



What is BASIS?

The Bering-Aleutian Salmon International Survey (BASIS) is NPAFC's coordinated program of cooperative research on Pacific salmon in the Bering Sea that was designed to clarify the mechanisms of biological response by salmon to the conditions caused by climate changes. Scientific issues that provide necessary direction to the research include (but are not limited to):

- Seasonal-specific migration patterns of salmon and their relation to the Bering Sea ecosystem
- Key biological, climatic, and oceanographic factors affecting long-term changes in Bering Sea food production and salmon growth rates
- Similarities in production trends between salmon populations in the Bering Sea and common factors associated with their trends in survival
- Overall limit or carrying capacity of the Bering Sea ecosystem to produce salmon

Background Information

By mutual agreement of the five nations, the NPAFC Convention Area forms the world's largest marine conservation area for seven species of Pacific salmon, including chum salmon (*O. keta*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), sockeye salmon (*O. nerka*), chinook salmon (*O. tshawytscha*), cherry salmon (*O. masou*), and steelhead trout (*O. mykiss*).

Throughout this huge marine conservation area, directed fishing for Pacific salmon is prohibited, incidental taking of Pacific salmon is minimized to the maximum extent, and retention of Pacific salmon on board vessels fishing for non-anadromous fish is strictly prohibited and enforced.



The NPAFC Convention area forms a common feeding ground for salmon from all NPAFC member parties. To achieve a common goal of conservation and sustainable management of Pacific salmon resources, the best available scientific information on the condition of fish migrating in the Convention area is needed. Questions about ocean migration, distribution, intermixing of stocks, associated effects on growth rates, and the need for international baselines to identify stock origins of salmon are major research issues faced by all NPAFC member parties.

A growing body of scientific evidence supports hypotheses about the direct and indirect effects of environmental change on salmon production. For example, there is a strong correspondence between salmon catch and climate indices, indicating a shift to a more productive regime in the late 1970s. To address the broader questions of salmon carrying capacity in the North Pacific Ocean and how the environment influences salmon biology and population dynamics, we need stock-specific information on ocean distribution, migration, and behavior patterns of salmon. Knowledge of underlying processes gained from research in specific areas should be applicable to stocks in other regions. Changes in the production of salmon are often the consequence of complex changes in marine and freshwater ecosystems.

To assess and manage salmon populations methods must be developed to incorporate all relevant information affecting their production including the effects of climate change, stock-recruitment relationships, and fishing. The NPAFC provides a forum for international coordination of regional salmon research programs, essential to resolution of these important issues.

What is the Current Focus of International Cooperative Salmon Research Activities?

As a part of NPAFC's efforts to achieve sustainable conservation of salmon stocks in their ocean ecosystems, the present focus of cooperative research activities is on salmon in the Bering Sea and adjacent waters. Asian and North American salmon stocks are distributed in high density in the Bering Sea during summer. Intra- and inter-specific interactions have been observed in some species and stocks.

Physical and biological conditions in the Bering Sea changed drastically in the 1990s, and there were extreme fluctuations in the abundance and growth of some stocks. These changes in carrying capacity and salmon growth and production are not coincidental, but show a clear linkage between the marine environment and salmon production. Specific mechanisms underlying these linkages, however, are unknown principally due to absent or outdated information on the life history of many salmon populations in the Bering Sea.



BASIS Working Group Points of Contact:

Chairman: Jack Helle
Auke Bay Laboratory, NMFS, Juneau, Alaska, USA
Tel: 1-907-789-6038,
email: jack.helle@noaa.gov

For

Canada:



Pacific Biological Station Fisheries and Oceans Canada
R. Beamish: Tel: 1-250-756-7029, email: beamishr@pac.dfo-mpo.gc.ca

For

Japan:



Hokkaido National Fisheries Research Institute, Fisheries Research Institute
Tomonori Azumaya: Tel: 81-154-92-9136, email: azumaya@fra.affrc.go.jp
Toru Nagasawa: Tel: 81-154-92-1715, email: nagasat@affrc.go.jp

