

**Annual Report of Bering-Aleutian Salmon International
Survey (BASIS) Research Activities 2009 to 2012 Related to the
2009 to 2013 BASIS Science Plan Research Questions**

**Submitted to the
NORTH PACIFIC ANADROMOUS FISH COMMISSION**

by

**BASIS Working Group
Committee on Scientific Research and Statistics**

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Background

In October 2006, the NPAFC Parties agreed to continue the international effort to study salmon in the Bering Sea and requested a draft scientific plan for BASIS Phase II (NPAFC Doc 1164). BASIS phase II continued the efforts of Phase I by proposing a set of surveys within three regions of the Bering Sea to establish when and where salmon stocks migrate and rear in the Bering Sea, and to clarify the mechanisms of biological response by salmon and ecological related species to the conditions affected by climate change.

This document summarizes the published results for research questions proposed within the BASIS Phase II research plan. BASIS Phase II began during 2009 and finished in 2013.

Research Questions

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

- Bugaev A. V., Tepnin O. B. 2011. Estimation of some climatic factors influence on abundance of Asian pink and chum salmon. *Izv. TINRO* 166: 67-87 (In Russian with English abstract).
- Eisner, L., N. Hillgruber, E. Martinson, and J. Maselko. 2013. Pelagic fish and zooplankton species assemblages in relation to water mass characteristics in the northern Bering and southeast Chukchi seas. *Polar Biology*. 36(1):87-113.
- Farley, E.V., Jr., A. Starovoytov, S. Naydenko, R. Heintz, M. Trudel, C. Guthrie, L. Eisner, and J. Guyon. 2011. Implications of a warming eastern Bering Sea for Bristol Bay sockeye salmon. *ICES Journal of Marine Science* 68(6): 1138-1146.
- Heintz, R.A., E.C. Siddon, E.V. Farley, Jr., and J.M. Napp. 2013. Correlation between recruitment and fall condition of age-0 pollock (*Theragra chalcogramma*) from the eastern Bering Sea under varying climate conditions. *Deep Sea Research II*. 94:150-156.
- Hollowed. A.B., S.J. Barbeaux, E.D. Cokelet, E. Farley, S. Kotwicki, P.H. Ressler, C. Spital, and C. D. Wilson. 2012. Effects of climate variations on pelagic ocean habitats and their role in structuring forage fish distributions in the Bering Sea.
- Hurst, T.P., J.H. Moss, and J.A. Miller. 2012. Distributional patterns of 0-group Pacific cod (*Gadus macrocephalus*) in the eastern Bering Sea under variable recruitment and thermal conditions. *ICES Journal of Marine Science* 69(2): 163 – 174.
- Khen, G.V., E.O. Basyuk, N.S. Vanin, V.I. Matveev. 2013. Hydrography and biological resources in the western Bering Sea. *Deep Sea Research Part II: Topical Studies in Oceanography*. *Deep-Sea Research II* 94: 106-120.
- Krovnin, A., Klovach N. 2012. The association of long-term changes in West Kamchatka pink salmon catches with climate regime shifts in the Northern Hemisphere. *North Pacific Anadromous Fish Commission Technical Report* 8: 126-129.
- Martinson, E.C., H.H. Stokes, and D.L. Scarnecchia. 2012. Use of juvenile salmon growth and temperature change indices to predict groundfish post age-0 year class strengths in the Gulf of Alaska and eastern Bering Sea. *Fisheries Oceanography*. 21(4):307 – 319.
- Parker-Stetter, S.L., J.K. Horne, E.V. Farley, D.H. Barbee, A.G. Andrews, L.B. Eisner, and J.M. Nomura. 2013. Summer distributions of forage fish in the eastern Bering Sea. *Deep-Sea Research II*. 94:211-230.
- Siddon, E.C., R.A. Heintz, and F.J. Mueter. 2013. Conceptual model of energy allocation in walleye pollock (*Theragra chalcogramma*) from age-0 to age-1 in the southeastern Bering Sea. *Deep-Sea Research II*. 94:140-149.
- Shuntov, V.P. and O.S. Temnykh. 2011. Current changes in marine ecosystems in relation with climate changes: priority of global or regional factors? *Bulletin of Pacific salmon studies in the Russian Far East* 6: 49-64 (In Russian).

