

## *EVOSTC PROJECT REPORT*

*Project Number: ..... 12120111*

*Project Title: ..... Herring Research and Monitoring Program*

*Team Lead Name: ..... W. Scott Pegau*

*Time period covered: ..... October 2011 thru May 2012*

*Date of Report: ..... May 31, 2012*

*Report prepared by: ..... W. Scott Pegau*

*Project website (if applicable): ..... <http://www.pwssc.org/herringsurvey/>*

**Work Performed:** Summarize work performed during the reporting period, including any results available to date and their relationship to the original project objectives. Explain deviations from the original project objectives, procedural or statistical methods, study area or schedule. Also describe any known problems or unusual developments, and whether and how they have been or can be overcome. Include any other significant information pertinent to the project.

The HRM program has a goal to improve predictive models of herring stocks through observations and research. To achieve this goal it has four objectives.

- Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.
- Inform the required synthesis effort.
- Address assumptions in the current measurements.
- Develop new approaches to monitoring.

The program is designed around a mix of monitoring programs and process studies. The program is composed of seventeen projects, with not all projects occurring in any one year. The projects include the following (organizations involved and proposed periods):

1. Coordination and logistics – Prince William Sound Science Center (PWSSC) – all years
2. Outreach – PWSSC – all years
3. Disease monitoring and research – United States Geological Survey (USGS) – starts in year 3
4. Expanded adult herring surveys – PWSSC – all years
5. Juvenile abundance index– PWSSC – all years
6. Herring condition monitoring – National Oceanic and Atmospheric Administration (NOAA), PWSSC – years 2-5
7. Age at first spawn – NOAA – years 1 & 2
8. Herring genetics – NOAA – year 3 and 4
9. Population dynamics modeling - University of Washington (UW) – all years
10. Scales as growth history – Alaska Department of Fish and Game (ADFG) – years 1 & 2
11. Data management support – Axiom consulting – all years.

12. Juvenile herring intensive – NOAA, PWSSC – years 1-3
13. Fatty acid analysis – NOAA – years 1-2
14. Intensive surveys of juvenile herring – PWSSC – years 1, 3, 4
15. Validation of acoustics – PWSSC – all years
16. Tracking seasonal movements – PWSSC – years 1-3
17. Non-lethal sampling - PWSSC, Florida International University – years 1, 3

Proposed periods are based upon a budget year beginning in October each year. Several of the projects are scheduled to start later in the program because of the overlap with the Prince William Sound Herring Survey program, which supports similar research. Some projects received limited funding in year one to purchase new equipment and were not scheduled to begin sampling until later years.

Additionally, the HRM program is being coordinated with the Long-Term Monitoring program and the projects contained in that program.

### **Progress to date**

Much of the effort to date has involved in getting the funding in place. The level of effort and the date that funding began has differed between the trustee agency participants and the non-trustee agency participants. The non-trustee component is led by the Prince William Sound Science Center, which established funding through NOAA in February 2012. The subcontracts to Axiom consulting and the University of Washington were sent out once funding to PWSSC was established. Despite the mixed funding start dates most of the projects are on schedule with their deliverables. All projects are new and do not have specific results to share at this time.

The shift from the proposed October 1 start to the budget year, to the February 1 start that has been established affects the budget timing of projects beginning in later years. Much of the sampling effort occurs in November so to maintain the research schedule we will need to alter the funding requests of individual budget years, but will not change the total budget requested.

### *Coordination and logistics - Pegau*

The focus of this component has been in establishing the funding for the non-trustee agency lead components. This involved revising the proposal in the format needed for submission to NOAA. Additionally, effort was put towards establishing a small group for external oversight of the HRM program, and with the Trustee Council staff to establish the reporting requirements for the HRM program.

In addition to coordination efforts the project set up meetings for herring researchers at the Alaska Marine Science Symposium and a principal investigator (PI) meeting with the PWS Herring Survey Program that occurred in April 2012. All investigators attended the PI meeting either in person or through teleconference. Vessel time was obtained to collect the samples

needed by the herring condition intensive project. The remotely operated vehicle was ordered for the non-lethal sampling program.

#### *Outreach - Butters*

All outreach deliverables have been met. The revised herring *Discovery Room* activities focused on fifth grades students that worked on ocean monitoring and connecting the ocean conditions with herring characteristics. This included working with ADFG to allow the students to examine herring scales for growth. They also dissected herring to better understand the organism being studied. Evaluation of the herring portion of the activities is currently underway.

Other outreach activities include the development of four *Field Notes* radio programs, creation of three project profiles, articles on herring research and the HRM program published in the *Delta Sound Connections*, an article about engagement with local fishermen in the PWSSC *Breakwater*, and participation in the principal investigator meeting.

#### *Disease monitoring and research – Hershberger*

No activities were scheduled under the HRM program this year.

#### *Expanded adult herring surveys – Buckhorn*

This year's effort is limited to ordering equipment in conjunction with the hydroacoustic validation project. The equipment has not been ordered yet because we want to work with the forage fish component of the LTM program before establishing the exact protocols to be used in the future. With the forage fish sampling scheduled the summer of 2012 we will have time to learn from that effort before ordering equipment.

