University of Washington

School of Aquatic & Fishery Sciences
Seattle, Washington

To:	Alaska Sea Grant College Program University of Alaska - Fairbanks
Title of Project:	Acoustic Behavior of Salmon
Principal Investigators:	John K. Horne Research Associate Professor School of Aquatic & Fishery Sciences Box 355020 University of Washington Seattle, WA 98195-5020 (206) 221-6890 – phone (206) 221-6939 - fax jhorne@u.washington.edu
Institutional Official:	Carol Zuiches Assistant Vice Provost - Research Office of Sponsored Programs University of Washington 1100 NE 45th Street, Suite 300 Seattle, WA 98105 206-543-4043 osp@u.washington.edu
Amount Requested:	$60,236
Desired Period:	February 1, 2006 – January 31, 2009

Date:______________ ________________________________
John K. Horne, Research Associate Professor

Date:_______________ _______________________________
David A. Armstrong, Director
School of Aquatic & Fishery Sciences

Date:______________ ________________________________
Carol Zuiches
Assistant Vice Provost – Research
Executive Director, Office of Sponsored Programs

SEA GRANT PROJECT SUMMARY

INSTITUTION: **Alaska Sea Grant College Program** ICODE:

TITLE: **ACOUSTIC BEHAVIOR OF SALMON**

PROJECT NUMBER: **2005-33** REVISION DATE: May 13, 2005
PROJECT STATUS: INITIATION DATE: Feb. 2006
COMPLETION DATE: Dec. 2008

SUB PROGRAM:

PRINCIPAL INVESTIGATOR: John K. Horne EFFORT:
AFFILIATION: University of Washington
School of Aquatic and Fishery Sciences

AFFILIATION CODE:

SG FUNDS:	$60,236	STATE MATCHING FUNDS:	$40,634
LAST YEARS SG FUNDS:	$0	LAST YEARS MATCHING FUNDS:	$0
PASS-THROUGH FUNDS:	$0	LAST YEARS PASS THROUGH FUNDS:	$0

RELATED PROJECTS:
PARENT PROJECTS:
SEA GRANT STRATEGIC PLAN CLASSIFICATION#: 3 Fisheries
KEYWORDS: salmon, acoustic assessment, species discrimination, student training

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OBJECTIVES:
This program will combine the use of two acoustic technologies to examine the influence of fish behavior on the amplitude and shape of reflected sound from salmon in rivers. Primary research objectives include:
1. Characterizing variability in backscattered echo amplitude and shape
2. Determining the influence of behavior on echo amplitude and shape
3. Quantifying echo width to fish morphometric relationship (e.g. length, width)
4. Examining the potential of using differences in echo characteristics to discriminate Chinook from Sockeye Salmon in acoustic data.

METHODOLOGY:
A splitbeam echosounder will be synchronized with an imaging sonar to collect acoustic data on tethered and free-swimming fish. Metrics will be used to characterize echo shapes and compared to fish orientation.

RATIONALE:
Understanding how fish scatter sound improves discrimination of species and the accuracy of acoustic-based assessment.

BENEFITS:
Results of this project will increase methods to discriminate chinook from sockeye salmon, the understanding of how fish in rivers scatter sound, and the accuracy of acoustic-based escapement assessment on the Kenai River.

Proposal Objectives

This program will combine the use of two acoustic technologies to examine the influence of fish behavior on the intensity and shape of reflected sound from salmon in rivers. Primary research objectives include:

1. Characterizing variability in backscattered echo amplitude and shape
2. Determining the influence of behavior on echo amplitude and shape
3. Quantifying echo width to fish morphometric relationship (e.g. length, width)
4. Examining the potential of using differences in echo characteristics to discriminate Chinook from Sockeye Salmon in acoustic data.

This program is also explicitly designed to include training of an Alaskan resident in fisheries acoustics research techniques. Salmon abundance on at least two rivers in Alaska (e.g. Kuskokwim River, Noatak River) is not being assessed using acoustic technologies due to a lack of trained personnel. Alaska's need for trained fisheries acousticians is great. If an Alaskan student (native or non-native) is trained during this program, it is believed that there is a greater likelihood that the student will return to Alaska and will be an attractive employee for the Alaska Department of Fish and Game (ADF&G), NOAA fisheries, or the fisheries acoustic industry.

