NPRB PROPOSAL SUMMARY PAGE
(To be filled in by applicant)

NPRB Use Only
Reference No: _____
Date Received: _____

Project Title: NPAFC Salmon Tagging

Project Period: From Date: July 2002 to October 2003

Name, Address, and Telephone Number of Applicant:

North Pacific Anadromous Fish Commission (NPAFC)
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Principal Investigator(s):

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Legislative Criteria and Research Priorities Addressed:

1. Legislative Criteria: ☑ NPRB ☐ NPMRI ☐ Both
2. Research Priorities (one or more, a - h): f

Summary of Work (250 words or less):

This proposal is submitted by the United Sates on behalf of the North Pacific Anadromous Fish Commission (NPAFC). The goal of the proposed research is to understand the distribution patterns, habitat utilization, and movements of Bering Sea salmon stocks through an at-sea tagging program of immature and maturing fish. The proposed work directly addresses the priority of the North Pacific Research Board (NPRB) to study factors salmon stock dynamics, mortality, and migration. The proposed work is part of an international cooperative research program, the Bering-Aleutian Salmon International Survey (BASIS), planned and coordinated by NPAFC, to study the stock dynamics of salmon in the Bering Sea and Aleutian Island ecosystems. The NPRB funding would be used to tag and release approximately 1000 salmon caught during 2002-2003 salmon research vessel cruises in the Bering Sea and Gulf of Alaska. Several types of tags, ranging from simple numbered plastic discs to complex electronic tags that record sea temperature, depth, and daily position estimates would be used. A tag recovery reward program administered by NPAFC would provide incentive to fishermen and processors to return tags. The BASIS working group of NPAFC will coordinate, implement, and report the results of the tagging research. The proposed work will complement ecosystem research and monitoring activities of the North Pacific Marine Science Organization (PICES) and Global Ocean Ecosystem Dynamics (GLOBEC), and the electronic tagging research activities of the Pacific Ocean Salmon Tracking (POST), Census of Marine Life.

Funding: Total NPRB Funding Requested: $190,800

Total Matching Funds Used: $1,420,000

Legally Binding Authorizing Signature and Affiliation:

STATEMENT OF WORK

1. **Project Title: NPAFC Salmon Tagging**

2. Proposal Summary

This proposal is submitted by the United Sates on behalf of the North Pacific Anadromous Fish Commission (NPAFC). The goal of the proposed research is to understand the distribution patterns, habitat utilization, and movements of Bering Sea salmon stocks through at-sea tagging of immature and maturing fish. The proposed work directly addresses the priority of the North Pacific Research Board (NPRB) to study factors affecting salmon stock dynamics, mortality, and migration. The proposed work is part of an international cooperative research program, the Bering-Aleutian Salmon International Survey (BASIS), planned and coordinated by NPAFC, to study the stock dynamics of salmon in the Bering Sea and Aleutian Island ecosystems. The NPRB funding would be used to tag and release approximately 1000 salmon caught during 2002-2003 salmon research vessel cruises in the Bering Sea and Gulf of Alaska. Several types of tags would be used, ranging from simple numbered plastic discs to complex electronic tags that record sea temperature, depth, and daily position estimates. A tag recovery reward program administered by NPAFC would provide incentive to fishermen and processors to return tags. The BASIS working group of NPAFC will coordinate, implement, and report the results of the tagging research. The proposed work will complement ecosystem research and monitoring activities of the North Pacific Marine Science Organization (PICES) and Global Ocean Ecosystem Dynamics (GLOBEC), and the electronic tagging research activities of the Pacific Ocean Salmon Tracking (POST), Census of Marine Life.

3. Project Responsiveness to NPRB Research Priorities

This tagging project addresses the NPRB Research priority to study factors affecting salmon stock dynamics, mortality and migration throughout their range and life cycle. Funding is requested to support tagging research during NPAFC salmon research vessel cruises, which will sample salmon throughout the Bering Sea during the summer and fall seasons of 2002-2003. Tag recoveries will provide information on the distribution of salmon stocks in the Bering Sea and will complement the genetic stock identification research planned for the surveys. The primary focus of this tagging project, however, will be information recovered from the electronic tags. Electronic tags will provide important information on salmon migration and their migratory corridors through a continuous record of depth, temperature, and/or daily position estimates. These data will be particularly important to understanding salmon migration and ocean conditions in times and areas not sampled by the BASIS surveys such as their overwintering habitats. Depth information from electronic tags will provide key data on the vertical migration and distribution of salmon with depth, required to relate surface catch rates of salmon to their abundance levels and ensure surface catch rates are comparable between species and between samples collected at different times of the day. Temperature data from electronic tags will provide insight into habitat utilization and the metabolic effects of temperature on growth important to the development of bioenergetic models of salmon growth.