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

- Coyle, K.O., L.B. Eisner, F.J. Mueter, A.I. Pinchuk, M.A. Janout, K.D. Cieciel, E.V. Farley, and G. Andrews. 2011. Climate change in the southeastern Bering Sea: impacts on pollock stocks and implications for the oscillating control hypothesis. *Fisheries Oceanography*. 20(2): 139-156.
- Eisner, L.B., J.M. Napp, K.L. Mier, A.I. Pinchuk, A.G. Andrews III. In press. Climate-mediated changes in zooplankton community structure for the eastern Bering Sea. *Deep Sea Research II*.
- Herman, A.J., G.A. Gibson, N.A. Bond, E.N. Curchitser, K. Hestrom, W. Cheng, M. Wang, P.J. Stabeno, L. Eisner, K.D. Cieciel. In press. A multivariate analysis of observed and modeled biophysical variability on the Bering Sea shelf: multidecadal hindcasts (1970 – 2009) and forecasts (2010 – 2040). *Deep-Sea Research*.
- Hunt, G.L. Jr., K.O. Coyle, L.B. Eisner, E.V. Farley, R.A. Heintz, F. Mueter, J.M. Napp, J.E. Overland, P.H. Ressler, S. Salo, and P.J. Stabeno. 2011. Climate impacts on eastern Bering Sea foodwebs: a synthesis of new data and an assessment of the Oscillating Control Hypothesis.
- Pinchuk, A.I., K.O. Coyle, E.V. Farley, and H.M. Renner. In press. Emergence of the Arctic Themisto libellula (Amphipoda: Hyperiididae) on the southeastern Bering Sea shelf as a result of the recent cooling and their potential impact on pelagic food web. *ICES Journal of Marine Science*.
- Volkov A.F., Kuznetsova N.A., Farley E.V., Murphy J.M. 2009. Composition and distribution of zooplankton and feeding of Pacific salmon in the eastern Bering Sea in fall 2003-2008. *Izv. TINRO* 158: 275-292.
- Volkov, A.F., Farley E.V., Murphy J.M. 2009. Is it possible the stabilization in the plankton community of the eastern Bering Sea? *Bulletin №4 of realizations of «Concept of the Far Eastern basin research program of Pacific salmon study»*. Vladivostok. TINRO-CENTER Publ. 4: 159-166. (In Russian).
- Volkov, A.F. 2012. Mass development of Themisto libellula in the northern Bering Sea: invasion or bloom? *Izv. TINRO* 168: 142-151 (In Russian with English abstract).
- Volkov, A.F. 2012. Results of zooplankton research in the Bering Sea under NPAFC program (expedition BASIS). Part 1. Eastern areas. *Izv. TINRO* 169: 45-66 (In Russian with English abstract).
- Volkov, A.F. 2012. Results of the studies on zooplankton in the Bering Sea under NPAFC program (expedition BASIS). Part 2. Western areas. *Izv. TINRO* 170: 151-171 (In Russian with English abstract).

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

- Danielson, S., L. Eisner, T. Weingartner, K. Aagaard. 2011. Thermal and haline variability over the central Bering Sea shelf: seasonal and interannual perspectives. *Continental Shelf Research* 31: 539-554.
- Figurkin, A.L. and S.V. Naydenko. 2013. Spatial distribution of pink salmon in the Subarctic Front zone in winter-spring. *Izv. TINRO* 174: 69-84. (In Russian with English abstract).
- Habicht, C., L.W. Seeb, K.W. Myers, E.V. Farley, and J.E. Seeb. 2010. Summer-Fall distribution of stocks of immature sockeye salmon in the Bering Sea as revealed by single-nucleotide polymorphisms. *Transactions of the American Fisheries Society*. 139:1171 – 1191.
- Khen G.V., Zavolokin A.V. in press. Change in water circulation and its implication for distribution and abundance of salmon in the western Bering Sea in 21 century. *Izv. TINRO*.

- Larson, WA, Utter FM, Myers KW, Templin WD, Seeb JE, Guthrie III CM, Bugaev AV, Seeb LW. 2013. Single-nucleotide polymorphisms reveal distribution and migration of Chinook salmon (*Oncorhynchus tshawytscha*) in the Bering Sea and North Pacific Ocean. *Canadian Journal of Fisheries and Aquatic Sciences* 2012, 70(1):128-141.
- Seeb, L.W., J.E. Seeb, C. Habicht, E.V. Farley, Jr., F.M. Utter. 2011. Single-nucleotide polymorphic genotypes reveal patterns of early juvenile migration of sockeye salmon in the eastern Bering Sea. *Transactions of the American Fisheries Society* 140:734 – 748.
- Seeb, LW, Templin WD, Sato S, Abe S, Warheit K, Park JY, Seeb JE. 2011. Single nucleotide polymorphisms across a species' range: implications for conservation studies of Pacific salmon. *Molecular Ecology Resources* 11(Suppl. 1), 184-206.
- Stabeno, P.J., E.V. Farley, Jr., N.B. Kachel, S. Moore, C.W. Mordy, J.M. Napp, J.E. Overland, A.I. Pinchuk, and M. F. Sigler. 2012. A comparison of the physics of the northern and southern shelves of the eastern Bering Sea and some implications for the ecosystem. *Deep-Sea Research II*. 65-70: 14-30.
- Templin, WD, Seeb JE, Jasper JR, Barclay AW, and Seeb LW. 2011. Genetic differentiation of Alaska Chinook salmon: the missing link for migratory studies. *Molecular Ecology Resources* 11:226-246.
- Zavolokin, A.V., and G.V. Khen. 2012. Decreases in abundance of immature Pacific salmon in the western Bering Sea from 2002 to 2011: link to hydrological and forage conditions. NPAFC Doc. 1398. 20 pp. (Available at www.npafc.org).