Milestones have been identified for the project. By the end of the first year, the graduate student will have completed two quarters of course work and participated in the first set of acoustic backscatter measurements in conjunction with ADF&G researchers and staff at the Kenai River sampling site. Data analysis will commence directly after field measurements and continue throughout the duration of the project. Outreach activities will be coordinated in part with the summer field season and extend to the end of the year. By the end of the second year, graduate student coursework will be completed, a second field season will have collected additional data, data from the first field season will be analyzed, and the second round of outreach activities will be well underway. By the end of the third year, the student will complete the Master's program and outreach activities.

Justification and Need

Fixed-location, side-looking acoustic techniques are often the only way to obtain in-season abundance estimates for anadromous fish stocks in rivers that are too wide for weir structures and too occluded for visual observations (Daum and Osborne 1998; Osborne and Melegari 2002; Westerman and Willette 2003). Acoustic assessment sites currently exist on 15 rivers in Alaska. One of the primary barriers to wider use of sonar assessment has been the inability to acoustically discriminate among fish sizes and species (cf. Horne 2000).

Acoustic techniques used to discriminate and classify fish species traditionally rely on the intensity of reflected sound (i.e. target strength, TS) to determine the size and then species of an insonified target. Using this approach in shallow water, riverine environments include additional challenges (Trevorrow et al. 2000). Boundary effects (i.e. water surface and river bottom) may distort echoes and impede detection of individual animals (Mulligan 2000; Gerlotto et al. 2000). Distances to targets are generally short and when combined with narrow beam angles, violate the point source assumption of reflected energy (i.e. backscatter) from targets because fish are large relative to the beam swath (Dawson et al. 2000). Under these conditions, fish become complex backscatter targets and the intensity and phase of echoes can be corrupted. Variability in fish orientation relative to the transducer when the beam is directed across the river also influences intensity and phase of TS measurements (Love 1969; Dahl and Matthisen 1983; Kubecka 1993; Horne 2003). Acoustic signal to noise ratios are generally low in riverine environments which may bias estimates of fish position within the beam (Kieser et al. 2000) and resulting TS (Fleischman and Burwen 2000). The combination of these factors potentially result in variable TS measurements that makes it difficult, if not impossible, to identify fish species using only target strength as the discriminating metric.

On the Kenai River in southcentral Alaska, chinook salmon *Oncorhynchus tshawytscha* migrate concurrently with more numerous sockeye salmon *Oncorhynchus nerka*. The two species differ in size and migratory behavior: sockeye salmon average less than 60 cm in length and migrate primarily in shallow water close to the river bank; chinook salmon often exceed 100 cm and migrate in deeper water near mid-channel. These differences were used as justification to initiate a chinook salmon sonar assessment program in the late 1980s (Eggers et al. 1995). Currently, the Kenai River chinook sonar program is the only assessment in Alaska that apportions sonar counts by species using only acoustic data (cf. Fleischman and Burwen 2003). Target strength and range criteria are used to separate the more abundant sockeye from chinook salmon (Miller et al. 2003). Recent studies indicate that a fraction of sockeye salmon are being erroneously classified as chinook salmon, which results in an inflated chinook abundance estimate (Burwen et al. 1998, 2003).

In the mid-1990's, results from experiments on the Kenai River using tethered and free-swimming fish identified echo envelope length as a potential species discriminating metric. An echo envelope is the time-dependent intensity of the reflected sound. Echo envelope metrics characterize a target primarily using time delay rather than the amplitude of the returned echo. Burwen and Fleischman (1998) found that the accuracy of distinguishing chinook from sockeye salmon increased when using echo envelope length relative to target strength. This result is promising for species classification but the mechanism influencing echo length is not understood and uncertainty remains why this metric performs better than target strength in riverine applications.