4. Project Design and Conceptual Approach

An understanding of the migration and distribution of Bering Sea salmon stocks is needed to determine the extent to which competitive feeding dynamics between different stocks and species may be negatively affecting the growth, maturation rates, and survival of salmon in the Bering Sea. Significant reductions in size-at-maturity and increases in age-of-maturity have occurred in salmon stocks throughout the Bering Sea basin, and are thought to be the result of limited food supply during their ocean growth period (e.g., Kaeriyama 1989; Ishida et al. 1993; Bigler et al. 1996, Helle and Hoffman 1998; Watanabe 2000; Azumaya and Ishida 2000). Bioenergetic modeling of observed size changes in salmon in the Bering Sea in early summer indicates that salmon are feeding at rates close to their physiological maxima, and that any reduction in daily ration could cause a significant decrease in growth over a time period as short as two months (Davis et al. 1998). Studies of scale growth patterns of Japanese chum salmon and Bristol Bay sockeye indicate that growth reduction occurs during the second or third summers in the Bering Sea, and is significantly correlated with salmon abundance (Fisheries Agency of Japan 2001; G. Ruggerone, Natural Resource Consultants, Seattle, Washington, unpublished data). Chum salmon in the Bering Sea are thought

to switch their diets from high to low energy prey in response to increased salmon abundance (Tadoroko et al. 1996; N. Davis, University of Washington, Seattle, unpublished data). These ocean carrying capacity concerns leading to reduced growth or nutritional status of salmon may be linked to increased ocean mortality during their overwintering period (Beamish and Manhken 1998; Nomura et al. 2000).

Previous Tagging Research

Direct information on salmon stocks migrating in the Bering Sea is largely from historical tagging studies by the International North Pacific Fisheries Commission (INPFC, 1955-1992) and by a U.S.-U.S.S.R. bilateral salmon tagging research program (1983-1991). All of the Bering Sea tagging work was done in summer, primarily June-August. Salmon were caught with surface longline or purse seine gear, and viable fish were tagged with external (usually disc) tags and released. Most tag recoveries were voluntary returns from high seas or terminal area fisheries, hatcheries, or spawning streams. Since the implementation NPAFC (1992-present), one research vessel, the *Wakatake maru*, has been used to tag salmon in the Bering Sea in July. The largest returns were from major stocks subject to intense commercial fisheries, particularly in western Alaska sockeye salmon, Japanese hatchery chum salmon, and Russian (East Kamchatka) pink salmon. The INPFC (1980-1992) and the NPAFC (1993-present) have also coordinated efforts for recoveries of North American coded-wire tagged (CWT) salmon during high seas commercial fishing and research vessel operations. The combined results of these tagging studies, show that there are at least some fish from nearly every geographic region of Asia and North America that migrate to the Bering Sea (French et al. 1975; Myers et al. 1996).

New tagging technologies have enabled us to get more precise detailed data from individual fish as they migrate. NPAFC scientists have cooperated in the deployment of data storage tags (DSTs) for international cooperative high seas tagging programs since 1998. Archival DSTs that recorded temperature or temperature and depth during salmonid ocean migrations were applied to salmon captured during U.S. and Japanese research cruises. The number of recoveries (for example, 6 of 24 sockeye salmon tagged in the Gulf of Alaska, 1 of 1 chinook salmon tagged in the Gulf of Alaska, 5 of 23 chum salmon in the Bering Sea) demonstrated that DST tagging programs were feasible and justified. Japanese scientists have also recovered chum salmon with surgically inserted tags that recorded temperature, depth, light levels, and swimming (current meter) speeds in the Bering Sea (unpublished data).

Data storage tag studies have provided new insight into the migratory behavior and habitat utilization of salmon (Walker et al. 2000a, b; Friedland et al. 2001; Murphy and Heard 2001; Walker 2001). These studies have shown that salmon undergo extensive vertical migrations, and that their vertical distribution varies significantly by species and time-of-day. Data from the first recoveries of temperature-recording DSTs from salmon tagged on the high seas showed a clear diel pattern of higher, relatively constant average temperatures at night, with narrower temperature ranges and fewer descents than during the day (Walker et al. 2000a). Alaskan pink and coho salmon and steelhead tagged in the Gulf of Alaska were at higher temperatures on average (10°-12°C) than Japanese chum salmon tagged in the Bering Sea (8°-10°C). Japanese chum salmon were also found at a wider range of temperatures (-1°-22°C vs. 5°-15°C). This is probably related both to the different oceanographic regions through which the fish migrated, as well as species differences in thermal ranges and vertical movements. Proportions of time that individual fish spent at different temperatures seemed to vary among oceanographic regions. Data from temperature-depth tags recovered in 1999 (one sockeye, two pink, and four coho salmon tagged in the GOA in July) show that salmon spent most of the time in the top 40 meters, with infrequent excursions to 60-100 m. All species show considerable diurnal and shorter-term variation in ambient temperatures, which suggests that ocean distribution of salmon may be linked more to prey distribution, foraging, and migration than to sea surface temperatures. Walker et al. (2000b) used actual temperatures recorded on DSTs in a bioenergetic model to estimate daily ration and to compare simulated salmon marine growth under differing temperature conditions. Friedland et al. (2001) used differences in sea surface temperatures between the beginning and end of day and night as indications of progress against thermal gradients, and concluded that chum salmon migrating from the Bering Sea to Japan make more progress in their migration during the day than during the night. Rough migration routes based on sea surface temperatures are also estimated. Using depth information from DSTs, Murphy and Heard (2001) showed that chinook salmon maintain a reverse diel migration pattern, which is unlike the diel vertical migration observed in other species of salmon.