National Salmon Resources Centre
Shigehiko Urawa: Tel: 81-11-822-2341, email: urawa@salmon.affrc.go.jp

For Korea:



Salmon Research Center
Sukyung Kang: Tel: 82-33-672-4180, email: kangsk@momaf.go.kr

National Fisheries Research & Development Institute
Jung Youn Park: Tel: 82-51-720-2466, email: popgenet@momaf.go.kr

For

Russia:



Kamchatka Fishery & Oceanography Research Institute (KamchatNIRO)
Nikolay Antonov: Tel: 7-415-211-2738, email: antonov@kamniro.ru
Vladimir Karpenko: Tel: 7-415-212-5598, email: karpenko@kamniro.ru

Pacific Scientific Research Fisheries Centre, (TINRO-Centre)
Olga Temnykh: Tel: 7-4232-401-504, email: temnykh@tinro.ru

For USA:



Auke Bay Laboratory, National Marine Fisheries Service
Ed Farley: Tel: 1-907-789-6085, e-mail: ed.farley@noaa.gov
Jack Helle (Chair): Tel: 1-907-789-6038, email: jack.helle@noaa.gov

School of Aquatic & Fishery Sciences, University of Washington
Kate Myers: Tel: 1-206-543-1101, email: kwmyers@u.washington.edu

Alaska Department of Fish & Game
Jim Seeb: Tel: 1-907-267-2385, email: jseeb@fishgame.state.ak.us

RESEARCH PROGRESS

What research progress has been made?

In 2002-2005 scientists of all NPAFC member nations cooperated in the design and execution of a complex ecosystem survey of salmon across the entire Bering Sea (Fig 1). ([NPAFC Doc. 579, Rev. 2](#))

