (In Russian).**

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**Khrustaleva, A.M., A.A. Volkov, S.M. Rastorguev, and T.Yu. Uglova. 2016. Postglacial colonization reconstruction of Asian sockeye salmon Oncorhynchus nerka // VNIRO Proceedings. 161:6 5-77. (In Russian with English abstract).**

Analysis of the mtDNA control region (D-loop) polymorphism was conducted for sockeye salmon from the Russian Far East on a wide part of its range from Chukotka to the Kuril Islands. Two basic haplotypes (13T and 10T) were revealed in the samples from 16 lake-river systems of the Asia-Pacific coast. They differed in five nucleotide positions and were discovered in most populations. In the Kuril Islands populations (except Shumshu Island) there was observed 13T haplotype only, in the Commander Island sample only 10T was found out. All variants of D-loop nucleotide sequences were distributed among the two phylogenetic groups. In the first group the central haplotype was 13T, in the second — 10T. That probably can be explained by dividing the species range as well as gene pool into the two genetic lines in the past. The data obtained allow us to consider two scenarios of modern diversity of mtDNA haplotypes of Asian sockeye salmon. Both of them imply multiple expansions of the species in Asia during oceanic transgression periods after Pleistocene glaciation. According to one of them 13T haplotype had more ancient origin in the Asian part of the range, whereas 10T appeared later in the central Kamchatka refugia.

**Shpigalskaya, N.Yu., A.I. Kositsina, U.O. Muravskaya, and O.N. Saravansky. 2016. Genetic identification of juvenile pink salmon improves accuracy of forecasts of spawning runs in the Okhotsk Sea basin. N. Pac. Anadr. Fish Comm. Bull. 6: 415–420. doi:10.23849/npafcb6/415.420.**

Genetic methods were applied to identify the origin of juvenile even-year pink salmon (Oncorhynchus gorbuscha), collected from 12 locations in the Okhotsk Sea surveyed by the RV TINRO in October and November 2013. According to the results we have obtained, the proportion of the ’northern’ group of populations in the Okhotsk Sea basin, including western Kamchatka and the northern continental coast of the Okhotsk Sea, in mixed aggregations of juvenile pink salmon, is relatively small—about 24%. The largest proportion (58%) of the juvenile aggregations was identified as Sakhalin-Kuril stocks. The proportion identified as populations from the Amur River and Primorye was about 17%, with fish of ’unknown’ origin making up < 1%. It should be noted that the results obtained for 2013 did not correspond to the existing regional ratio for pink salmon runs of even-year generations in the Okhotsk Sea basin.

**Zhivotovsky, L.A. 2016. Chum salmon stock units provisory zoning along Russian Far East. Bulletin of Pacific salmon studies in Far East 11: 193-198. (In Russian).**

**Zhivotovsky, L.A., T.G. Tochilina, E.G. Shaikhaev, V.P. Pogodin, T.V. Malinina, and A.J. Gharrett. 2016. Hybrids between chum Oncorhynchus keta and pink Oncorhynchus gorbuscha salmon: age, growth and morphology and effects on salmon production // Journal of Fish Biology. 89: 2098-2106. (In English).**

Mature hybrids between chum salmon *Oncorhynchus keta* and pink salmon *Oncorhynchus gorbuscha*, which were identified by an intermediate colour pattern, were caught at the Kurilsky Hatchery, Iturup Island, Russia. Most of them were female and 3 years old (a partial freshwater year and 2marine years), which is intermediate between the ages of maturity of the parental species. The hybrids exceed both parental species in the rate of growth, are large in size and robust and might successfully compete for mating in the wild or be chosen for artificial reproduction. The ratio of the scale length over width, *R*, is oblate ($R<1$), whereas scales of the parental species are prolate ($R>1$). From scale analyses, the c.v. in body size of hybrid females at the second marine year is twice that of *O. keta*, which suggests developmental instability in the hybrid. A dynamic model predicted that continuing hybridization at a low rate does not produce a substantial hybrid load due to selection against advanced-generation hybrids and backcrosses. A high hybridization rate, however, may be an additional risk for genetic management and should be taken into account in programmes of artificial reproduction of Pacific salmon *Oncorhynchus* spp., although such hybrids might have commercial use in confined production systems.