As a result of these studies, NPAFC has recommended the use of data from archival (geoposition) and data storage tags (DST) tags to address issues concerning (1) conservation (stock-specific migration behavior), (2) global warming (vertical and horizontal behavior and associated environmental factors), (3) carrying capacity (swimming behavior and bioenergetics), (4) salmon enhancement (migration mechanisms of Pacific salmon), and (5) technical considerations, for example, geoposition algorithms and incorporation of new tag features.

NPAFC and BASIS Research

The NPAFC Convention (Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean) entered into force in 1993. The NPAFC, established under the Convention, serves as a forum for international coordination of scientific research and enforcement activities and promotion of conservation of Pacific salmon and ecologically related species. NPAFC research from 1995 to 2000 focused on two broad areas: (1) the factors affecting current trends in the productivity of the North Pacific Ocean and their impacts on salmonid carrying capacity, and (2) the factors affecting changes in biological characteristics of Pacific salmon, including growth, size at maturity, age at maturity, oceanic distribution, survival, and abundance. Each member nation of NPAFC implemented its own national research plan to address this work. While significant scientific results were obtained under this science plan, some national representatives felt that NPAFC was not using to full advantage its unique forum for international coordination of regional salmon research programs. As a result, in November 2000 NPAFC adopted a new science plan calling for cooperative salmon research activities among the four nations (NPAFC 2000). As stated in the science plan, "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."

In an historic agreement at the 2001 NPAFC annual meeting, Canada, Japan, Russia, and the United States proposed for the first time to work together on salmon stock dynamics in the Bering Sea (NPAFC 2001). A draft plan for the research, called the "Bering-Aleutian Salmon International Survey (BASIS)," was developed by NPAFC. BASIS will provide the first synoptic, seasonal information on salmon stock dynamics throughout their range and life cycle in the Bering Sea and Aleutian Island ecosystems (Fig. 1). This major achievement was due in large part to the efforts of Fran Ulmer, Alaska Lieutenant Governor, who served as NPAFC President in 2000-2001, and as one of the three U.S. representatives to NPAFC since 1994. One of her highest priorities in NPAFC has been to advance the coordination of international high seas salmon research. As Lt. Governor Ulmer explained to her U.S. constituents, "under the (BASIS) agreement, the United States, Canada, Russia and Japan will cooperatively conduct needed research on what happens to our salmon during the years they spend in the open ocean. Where do they migrate? What do they eat? How are they impacted by sea temperature changes? Over the next five years, BASIS will enable us to expand our scientific understanding of U.S. salmon resources and salmon stocks of other Pacific Rim nations, and build important scientific and political bonds that will serve us well into the future." In addtion to cooperation within the Commission, NPAFC scientists plan to integrate the their work with the climate, ocean, and ecosystem research and monitoring activities of other international organizations, such as the North Pacific Marine Science Organization (PICES) and Global Ocean Ecosystem Dynamics (GLOBEC).

To coordinate, implement, and report on the research, and to prepare proposals for external funding, a BASIS Working Group was formed within NPAFC with members from Canada: R. Beamish; Japan: S. Urawa and T. Azumaya; Russia: V. Karpenko, S. Sinyakov, and V. Lapko; and the United States: J. Helle (Chairman), D. Eggers, and K. Myers. This fall the United States made an unprecedented one-time contribution of $175,000 to the NPAFC to facilitate this joint research planning and coordination. This seed money was used to establish the NPAFC Special Fund for Scientific Research (NPAFC, amendment of the Financial Rules 19). Some of the money will be used to hold a special meeting of the BASIS Working Group in Vladivostok, Russia, in May 2002, to further plan and implement cooperative Bering Sea Research. Full funding of the BASIS proposal remains a major challenge for all four nations.

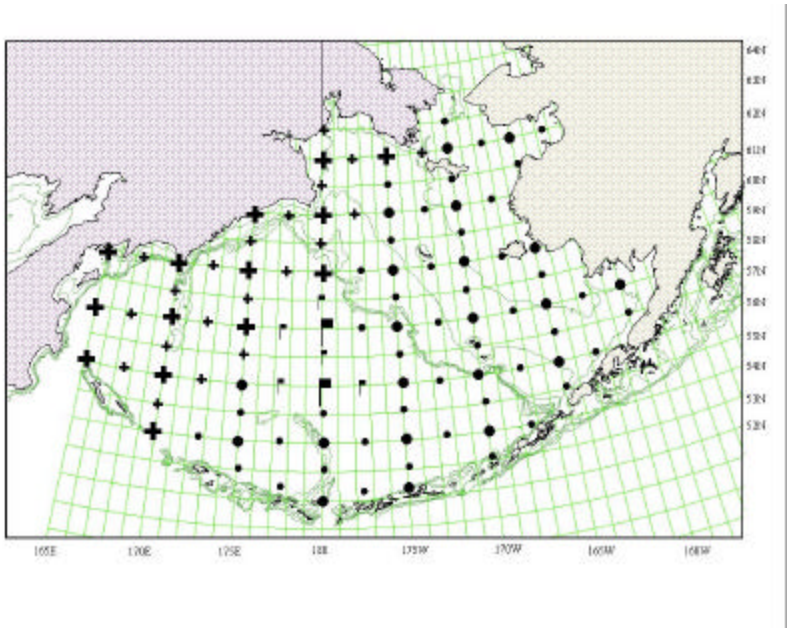

Figure 1. Bering Sea study area and grid of salmon research vessel sampling locations for BASIS (*from* NPAFC 2001).