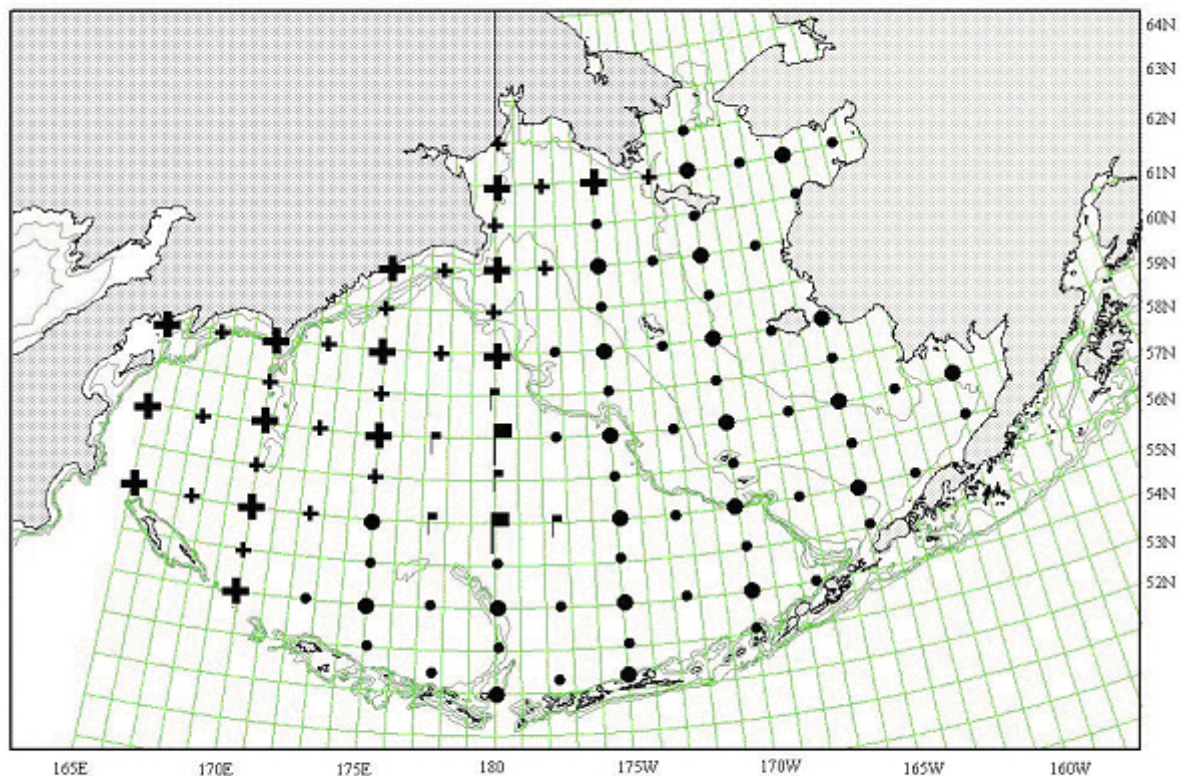


Fig. 1. Map showing BASIS study area and research vessel stations in the Bering Sea. Dots show stations in U.S. waters, flags show stations in international waters, and pluses show stations in Russian waters.

Vast amounts of new information on the biology and ecology of foraging salmon and other fish species were collected. Oceanographic and other environmental data were gathered simultaneously with fishing operations. Research vessels sampled all major geographic regions, marine habitats (coastal, shelf, basin), and life history stages of salmon during summer and fall (July-November).

A variety of fishing gear (trawl, gillnet, and longline) and plankton sampling gear were used. Calibration experiments were conducted to evaluate differences in some vessel/gear combinations. Samples and data for salmon age, growth, food habits, lipid content, bioenergetics, stock identification, and parasite research were collected. A shipboard technique to rapidly identify genetic stocks of salmon on the high seas was tested. Some fish were tagged and released with archival and data-storage tags that measure water temperature, swimming depth, and swimming speed.

Over 50 scientific publications detailing the methods and results of BASIS research are in preparation. A BASIS workshop, hosted by NPAFC, was held on October 30-31, 2004, in Sapporo, Japan, to review the progress of recent research and to plan future research. Some examples of preliminary results from 2002-2004 BASIS research include:

- BASIS is providing some of the first comprehensive hydrographical observations over large areas of the Bering Sea; these data can be used to estimate temperature, salinity, and current structures that influence the distributions and movements of salmon and ecologically related species.
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- BASIS investigations (2002-2004) have coincided with warming and intensification of water exchange between the Pacific Ocean and the Bering Sea, which has important implications for salmon production.
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- Since the start of BASIS, high sea temperatures and lack of extensive coccolithophores (phytoplankton) blooms in the eastern Bering Sea seem to have contributed to high juvenile sockeye salmon survival; coccolithophore blooms and cold surface temperatures may restrict the offshore distribution and effective forage area of juvenile salmon on the eastern Bering Sea shelf, reducing the carrying capacity of the shelf for juvenile salmon.
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- Comprehensive zooplankton sampling at daytime stations across the Bering Sea in fall (2003-2004) showed well-defined spatial separation in major concentrations of different size groups of zooplankton, with small zooplankton (copepods) dominant the eastern Bering Sea and large zooplankton (euphausiids, amphipods) dominant in the western Bering Sea.
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- In the western Bering Sea (2003-2004), there has been a steady decline in the overall abundance of mesopelagic species, including northern lampfish (*Stenobrachius leucopsarus*), which is a stable component of the diets of Pacific salmon in western North Pacific waters off Kamchatka and of walleye pollock (*Theragra chalcogramma*) in continental shelf-break areas; in 2003-2004, southern boreal and subtropical species including Pacific pomfret (*Brama japonica*) and Japanese common squid (*Todarodes pacificus*) penetrated into the western Bering Sea survey area.
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- Large body sizes and an increase in relative abundance of juvenile salmon on the eastern Bering Sea shelf (2002-2004) indicated excellent early marine growth and survival, and corresponded to subsequent increases in adult salmon returns to western Alaska.
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- In the western Bering Sea, the offshore migrations of all species of juvenile salmon to deep-water areas were earlier in fall 2004 than in 2002-2003; juvenile sockeye salmon were more abundant in 2004 than in 2002 and 2003, were caught over a very broad range of SSTs (4.5-10C), and were concentrated in shelf-break areas; the estimated abundance of juvenile chinook salmon in this region was the highest among all previous surveys (since the 1980s; twice as high as in 2003).
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- Since the start of BASIS, chum salmon have dominated catches of immature and maturing salmon in the central and western Bering Sea in summer and fall; in the central Bering Sea and adjacent areas of the North Pacific Ocean, overall distribution patterns of immature chum, sockeye, and chinook salmon have been similar in all three years of BASIS, indicating a relation to geography of the ocean.
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- Diel studies of vertical distribution of salmon using research trawls indicate that the overwhelming majority of salmon are located in the 0-40 m depth layer; experiments with electronic tags that measure sea temperature and swimming depth, indicate that each salmon species has a characteristic pattern of diurnal vertical migration; as individual fish migrate through different water masses they appear to be selecting maximum swimming depths rather than sea temperature ranges.
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- The diets of salmon across the Bering Sea vary by species, oceanic region, body size group, and maturity stage; in the eastern Bering Sea, juvenile salmon were distributed in areas of highest densities of their preferred prey; juvenile salmon consumed a broader spectrum of prey, including more plankton species, in 2004 than in 2003; in both years juvenile pink, chum, sockeye, and coho salmon fed primarily on fish, particularly walleye pollock.
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- Predators of salmon investigated by BASIS researchers include several species of fish: North Pacific daggertooth (*Anotopterus nikparini*), longnose lancetfish (*Alepisaurus ferox*), Pacific lamprey (*Lampetra tridentata*), Arctic lamprey (*L. camtschatica*), salmon shark (*Prionace glauca*), and Pacific sleeper shark (*Somniosus pacificus*); few injuries to salmon by marine mammals were observed in the western Bering Sea (2002-2003), perhaps because attacks by marine mammals are often lethal and occur mainly in the coastal zone.
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- New advances in genetic (DNA) stock identification techniques are rapidly improving the ability of BASIS researchers to accurately identify the geographic region or river of origin of salmon caught at sea; preliminary DNA results show intermingling of immature Russian and Alaskan sockeye salmon in the western and central Bering Sea in August-October; DNA analyses of immature and maturing chum salmon indicate that Asian stocks were dominant in the central Bering Sea.

NPAFC BASIS projects are funded by Special Fund for Scientific Research through member country governments and [North Pacific Research Board](#).

How can You help?

Inadequate funding continues to be a major challenge to the future of BASIS research. Each national party of NPAFC has made a substantial commitment of resources to the joint work, including research vessels and scientific expertise. Analyses of many samples and data collected in 2002-2003, however, have had to be postponed until more funding is available. Some participants lack even the most basic equipment for carrying out field and laboratory research and data analysis. We welcome your support for BASIS research.

External Funding Working Group Points of Contact:

Chairman: Frank L. Cassidy, Jr., Northwest Power and Conservation Council, USA, e-mail: fcassidy@cassidyjr.com

For Canada: Gerry Kristianson, Sport Fishing Institute
Tel: 1-250-656-5829, Fax: 1-250-656-5829 Email: gerrykr@telus.net



For Japan: Koji Miyaura, Fisheries Agency
Tel: 81-3-3501-3861, Fax: 81-3-3502-0571, Email: koji_miyaura@nm.maff.go.jp



For Korea: Kyu Jin Seok, Ministry of Maritime Affairs and Fisheries
Tel: 82-2-3148-6994, Fax: 82-2-3148-6996, Email: pices@momaf.go.kr