Experiments conducted in 2002 included a recently developed sonar technology that enables acoustic imaging of fish targets. The DIDSON (**D**ual frequency **ID**entification **SON**ar) imaging sonar can be used to examine how echoes are influenced by the size and behavior of fish as they swim through a side-looking acoustic beam. The DIDSON provides near video-quality images for identifying objects underwater (Belcher et al. 2001). During the 2002 field measurements, a splitbeam echosounder was paired with a DIDSON to record echo intensity and fish orientation from 12 tethered chinook and 9 sockeye salmon. A few sockeye salmon serendipitously swam through the beam during tethered fish measurements. Repeated series of measurements were collected from these fish at various ranges (4-17 meters) to assess potential range effects on echo intensities and the measurements used to characterize echo shapes. Ongoing analyses of the data indicate that as fish swim through the beam and are oriented at oblique angles relative to the transducer face echoes are recorded that have complex envelope shapes including multiple peaks. This is the first indication why target strength measurements are highly variable. The duration of an echo from a large target such as a chinook salmon was also observed to be sensitive to the length of the target, potentially due to near simultaneous reflections from several body parts (e.g. head and tail).

The next logical step in this research is to examine the influence of fish orientation and position in the beam on the number, shape, and intensity of echoes recorded by the splitbeam echosounder. For riverine applications, time-based metrics appear to be superior predictors of fish length and therefore species because they exploit or are robust to factors that compromise amplitude-based metrics such as target strength. It is imperative to understand how sound interacts with and forms echoes from large target that simultaneously reflects sound from multiple body parts. This knowledge will improve precision and accuracy of acoustic-based fish length, species, and abundance estimates in freshwater and marine environments.

This proposal addresses the Fisheries Theme in Alaska Sea Grant's (ASG) strategic plan. An investigation into the relationship between fish size and swimming behavior on echo returns directly applies to the goal of "Developing management strategies that balance optimum sustainable yield with conservation of Alaska's living resources from a coastal watershed ecosystem." It also meets both objectives under this goal because it seeks to:

1) conduct biological research on new methodologies to optimize fishery harvests that are sustainable, and
2) develop collaborative partnerships with NOAA Fisheries and the Alaska Department of Fish and Game to fund relative research.

To assist in managing its salmon stocks for optimal sustainable yields, ADF&G establishes escapement goals for many of its economically important fish stocks. These escapement goals attempt to produce optimal yields for each stock by ensuring that a sufficient number of fish are guaranteed access to their spawning grounds. To ensure that escapement goals are met, fisheries managers rely heavily on timely and accurate inseason estimates of inriver stock abundance to regulate both commercial and sport interception fisheries. Acoustic technologies will continue as the primary assessment tool used in the management and conservation of some of Alaska's most economically important salmon resources (e.g. Kenai River chinook salmon). This proposal seeks to improve the information provided by these assessment programs. Improving our ability to apportion acoustic estimates to species, this research will directly aid the ADF&G with its task of optimizing fishery harvests. Because fisheries acoustic research is technically challenging and requires expertise that is limited within the ADF&G, collaborating with University and Industry personnel is an effective way to further the research efforts and needs of department staff.

Research results will be communicated through: a Master's student thesis; peer-reviewed publications; presentations at national or international scientific conferences; regional seminars at the ADF&G sportfish and marine divisions; and be integrated within the ADF&G Information and Education and ASG Extension and Education Services Programs.

Methods

An important first step in this research program is to identify a suitable candidate for a graduate program for training in Fisheries Acoustics. A previous attempt in 2001 to identify an Alaskan resident with a quantitative background and interest in fisheries research was unsuccessful. It is envisioned that this student will be supported as a National Sea Grant Scholar and enroll at the University of Washington, School of Aquatic and Fishery Sciences under the supervision of Dr. John Horne. ADF&G and Dr. Horne are currently completing a salmon research collaborative project that includes the training of a Masters student (who is also a Hydroacoustic Technology Incorporated (HTI) employee). The student's thesis is entitled, "Acoustic characterization of chinook and sockeye salmon on the Kenai River." Features of the echo envelope, the time-dependent intensity of the reflected sound, are being quantified and examined on their ability to distinguish between the two species.

The addition of a DIDSON imaging sonar extended the breadth of the current project and is will be used during field measurements in the proposal. A 200 kHz splitbeam echosounder was paired with a multibeam, imaging sonar to simultaneously record echo intensity and orientation of tethered fish. The DIDSON unit operates at 1.0 and 1.8 MHz to provide near video quality images. Synchronizing data acquisition between the DIDSON sonar and the splitbeam echosounder showed that data from the two technologies improves species identification, provides additional data on fish behavior, and can be used to increase understanding of fish as acoustic targets. For each split-beam echo, the exact position and orientation of the fish can be determined from the DIDSON image (Fig. 1).