National Surveys Supporting BASIS Research in 2002

Presently, the United States, Japan, and Russia have planned surveys in the Bering Sea during the summer and fall seasons of 2002 to support the development of BASIS, and tags will be deployed from as many of these surveys as possible. The surveys will use a combination of stock assessment, stock identification, and oceanographic sampling methods to define migratory routes of salmon and characteristics of their migratory corridors in the Bering Sea and Aleutian Island ecosystems. Japanese research vessels, the *Kaiyo maru* and the *Wakatake maru*, will survey the Bering Sea during the summer and fall seasons (Fukuwaka and Azumaya, 2001; N. Davis, U.S. cruise participant, *Wakatake maru*, Univ. Washington, pers. comm.; Fig. 2). The Japanese research vessel *Oshoro maru,* operating in the Gulf of Alaska in July will have the opportunity to tag immature sockeye and chum salmon stocks that migrate between the Bering Sea and Gulf of Alaska (R. Walker, U.S. cruise participant, Univ. Washington, pers. comm.). Up to three Russian vessels, will survey BASIS stations during summer and fall 2002 in the western Bering Sea (Fig. 1; V. Karpenko, KamchatNIRO, Petropavolvsk, pers. comm.). One of these cruises will start on June 15 (departing from the port of Vladivostok) and finish at the end of July-beginning of August (arriving at the port of Anadyr; O. Temnykh, TINRO-Center, Vladivostok, pers. comm.). The United States is planning a survey in the Bering Sea during the fall season to support the development of BASIS (Jack Helle and Jim Murphy, NMFS, ABL, pers. comm.; Fig. 3). Intense sampling by another U.S. vessel during three cruise legs in the eastern Bering Sea will provide additional opportunities to tag salmon (Ed Farley, NMFS, ABL, pers. comm; Fig. 4).

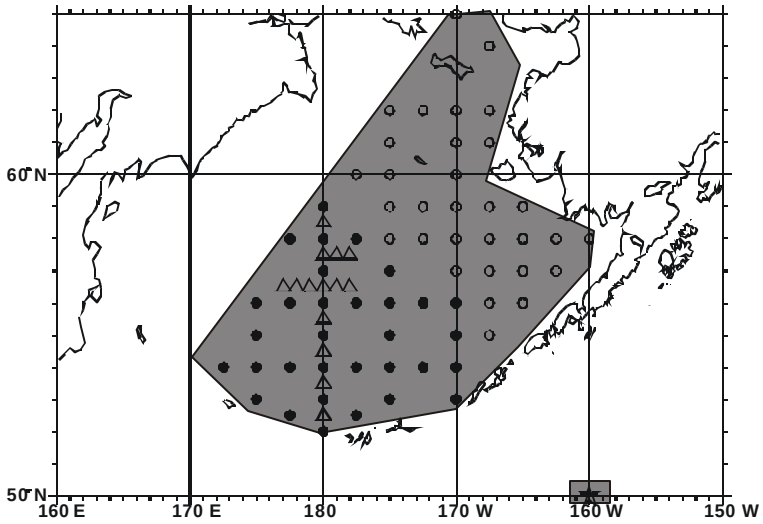

Figure 2. Station locations of the *Kaiyo maru*, June 20 (Tokyo) – September 30 (Tokyo), and *Wakatake maru*, June 6 (Hakodate) - July 23 (Hakodate). Solid circles identify rope trawl and oceanographic stations, open circles identify oceanographic only stations by the *Kaiyo maru*. Open triangles identify drift gillnet stations by the *Wakatake maru*.

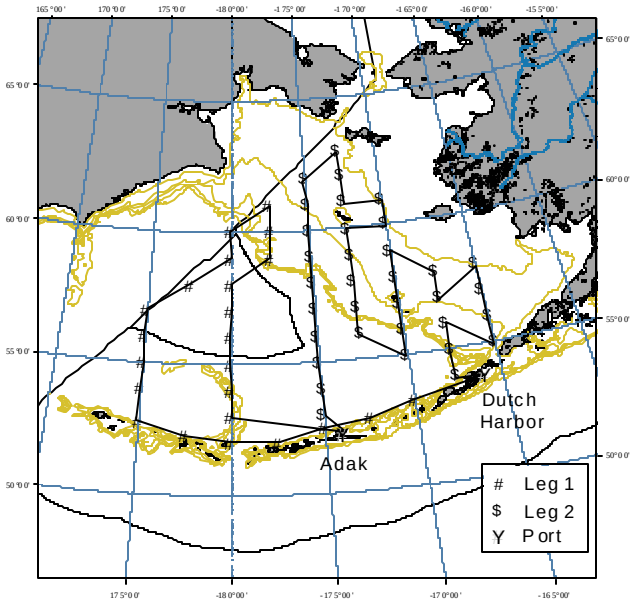

Figure 3. Map of U.S. Bering Sea and Aleutian Island (BASIS) survey identifying the cruise track, stations, and ports of call, September-October, 2002.