4) How will climate change and climate cycles affect Pacific salmon carrying capacity within the Bering Sea?

- Karpenko V. I. and Maxim V. Koval 2012. Feeding Strategies and Trends of Pink and Chum Salmon Growth in the Marine Waters of Kamchatka North Pacific Anadromous Fish Commission Technical Report No. 8: 82-86.
- Shuntov, V.P., and O.S. Temnykh. 2008. Pacific salmon in marine and oceanic ecosystem. Vladivostok: TINRO-Centre. V. 1. 481 pp. (In Russian with English abstract).
- Shuntov, V.P., and O.S. Temnykh. 2011. Pacific salmon in marine and oceanic ecosystem. Vladivostok: TINRO-Centre. V. 2. 473 pp. (In Russian with English abstract).
- Shuntov V.P., Volvenko I.V., Temnykh O.S., Volkov A.F., Zavolokin A.V., Naydenko S.V., Dolganova N.T. 2010. To the substantiation of carrying capacity of Far-Eastern Seas and Subarctic Pacific for pacific salmon pasturing. Report 1. Forage areas of Pacific salmon. *Izv. TINRO* 160: 149 – 184.
- Shuntov V.P., Volkov A.F., Dolganova N.T., Zavolokin A.V., Temnykh O.S., Naydenko S.V., Volvenko I.V. 2010. To the substantiation of carrying capacity of Far-Eastern Seas and Subarctic Pacific for pacific salmon pasturing. Report 2. Composition, stock and dynamic of zooplankton and nekton — forage base of Pacific salmon. *Izv. TINRO* 160: 185 – 208.
- Shuntov V.P., Naydenko S.V., Zavolokin A.V., Volkov A.F., Dolganova N.T., Temnykh O.S., Volvenko I.V. 2010. To the substantiation of carrying capacity of Far-Eastern Seas and Subarctic Pacific for pacific salmon pasturing. Report 3. Daily feeding rhythm, food composition, and feeding selectivity of pacific salmon. *Izv. TINRO* 161: 3-24.
- Shuntov V.P., Temnykh O.S., Naydenko S.V., Zavolokin A.V., Dolganova N.T., Volkov A.F., Volvenko I.V. 2010. To the substantiation of carrying capacity of Far-Eastern Seas and Subarctic Pacific for pacific salmon pasturing. Report 4. Effect of density-dependant interactions on pacific salmon food supply and role of the salmon in consumption of nekton's forage base. *Izv. TINRO* 161: 25 – 52.
- Shuntov, V. P. and O. S. Temnykh. 2013. Illusions and realities of the ecosystem approach to the study and management of marine and oceanic biological resources. *Russian Journal of Marine Biology* 39(7): 455-473 (In English).

- Temnykh O.S., A.V. Zavolokin, L.O. Zavarina, V.V. Volobuev, S.L. Marchenko, S.F. Zolotuhin, N.F. Kaplanova, E.V. Podorozhnyuk, A.A. Goryainov, A.V. Lysenko, A.M. Kaev, Y. I. Ignat'ev, E.V. Denisenko, Y. N. Khokhlov, and O.A. Rassadnikov. 2012. Interannual variability in size and age structure of Russian chum salmon stocks. *Bulletin of Pacific salmon studies in the Russian Far East* 6: 226-239 (In Russian).
- Zavolokin, A.V., V.V. Kulik, I.I. Glebov, E.N. Dubovets, and Yu.N. Khokhlov. 2012. Dynamics of size, age, and intra-annual growth of Anadyr chum salmon in 1962-2010. *Journal of Ichthyology*. 52(3): 207-225. (In English).
- Zavolokin, A.V. 2013. Feeding habits, consumption rates, and growth of juvenile Pacific salmon in relation to fluctuations of the forage base and salmon abundance. NPAFC Technical Report 9: 97-100 (Available at www.npafc.org).