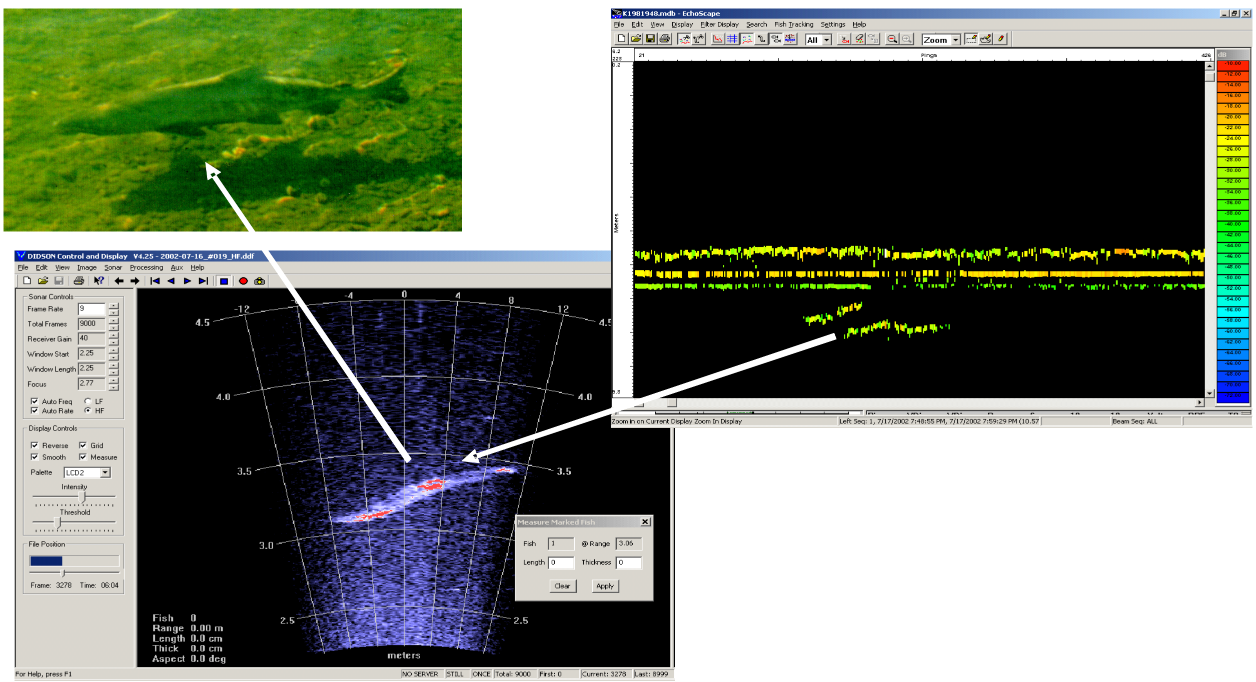

Figure 1. Schematic diagram showing how a fish (upper left) is perceived by the DIDSON imaging sonar (lower) and the splitbeam echosounder (upper right).

In the current project, 16 echo metrics were tabulated from individual echoes returned from tethered and free-swimming salmon. Echo metrics, grouped by attribute, include: range (i.e. distance) from the transducer, envelope shape, phase stability (i.e. consistency of position in space), roughness (i.e. geometry and self-similarity), and amplitude (Table 1).

Table 1. Echo attribute type and metrics used to characterize echoes from chinook and sockeye salmon on the Kenai River.