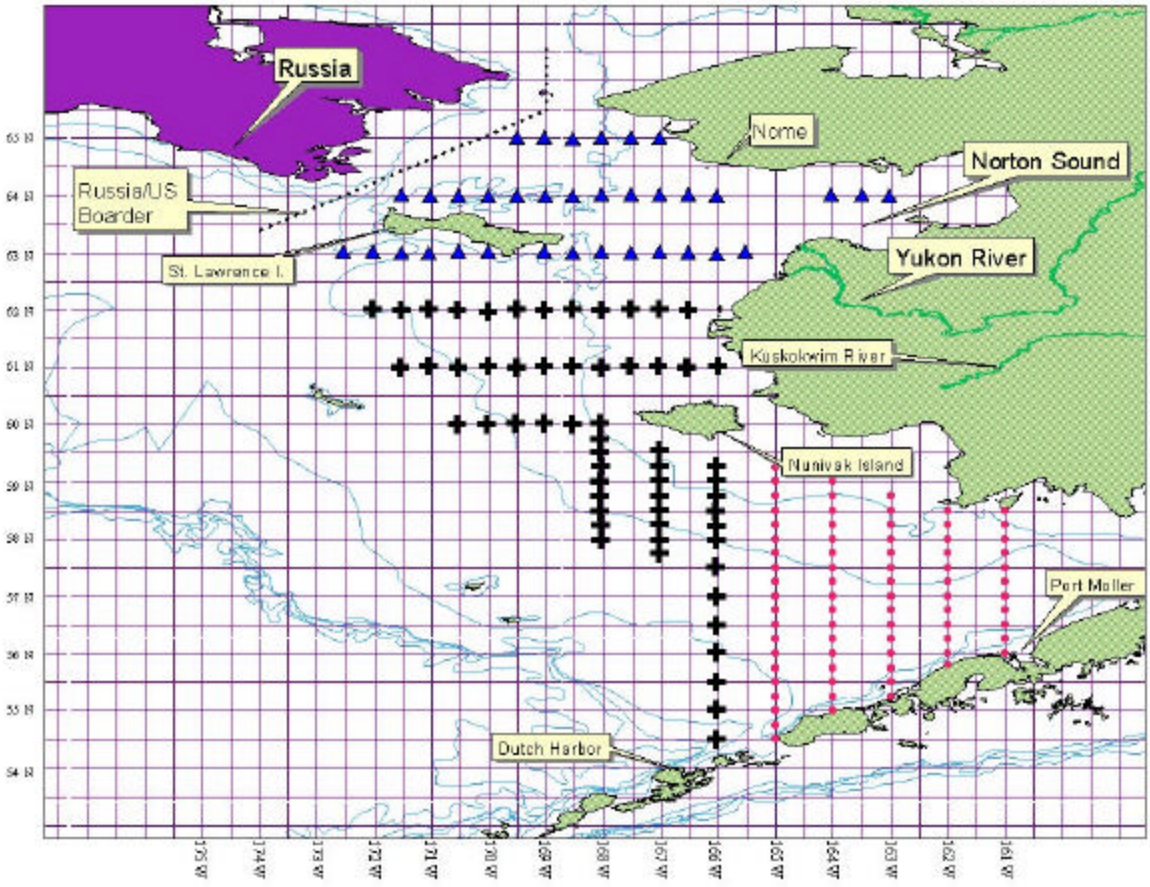

Figure 4. Proposed transects and station locations (dot – Leg 1; plus – Leg 2; triangle – Leg 3) to be sampled by NMFS Ocean Carrying Capacity program in the eastern and northeastern Bering Sea, August 17 – October 13, 2002.

Tag Types

Four types of tags are being requested in this tagging proposal: (1) simple disc tags, (2) geoposition tags, which record temperature, depth, and light levels. (3) data-storage tags, which record temperature and depth, and (4) iButton tags, which record temperature. Information from all tag returns will provide direct evidence of the distribution of stocks in the Bering Sea, which can be used to verify results of indirect methods of stock identification, such as genetic stock identification and scale pattern analysis. The combination of depth and light data can be used to estimate daily position from sunrise and sunset times. Daily position estimates will provide significant insight into the movement and migration behavior of salmon, and will provide information on the migration pattern of salmon in times and areas not sampled by surveys supporting BASIS research. Temperature data from the data tags can be used to define migration patterns between water mass types with different water temperatures.

Disk tags: One thousand salmon will be tagged with standard high-seas Petersen disk tags. These tags have return instructions in English, Japanese, and Russian.

Geoposition tags: Forty salmon will be tagged with geoposition tags from Lotek Wireless (model LTD_2410). The LTD_2410 tag is an internally mounted tag that measures light levels (with a 10 cm light stalk), temperature and depth. The tags dimensions are 11 x 36 mm, weigh 8 grams, have a polyester casing, and a battery life of 2 years. Time Extension Recording enables the tags to begin recording at a short sampling interval and is doubled each time the memory is filled. The temperature sensor has a range of 0 to 30° C with a 0.20° C resolution.