For Russia: Sergey Maksimov, Federal Agency for Fisheries of the Russian Federation
Tel: 095-942-32-71, Fax: 095-928-4798, Email: maksimovsv@fishcom.ru



For USA: Frank L. Cassidy, Jr. (Chairman), Northwest Power and Conservation Council,
Tel: 1-360-693-6951, Fax: 1-360-693-6079, Email: fcassidy@cassidyjr.com



For more information

NPAFC Secretariat
North Pacific Anadromous Fish Commission
Suite 502, 889 West Pender Street
Vancouver, B.C.
V6C 3B2
Canada

Telephone: 1-604-775-5550

Facsimile: 1-604-775-5577

e-mail: secretariat@npafc.org

URL: <http://www.npafc.org>. **Schedules of BASIS meetings and workshops**

The Basis Working Group is scheduled to meet at the NPAFC Thirteenth Annual Meeting in Jeju Island, Korea, October 24-28, 2005.

BASIS participating agencies and organizations

Canada:



[Fisheries and Oceans Canada](#)

Japan:



[Fisheries Agency of Japan \(FAJ\)](#) (in Japanese only)

[Hokkaido National Fisheries Research Institute \(HNFRI\)](#)

[National Salmon Resources Center \(NSRC\)](#) (in Japanese only)

Korea:



[National Fisheries Research & Development Institute](#)

Russia:



[Kamchatka Fishery & Oceanography Research Institute \(KamchatNIRO\)](#)

[Pacific Scientific Research Fisheries Centre, TINRO-Centre \(TINRO\)](#)

USA:



[National Marine Fisheries Service, Auke Bay Laboratory](#)

[School of Aquatic & Fishery Sciences, University of Washington](#)

[Alaska Department of Fish & Game](#)

List of reports and publications: NPAFC Documents

- [Doc. 579 \(Rev. 2\)](#) Draft Plan for NPAFC Bering-Aleutian Salmon International Survey (BASIS) 2002 - 2006
- [Doc. 622](#) International Salmon Research Aboard the R/V *Wakatake maru* in the Central North Pacific Ocean and Bering Sea during the Summer of 2002
- [Doc. 676 \(Rev.1\)](#) Cruise Report of the 2002 *F/V Northwest Explorer* BASIS Survey in the Bering Sea, September - October
- [Doc. 666](#) Review of the Zooplankton Sampling and Processing Methods Used During BASIS Cruises 2002
- [Doc. 677 \(Rev. 1\)](#) Trawl Comparisons and Fishing Power Corrections for the *F/V Northwest Explorer*, and *R/V Kaiyo maru* During the 2002 BASIS Survey
- [Doc. 678](#) Eastern Bering Sea (BASIS) Coastal Research (August - October 2002) on juvenile Salmon
- [Doc. 679](#) United States National Cruise Plan for BASIS Research by the *F/V Sea Storm*, August - October 2003
- [Doc. 682 \(Rev. 2\)](#) The results of the trawling survey in the epipelagic layer of the Russian Economic Zone in the Bering Sea during September - October, 2002
- [Doc. 684 \(Rev. 1\)](#) Annual Report of the Bering- Aleutian Salmon International Survey (BASIS), 2002
- [Doc. 691](#) Report of the Bering-Aleutian Salmon International Survey (BASIS) Working Group Meeting
- [Doc. 692](#) Proposed Cruise Plan of the R/V TINRO for Pacific Salmon Marine Period of life Research in the Bering Sea in 2003
- [Doc. 717](#) Results of the survey by *Kaiyo maru* in Bering Sea, 2002

- BASIS semi-annual reports of results

http://www.nprb.org/research/res_2002_projects_listing.htm

- [R0204:](#) NPAFC Salmon Tagging
- [R0303:](#) NPAFC Cooperative Research: Use of genetic stock identification to determine the distribution, migration, early marine survival, and relative stock abundance of sockeye and chum salmon in the Bering Sea