Attribute Type	Echo Metric
Range	*Peak Range "Jitter"*
Echo Envelope Width/Shape	*Mean_-3 dB Echo Envelope Width (PW)* *St Dev_-3 dB Echo Envelope Width* *Mean_-6 dB Envelope Width* *St Dev_-6 dB Envelope Width* *Mean_-12 dB Envelope Width* *St Dev_-12 dB Envelope Width* *Echo Correlation Coefficient* *St Dev_Correlation Coefficient* *Echo Return/Broadcast Ping Ratio*
Echo Phase Stability	*Up-Down Phase "Jitter"* *Left-Right Phase "Jitter"*
Echo "Roughness" (Self Similarity)	*Mean_Fractal Dimension* *St Dev_Fractal Dimension*
Amplitude (Backscatter)	*Mean_Target Strength* *St Dev_Target Strength*

If smaller sockeye act as point source scattering targets, echoes are predicted to have constant range and position, envelope widths/shapes similar to the original pulse, and low variability in echo intensity. Larger chinook (relative to the acoustic wavelength), are predicted to exhibit higher variability in all echo metrics. Pairwise comparisons from data collected at 0.2 milliseconds resulted in 12 of the 16 metrics differing between the two species. All range, echo width/shape, and position metrics were significantly different ($p<0.05$). Metric values from chinook echoes were larger and more variable than those from tethered or free-swimming sockeye. The same trend was evident in the data set collected at a larger pulse width (0.4 milliseconds) but only 7 of the 16 echo metrics were significantly different. Echo correlation coefficient, phase jitter, and some of the shape measures did not differ.

At this time, the DIDSON data is only being used to verify the identity and to estimate the width and length of free-swimming fish as they passed through the beam. Scrutiny of sonar images indicates that the intensity and number of echoes observed in the echosounder data are directly influenced by fish orientation. The 2002 data from the Kenai River provide an initial data set but improvements could be made on the synchronization of the echosounder and imaging sonar, and increased measurements on free-swimming fish are needed to verify existing metrics.

The graduate student working on this project will conduct target strength measurements at the Kenai River salmon research site in conjunction with staff from ADF&G and HTI. A DIDSON imaging sonar and an HTI splitbeam echosounder will be set up to laterally insonify the same volume of water. Chinook and sockeye salmon will be tethered within the acoustic beams and backscatter intensities will be simultaneously measured by both systems. Free-swimming chinook and sockeye salmon will also be directed through the acoustic beams using net weirs. The resulting synchronous acoustic data streams will contain time-dependent (i.e.

range) echo intensities from known tethered and free-swimming fish. Digitized echo intensity data from the echosounder will be quantified using echo shape metrics and compared to echo intensities and fish orientations from sonar data images. Echosounder and sonar comparisons will be used to quantify the number, magnitude, and variability of echoes as a function of fish width, length, and orientation relative to the transducer face.

Outreach Component

From the onset, student, scientific, and public outreach will form integral parts of this research program. We are interested in initiating a recruitment program with Alaska Sea Grant (ASG) to identify interested, qualified Alaskan residents as candidates for graduate student programs in aquatic science. We believe that the probability of a student returning to Alaska is higher if that student is an Alaskan resident. We feel that ASG is the best administrative body to identify and recruit interested students who could apply to graduate school. This joint initiative is potentially the first step in increasing participation of Alaskans, including natives and women, in advanced technical and academic training. Successful completion of this program will result in fisheries acoustics expertise to be transferred directly to the State of Alaska through student training and collaboration with ADF&G scientists. Assuming that the student returns to Alaska, he or she will then be available to ADF&G, NOAA fisheries, or the acoustics industry as a potential employee for a growing applied science field.

A comprehensive outreach program has been developed to translate and disseminate findings of this project to scientific and public audiences (Table 2). The student will work directly with extension and education specialists in ADF&G and ASG. The ADF&G outreach plan consists of two goals: to communicate research efforts to stakeholders in the community, and to communicate research efforts to scientists and practitioners involved in fisheries acoustics.

Table 2. Summary of objectives, target audience, message, packages, distribution channels, outcomes, and evaluations of joint UW/ADF&G outreach program.