Data Storage Tags: Two hundred salmon will be tagged with data storage tags containing temperature and pressure sensors from Lotek Wireless (model: LTD_1100-300). The LTD_1100-300 is an externally mounted tag with a depth range of 300 meters. These data tags are fully encapsulated in clear urethane and weigh approximately 5 grams. The tags are capable of storing up to 16,384 samples each of temperature and pressure, have a 3 year battery life, and use Time Extension Recording. Time Extension Recording enables the tags to begin recording at a short sampling interval (15 sec) and is doubled each time the memory is filled. The temperature sensor has a range of -5 to 35° C with a 0.20° C resolution.

Ibutton Tags: Two hundred salmon will be tagged with IButton tags manufactured by Alapha Mach Inc. (model: ER-1002). Ibutton tags are the latest development of low cost electronic tags and consist of an iButton thermochron (p/n DS-1921Z-F5) circuit and battery package from Dallas Semiconductor repackaged in a compact, pressure compensated casing embedded in electronic grade epoxy. The tags will be externally mounted on fish using nickle pins and highseas disk tags using the two holes on either side of the tags. The iButton thermochon has a resolution of 1/8 C, a temperature range of –5 to 25 C, and an expected battery life of approximately 3 years.

Tag Deployment

Tags will be made available to all participating nations and tag deployment schedules will be coordinated by the BASIS working group. All tags will be deployed in 2002 and 2003. Standardized forms, defined by the BASIS working group, will be used to record and collect information from tagged fish. Disk tags with instructions in English, Japanese, and Russian will be included on all tagged fish. Fish having signs of capture or tagging related stress will not be tagged with electronic tags. Salmon will be monitored in live tanks prior to tagging, to determine capture stress levels. Fish will be anesthesitized prior to implanting the geolocation tags and their recovery will be monitored in a live tank to determine tagging stress levels.

Tag Recovery

Based on previous electronic tag recovery rates (Wada and Ueno (1999)—12%; Walker et al. (2000)—15%; Murphy and Heard, (2001)—15%) we expect a recovery rate of 10—15% for maturing salmon. Based on disk tagging work aboard the Japanese research vessel, *Wakatake maru*, in the Bering Sea we expect tag recoveries to be 2—5% for immature salmon (Kate Myers, personal communication). Advertising campaigns for return of high seas salmon tags funded by NOAA and the Fisheries Research Agency of Japan are already in place in North America and Asia. Advertising in the Russian Far East and the Arctic-Yukon-Kuskokwim region of western Alaska would be intensified. As an incentive for fishermen, processors, and others to search for and return tags, we propose to pay a substantial monetary reward ($500 per tag) for the return of undamaged geolocation tags. The geolocation tags are expensive, but can be reused if returned undamaged. There would also be a drawing in October 2003 for large cash rewards (e.g., 1st place = $5,000; 2nd place = $3,000; 3rd place = $1,500; 4th place = $500) open to all people who have returned tags.

Products

Annual NPAFC documents will be published listing tag deployments and recoveries. Tag release and recovery data will be incorporated into the existing NPAFC high seas salmon tag database (managed by the University of Washington, NOAA contract 50ABNF-1-00002). The tag recovery data will be reported to NODC. A peer-reviewed publication(s) of the data will be prepared by the BASIS working group and other scientists participating in the research.

5. Project Management and Experience and Qualifications of Personnel

The BASIS Working Group of NPFAC will coordinate, implement, and report the results of the proposed research to the NPRB, and prepare the results for publication. Dr. John H. (Jack) Helle, who will serve as Principal Investigator, was appointed Chairman of the BASIS Working Group in 2002. Other members of the BASIS Working Group include from Canada: Dr. Richard Beamish, Pacific Biological Station; Japan: Dr. Shigehiko Urawa, National Salmon Resources Center, and Dr. Tomonori Azumaya, Hokkaido National Fisheries Research Institute; Russia: Drs. Vladimir Karpenko and Sergey Sinyakov, Kamchatka Fishery & Oceanography Research Institute (KamchatNIRO), and Dr. Victor Lapko, Pacific Scientific Research Fisheries Center (TINRO-Center); and the United States: Dr. Douglas Eggers, Alaska Department of Fish & Game, and Dr, Katherine (Kate) Myers, University of Washington. The NPAFC will administer and manage the proposed budget as part of the NPAFC Special Fund for Scientific Research (NPAFC, amendment of the Financial Rules 19).

Principal Investigator

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Dr. Helle was appointed Program Manager for the Ocean Carrying Capacity Program in 1996 at the Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, Juneau, Alaska. His research history at the Auke Bay Laboratory started as a seasonal employee in 1958-59, studying age and size at maturity of chum salmon in Prince William Sound. He began his full-time career as a fishery research biologist at Auke Bay Laboratory in 1960, studying the success of intertidal spawning pink and chum salmon in Prince William Sound. His research on age and size at maturity continued and expanded in the early 1970s to include chum salmon throughout their range in North America. Dr. Helle directed research on genetic stock identification at Auke Bay Laboratory in the 1980s to mid 1990s and this research was coordinated with other researchers in California, Oregon, Washington, British Columbia and Alaska. This genetic research was expanded to include cooperative genetic stockidentification research with groups in Russia and China. He has been active on technical committees within the U.S./Canada Pacific Salmon Treaty and the North Pacific Anadromous Fish Commission. He is a member of the Offshore Technical Working Group, Pacific Ocean Salmon Tracking Project, Census of Marine Life. He received his B.S. (1958) and M.S. (1961) degrees in Fishery Management from the University of Idaho, spent a year as an Honorary Research Fellow (1964-65) at Marischal College, University of Aberdeen, Scotland, and completed his Ph.D. (1979) degree in Fisheries Science at Oregon State University.

6. Coordination and Collaboration

To our knowledge, there is no other offshore salmon tagging effort in the Bering Sea. The proposed work would build on past high seas salmon tagging research by INPFC, Russia, and NPAFC. The BASIS working group of NPAFC will coordinate, implement, and report on the results of the tagging research. Methods, techniques, and research priorities on salmon tagging will be developed collaboratively with the Pacific Ocean Salmon Tracking (POST) program of the Census of Marine Life research. These studies will complement ecosystem research and monitoring activities of the North Pacific Marine Science Organization (PICES) and Global Ocean Ecosystem Dynamics (GLOBEC).

7. **Possible Peer Reviewers**

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References

Azumaya, T., and Y. Ishida. 2000. Density interactions between pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) and their possible effects on distribution and growth in the North Pacific Ocean and Bering Sea. N. Pac. Anadr. Fish Comm. Bull. No. 2:165-174.

Beamish R.J.., and C. Manhken. 1998. Natural regulation of the abundance of coho and other species of Pacific salmon according to the critical size and critical period hypothesis. (NPAFC Doc. 319). 26 p. Dept. of Fisheries and Oceans, Sciences Branch, Pacific Region, Pacific Biological Station, Nanaimo, B.C., Canada, V9R 5K6. National Marine Fisheries Service, 7305 Beach Drive East, Port Orchard, WA, USA, 98366.

Bigler, B.S., D.W. Welch, and J.H. Helle. 1996. A review of size trends among North Pacific salmon (*Oncorhynchus* spp.). Can. J. Fish. Aquat. Sci. 53:455-465.

Davis, N.D., K.W. Myers, and Y. Ishida. 1998. Caloric value of high-seas salmon prey organisms and simulated salmon ocean growth and prey consumption. N. Pac. Anadr. Fish. Comm. Bull. No. 1:146-162.

French, R., R.G. Bakkala, and D.F. Sutherland. 1975. Ocean distribution of stocks of Pacific salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri*, as shown by tagging experiments. Charts of tag recoveries by Canada, Japan, and the United States, 1956-69. NOAA Tech. Rep. NMFS SSRF-689.

Friedland, K.D., R.V. Walker, N.D. Davis, K.W. Myers, G.W. Boehlert, S.Urawa, and Y. Ueno. 2001. Open-ocean orientation and return migration routes of chum salmon based on temperature data from data storage tags. Mar. Ecol. Prog. Ser. 216: 235-252.

Fukuwaka, M., and T. Azumaya. 2001. Proposed cruise plans of Japanese research vessels for salmon in the North Pacific Ocean in 2002/2003 fiscal year. (NPAFC Doc. 551, Rev.1). Hokkaido National Fisheries Research Institute, Fisheries Research Agency, 116 Katsurakoi, Kushiro 085-0802, Japan. 5 p.

Helle, J.H., and M.S. Hoffman. 1998. Change in size and age at maturity of two North American stocks of chum salmon (*Oncorhynchus keta*) before and after a major regime shift in the North Pacific Ocean. NPAFC Bull. 1:81-89.

Ishida, Y., S. Ito, M. Kaeriyama, S. McKinnell, and K. Nagasawa. 1993. Recent changes in age and size of chum salmon (*Oncorhynchus keta*) in the North Pacific Ocean and possible causes. Can. J. Fish. Aquat. Sci. 50:209-295.

Kaeriyama, M. 1989. Aspects of salmon ranching in Japan. Physiol. Ecol. Spec. 1: 625-638.

Myers, K.W., K.Y. Aydin, R.V. Walker, S. Fowler, and M. L. Dahlberg. 1996. Known ocean ranges of stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. NPAFC Doc. 192. FRI-UW-9614. University of Washington, Fisheries Research Institute, Box 355020 Seattle, WA 98195-5020.

Murphy, J. M., and W. R. Heard. 2001. Chinook salmon data storage tag studies in Southeast Alaska, 2001. (NPAFC Doc. 555) 21 p. Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626, USA.

Nomura, T., S. Urawa, and Y. Ueno. 2000. Variations in muscle lipid content of high-seas chum and pink salmon in winter. N. Pac. Anadr. Fish Comm. Bull. No. 2: 347-352.

North Pacific Anadromous Fish Commission. 2000. NPAFC Science Plan 2001-2005. Pages 75-76 *in* North Pacific Anadromous Fish Commission 2000 Annual Report, Vancouver, B.C., Canada.

North Pacific Anadromous Fish Commission. 2001. Draft plan for NPAFC Bering-Aleutian Salmon International Survey (BASIS). North Pacific Anodromous Fish Commission Doc. 579. 27 p.