GOAL 1: Communicate research efforts to stakeholders in the community

Objective	Target audience	Message	Packages	Distribution Channels	Outcome/Evaluation
#1: Better compliance at sonar site with respect to avoiding sonar gear and minimizing boat activity at site	Sport fishing guides, sport fishers, neighboring community (nearby house owners)	More accurate escapement data from the sonar translates to better managed fisheries and maximum opportunity for user groups	Web pages; signs; brochures; presentation at local stakeholder meetings: Kenai River Guide Association, Kenai River Sportfishing Association, tours at sonar site	links on existing agency web sites; Local ADF&G office (brochures) Kenai River Guide Assn., Kenai River Sportfishing Association	Fewer negative interactions at sonar site (where sport fishing activity is restricted by research efforts and sometimes resented)
#2: Encourage high school students and community college students to consider working for ADF&G in home town	High school and community college students and educators	If you enjoy working with computers, and math, fish, and working outdoors, consider a job at ADF&G in one of the sonar programs – we need employees that are both technical and enjoy outdoor work	Presentations in classrooms, organized tours at sonar sites, poster or videos at established divisional education events such as salmon celebrations	Salmonids in the Classroom program, science fairs, Mobile Aquatic Education Classroom, career fairs; Kachemak Bay Research Reserve	Increased applicant pool for positions on local ADF&G sonar assessment projects, number of return postcards asking for more information

Objective	Target audience	Message	Packages	Distribution Channels	Outcome/Evaluation
#3: Introduce research funding opportunities to other agencies that are interested or have been receptive in the past	Kenai River Sportsfishing Association	Opportunity to fund research that improves public perception of agency	Presentation of research efforts at appropriate meetings	Kenai River Sportsfishing Association monthly meetings, presentation to Board of Directors	Increased partnership with community through collaborative efforts and funding. This organization funded the first DIDSON study

GOAL 2: Communicate research efforts to scientists and practitioners involved in fisheries acoustics

Objective	Target audience	Message	Packages	Distribution Channels	Outcome\Evaluation
#1: Introduce new techniques for analyzing and interpreting fisheries acoustic data (classifying acoustic targets to species)	Scientists, peers at ADF&G, other fisheries sonar practitioners	More accurate escapement data from fisheries acoustic assessment programs	Presentation of research efforts at appropriate scientific meetings	Acoustical Society of America meetings, American Fisheries Society meetings (local and national), ICES Acoustics in Fisheries and Aquatic Communities meeting, ICES WGFAST meetings	Peer review of research results, acceptance of new techniques for classifying fish species by broader scientific community and those involved with assessment programs, improved standardization of methodology for collecting, processing, analyzing acoustic data
#2: Introduce research funding opportunities to other agencies that are interested or have been receptive in the past	Kenai River Sportsfishing Association	Opportunity to fund progressive research that improves public perception of agency	Presentation of research efforts at appropriate meetings	Kenai River Sportsfishing Association monthly meetings, presentation to Board of Directors	Potential for additional funding from the Kenai River Sportfishing Association. This organization funded the first DIDSON study

Available Resources

Dr. John Horne has been using acoustics as a research tool and examining how aquatic organisms reflect sound since 1985. He has taught fisheries acoustic courses at the undergraduate and graduate levels, published 24 peer-reviewed scientific papers and presented 70 oral papers that use or investigate acoustic technologies in aquatic ecosystems. Dr. Horne currently heads the Fisheries Acoustics Research Laboratory at the University of Washington and is affiliated with the acoustic assessment group at the NOAA Alaska Fisheries Science Center. Dr. Horne will help design and coordinate field measurements, supervise the graduate student, analyze data, and co-author a manusc help coordinate

Debby Burwen is a research Biologist with the Alaska Department of Fish and Game and has specialized in implementing and supervising fisheries acoustic assessment programs since 1986. Since 1995, her research has primarily focused on species classification using acoustic information. She has published several peer-reviewed scientific papers and presented oral papers at a number of national meetings related to this research. Regional Information Services within ADF&G Sportfish division will work directly with the graduate student on all outreach components of the project.

Patrick Nealson has been working in the fisheries acoustics industry since 1982 and currently directs the consulting research division at Hydroacoustic Technology, Incorporated (HTI). His field experience includes over 200 studies quantifying fish distributions at dams, lakes, rivers, and the marine environment in North America, South America, Europe, and Scandinavia. His current research examines target identification based on acoustic echo envelope information. He has taught fisheries acoustic courses in the industry since 1985 and assisted in graduate-level courses at the University of Washington. HTI will provide staff time from Patrick Neaslon and a splitbeam echosounder to support this project.