Tadoroko, K., Y. Ishida, N.D. Davis, S. Ueyanagi, and T. Sugimoto. 1996. Change in chum salmon (*Oncorhynchus keta*) stomach contents associated with fluctuation of pink salmon (*O. gorbuscha*) abundance in the central subarctic Pacific and Bering Sea. Fish. Oceanogr. 5:89-99.

Wada, K., and Y. Ueno. 1999. Homing behavior of chum salmon determined by an archival tag (NPAFC Doc. 425) 29p. Hokkaido National Fisheries Research Institute, Japan.

Walker, R.V., K.W. Myers, N.D. Davis, K.Y. Aydin, K.D. Friedland, H.R. Carlson, G.W. Goehlert, S. Urawa, Y. Ueno, and G. Anma. 2000a. Diurnal variation in thermal environment experienced by salmonids in the North Pacific as indicated by data storage tags. Fish. Oceanogr. 9:2, 171-186.

Walker, R.V., K.W. Myers, N.D. Davis, K.Y. Aydin, and K.D. Friedland. 2000b. Using temperatures from data storage tags in bioenergetic models of high-seas salmon growth. NPAFC Bull. 2: 301-308.

Walker, R.V., N.D. Davis, K.W. Myers, J.M. Murphy, and M. Fukuwaka. 2001. Releases and recoveries of U.S. salmonid data storage tags, and recoveries of high seas tags in North America, 2001. (NPAFC Doc. 556.) AFS-UW-0112. School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA. 11 p.

Watanabe, K. 2000. Adults returning and ages at return of chum salmon around northern Japan. NPAFC Doc. 490. Nat. Res. Inst. Fish. Engineering, Fisheries Agency of Japan, Hasaki, Ibaraki 314-0421, Japan

NPRB BUDGET SUMMARY FORM

PROJECT TITLE:	NPAFC Salmon Tagging
PRINCIPAL INVESTIGATOR:	Jack Helle

FUNDING SOURCE	**YEAR 1**	**YEAR 2**	**YEAR 3**	**TOTAL**
NPRB Funding	190,800			190,800
Match/In Kind	1,420,000			1,420,000
TOTAL	1,610,800	0	0	1,610,800

COST CATEGORY TOTALS[1]	**NPRB FUNDING**	**MATCH/ IN KIND**	**TOTAL YEAR: 1**
1. Personnel Salaries		250,000	250,000
2. Personnel Fringe Benefits		25,000	25,000
3. Travel (include 1 trip to review meeting in Anchorage)	20,000	20,000	40,000
4. Equipment	125,800	100,000	225,800
5. Supplies	5,000	25,000	30,000
6. Contractual/Consultants	20,000	1,000,000	1,020,000
7. Other (Include $500 for education and outreach)	20,000		20,000
Total Direct Costs	190,800	1,420,000	1,610,800
Indirect Costs			0
TOTAL PROJECT COSTS	190,800	1,420,000	1,610,800

[1] Please explain budget detail in separate budget narrative

Budget Narrative

Match/In Kind funding in all categories are costs supplied by the nations participating in the BASIS surveys for the capture of salmon in the Bering Sea.

Personnel Salaries and Fringe Benefits: The principal investigator and other members of the BASIS Working Group that would participate in the proposed work are all salaried government and university personnel. Matching funds for salaries and benefits are a best estimate of the costs for their participation in the proposed work.

Travel: The NPRB costs include 1 trip to the NPRB review meeting in Anchorage ($1,500). The remaining NPRB costs would provide travel support for three meetings of project participants (October 2002, March 2003, and October 2003) to plan, coordinate, and review the results of the proposed work. The matching funds are a best estimate of travel support for participation in Bering Sea research vessel cruises.

Equipment: The NPRB costs include the purchase of tags. A detailed list of the tags and cost are shown below. Matching funds are a best estimate of the costs of other equipment that will be used during Bering Sea research vessel cruises.

Tag Type	**Manufacture**	**Model**	**Quantity**	*Unit Cost*	***Cost***
Geolocation	*Lotek Wireless*	*LTD_2410*	40	$ 1,695.00	$ 67,800.00
Data Storage	*Lotek Wireless*	*LTD_1100-300*	200	260.00	52,000.00
iButton	*Alpha Mach*	*ER-1002*	200	20.00	4,000.00
disk tag	*Floy Tag*		1000	2.00	2,000.00
					$ 125,800.00

Supplies: The NPRB costs for supplies include mounting hardware, live tanks, and tag applicators. The matching funds are a best estimate of the costs for other supplies that will be used during Bering Sea research vessel cruises.

Conractual/Consultants: The NPRB costs for contractual/consultants includes costs for additional financial and support services by the NPAFC Secretariat required to carry out the proposed work. Matching funds are a best estimate research vessel charter costs and other support services associated with Bering Sea research vessel cruises.

Other: The other NPRB costs are for a tag recovery reward program (for example, a $500 reward for the return of a geolocation tag; a drawing in October 2003 for large cash rewards; for example, 1st place = $5,000; 2nd place = $3,000; 3rd place = $1,500; 4th place = $500), costs for publication of research results ($4,500), and costs for other education and outreach ($500).