Dr. Ed Belcher, founder of Sound Metrics Corporation, will supply and support a Dual Frequency Identification Sonar (DIDSON) to be used at the Kenai River field site.

The field site at Kenai River, staff support to supply and manage fish, acoustic equipment, and processing software has been identified for this project. The ADF&G, HTI, and the UW will jointly participate in this project. The National Sea Grant Scholar will be enrolled in a Masters program at the University of Washington, School of Aquatic and Fishery Sciences.

Several key partnerships within the Kenai River user community will also participate and contribute to the program. As outlined in the outreach program tables, the Kenai River Sportsfishing Association and the Kenai River Guide Association will receive regular updates on progress from the project. High school and community college educator and student presentations are also planned for the Salmonids in the Classroom program, science fairs, Mobile Aquatic Education Classroom, career fairs, and the Kachemak Bay Research Reserve

Results from Previous Sea Grant Support

Co-PI's in this proposal have not received previous funding from Alaska Sea Grant.

Budget Justification

Personnel

Funds are requested to support John Horne for one month per year. Dr. Horne will help design field sampling measurements, supervise the graduate student, and co-author a scientific manuscript. Support for a Masters student is essential to the project but funds to support the student are not included in this budget request.. We anticipate that funds to support the student will be provided by the National Sea Grant Scholars Program. Salary costs for the student are projected to be: YrI 17,400; YrII 17,748; YrIII 18,103. Salaries reflect a 4% cost-of-living increase in years II and III. Fringe benefit rates are those current at the University of Washington: faculty 22.6%; student 11.7%. Student fringe costs are not included in the budget but are projected to be: YrI 2,036; YrII 2,077; YrIII 2,118. Tuition costs are projected at: YrI $8,339; YrII $8,673; YrIII $9,019. Matching salary funds are provided by ADF&G ($8,000). Letters of support from 3rd party contributors are appended to the proposal.

Permanent Equipment

A laptop computer to be used by the student is requested for use in the field and for outreach activities.

Expendable Supplies and Equipment

Funds are requested for computer software, recordable media, and a portable hard disk to be used during field measurements. A lump sum of $2,500 is included to purchase supplies or services to support all outreach activities.

Travel

We are requesting travel support at $700/trip/person to send 2 people during YrI and one person during YrII to the Kenai River field site. An additional $3,000 is allocated to support accommodation and field expenses during those trips. Funds are included to present results at one national scientific conference in year III of the project ($1,200).

Publication and Documentation Costs

A total of $1,300 will be provided from University of Washington funds to cover publication costs associated with this project as a matching funds contribution.

Other Direct Costs

Funds are requested for a subcontract to Hydroacoustic Technology, Inc. (HTI) to provide partial support Pat Nealson's time during field experiments. An equal amount of salary has been pledged as match money from HTI. Communications costs of $450 have been included to cover long distance phone, fax, and courier charges associated with the project.

Indirect Costs

Off-campus indirect rates are 26% modified total direct costs in accordance with the University of Washington's indirect cost agreement dated October 27, 2004. A copy of this agreement is appended.

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ALASKA SEA GRANT COLLEGE PROGRAM
PROJECT SCHEDULE AND BUDGET PROJECTION

PROJECT ACTIVITIES **Project Year**	**Year 1**				**Year 2**				**Year 3**				**Year 4**			
Student Graduate Program			X	X	X	X	X	X	X	X	X	X				
Field Work			X			X										
Data Analysis			X	X	X	X	X	X	X	X						
Outreach activities			X	X		X	X		X	X						
Paper preparation								X	X	X	X	X				
PROJECTED BUDGET **(Sea Grant share only)**	27,326				18,253				14,657							

(Form 90-6)

John K. Horne

School of Aquatic and Fishery Sciences
University of Washington
Box 355020
Seattle, WA 98115-0070

Phone: (206) 221-6890
Fax: (206) 221-6939
E-mail: jhorne@u.washington.edu

Education

1995 Ph.D. Memorial University of Newfoundland, Fisheries Ecology

1988 M.Sc. Dalhousie University, Fisheries Ecology

1985 B.Sc. (Honours) Dalhousie University, Marine Biology

Professional Appointments

2004- Research Associate Professor – School of Aquatic and Fishery Sciences, University of Washington. Affiliated with the Quantitative Ecology and Resource Management Program, University of Washington.

2001-2004 Research Assistant Professor – University of Washington, School of Aquatic and Fishery Sciences. Affiliated with the Quantitative Ecology and Resource Management Program.

1999-2000 Research Scientist – Joint Institute for the Study of the Atmosphere and Ocean, University of Washington.

1997-1999 Research Scientist - NOAA Great Lakes Environmental Research Laboratory. Adjunct Assistant Professor - School of Natural Resources and Environment and College of Engineering, University of Michigan.

1995-1997 Postdoctoral Fellow - Great Lakes Center. Adjunct Assistant Professor - Department of Biology. State University of New York College at Buffalo State.

Relevant Publications

Horne, J.K. and J.M. Jech. 2005. Models, measures, and visualizations of fish backscatter. *In* H. Medwin [ed.]. Sounds in the Seas: Introduction to Acoustical Oceanography. Academic, New York (in press).

Gauthier, S. and J.K. Horne. 2004. Potential acoustic discrimination of boreal fish assemblages. ICES Journal of Marine Science 61: 836-845.

Hazen, E.L. and J.K. Horne. 2004. Comparing modeled and measured target strength variability of walleye pollock, *Theragra chalcogramma*. ICES Journal of Marine Science 61: 363-377.

Horne, J.K. 2003. Influence of ontogeny, physiology, and behaviour on target strength of Walleye pollock (*Theragra chalcogramma*). ICES Journal of Marine Science 60: 1063-1074.

Towler, R.L., J.M. Jech, and J.K. Horne. 2003. Visualizing fish movement, behaviour, and acoustic backscatter. Aquatic Living Resources 16: 277-282.

Other Related Publications

Clay, C.S. and J.K. Horne. 1994. Acoustic models of fish: the Atlantic cod (*Gadus morhua*). The Journal of the Acoustical Society of America 96: 1661-1668.

Horne, J.K. 2000. Acoustic approaches to remote species identification: a review. Fisheries Oceanography 9: 356-371.

Horne, J.K. and C.S. Clay. 1998. Sonar systems and aquatic organisms: matching equipment and model parameters. Canadian Journal of Fisheries and Aquatic Sciences 55: 1296-1306.

Jech, J.M. and J.K. Horne. 2001. Effects of *in situ* target spatial distributions on acoustic density estimates. ICES Journal of marine Science 58: 123-136.

Gauthier, S. and J.K. Horne. 2004. Potential acoustic discrimination of boreal fish assemblages. ICES Journal of Marine Science 61: 836-845.

Synergistic Activities

Coordinator of the NOAA Alaska Fisheries Science Center and University of Washington, School of Aquatic and Fishery Sciences Undergraduate Summer Intern Program.

Developer of web-based simulcast of Fisheries Acoustics course lecture content.

University of Washington's research committee member to the North Pacific Universities Marine Mammal Consortium.

Co-coordinator of University of Washington and University of Alaska multicast of Acoustics Seminar course using Internet II.

Collaborators & Affiliations

Whitlow L. Au	University of Hawaii
John K.B. Ford	Department of Fisheries and Oceans, Canada
Stephane Gauthier	University de Montreal
Sarah Hinckley	NOAA Alaska Fisheries Science Center
J. Michael Jech	NOAA Northeast Fisheries Science Center
Rudy J. Kloser	CSIRO, Australia
Richard Towler	University of Washington
Paul D. Walline	NOAA Alaska Fisheries Science Center

Graduate and Postdoc Advisors

Stephen B. Brandt	NOAA Great Lakes Environmental Research Laboratory
David C. Schneider	Memorial University of Newfoundland
Steven E. Campana	Department of Fisheries and Oceans, Canada

Thesis Advisor (total: 11) and Postgraduate-Scholar Sponsor (total: 3)

Current Students/PostDocs

Carlos Alvarez	Alaska Fisheries Science Center
Steve Barbeaux	University of Washington
Julian Burgos	University of Washington
Mark Henderson	University of Washington
Patrick Nealson	University of Washington
Carolina Parada	Alaska Fisheries Science Center
Sandra Parker-Stetter	University of Washington