#### *Juvenile herring abundance index – Buckhorn*

The split beam acoustic system was ordered. We are waiting to order the trawl winches until after working with the forage fish program in the summer of 2012. The focus of efforts has been on establishing the exact locations for the surveys and the survey patterns.

#### *Herring condition monitoring – Kline, Heintz*

No activities were scheduled under the HRM program this year.

#### *Age at first spawn – Heintz*

There were some delays in getting the project operating, but it is mostly on schedule now. The live herring were collected and laboratory studies completed. The histological sampling is currently underway and expected to be completed before June. The delay in getting the histological work started was associated with the delay in funding becoming available.

#### *Herring genetics - Guyon*

No activities were scheduled under the HRM program this year.

#### *Population dynamics modeling – Branch*

The focus of effort to date has been in getting a graduate student in place to work on this project. The opportunity was advertised and a student selected. Other work included examining and participating in a discussion of the ASA model currently being used by ADF&G.

*Scales as growth history records – Moffitt*

This project is slightly behind schedule due to a late start in funding. The equipment needed has been ordered, and most of it has been delivered. A position is advertised for a technician to conduct the work. The trial processing and finalizing processing design will occur once all equipment and the technician have arrived. The project expects to be on schedule by July.

*Data management support – Bochenek*

The *Ocean Workbench* has been released and all investigators have gained access to the system. Several training seminars have been held via webinars and the PIs are beginning to use the system to organize and consolidate their project level data. Work continues on the system to provide a tool for investigators to add their metadata along with the data they are housing. Other modifications are underway based on input from the initial users of the system.

The process of identifying important data sets to recover and include in the system has begun. The initial focus is in ensuring the data for the PWS Herring Survey program are captured and archived. Other important data sets are also being identified. The speed of this effort is largely determined by the input from the individual investigators. Between the late start to funding and limited input about important data sets for recovery this component is behind the original schedule, but expected to catch up by late summer.

This effort is being coordinated with the work planned by the National Center for Ecological Analysis and Synthesis in the LTM program.

*Juvenile herring intensive monitoring – Kline, Heintz*

This project is on schedule. Working with the PWS Herring Survey program it was possible to begin collection of juvenile herring beginning in September. Spatial sampling was conducted in November and March as planned. Very limited numbers of fish were collected outside of the heads of the bay selected (Simpson Bay). Monthly sampling of juvenile herring has been conducted. Finding fish has been difficult through the spring, but adequate samples have been collected. Laboratory analysis of the fish is just beginning.

*Fatty acid analysis - Heintz*

This project was heavily dependent on fish collected as part of the spatial sampling for the previous project. Due to limited fish collected during the spatial sampling the project is using fish collected during previous efforts.

The laboratory component of this research has progressed further. The collection and laboratory trials are currently underway and the experimental phase is expected to be completed by the end of May. The chemical analysis of the samples is expected to be completed as scheduled.

*Intensive surveys of juvenile herring* - Buckhorn

The effort in this year is limited to the purchase of new processing software for the acoustic measurements. That software was purchased.

*Validation of acoustic surveys* – Bishop

Personnel were provided for sampling related to the *herring condition intensive* project. The purchase of equipment is delayed to provide the opportunity to work with the forage fish component of the LTM program.

*Tracking seasonal movements* – Bishop

Tags were purchased and a limited number of fish were collected during the November cruise in conjunction with the ADFG sampling. Since there were not enough fish collected of the appropriate size no fish were tagged in November 2011. Because there were very few fish collected, a second sampling was performed in April 2012 with 20 fish being tagged and released inside of the acoustic receiving array. Fish were tagged with dummy tags and held on the boat for three days with no apparent harm by the tags. All fish tagged and released appeared to be healthy and swimming well. Data from the receivers was uploaded in May and still awaits being analyzed.

*Non-lethal sampling* - Pegau, Boswell

Work on this project was limited to the purchase of a remotely operated vehicle (ROV) for use by PWSSC and FIU. The ROV is on order and we are expecting delivery in summer 2012.

**Future Work:** Summarize work to be performed during the upcoming year, if different from the original proposal. Describe any proposed changes in objectives, procedural or statistical methods, study area or schedule. *NOTE: Significant changes in a project's objectives, methods, schedule or budget require submittal of a new proposal subject to the standard process of proposal submittal, technical review and Trustee Council approval.*

We do not anticipate major changes to next year's work plan.

FY13 1<sup>st</sup> Quarter (October 1, 12 to December 31, 12)

October	Begin fatty acid analysis
November	Conduct juvenile index survey, validation and sampling for energetics and disease
November	Tag adult herring

FY13 2<sup>nd</sup> Quarter

January	Annual Marine Science Symposium
January	Update Ocean Workbench system
March	Conduct spring juvenile collection
March	Download acoustic array data

FY13 3<sup>rd</sup> Quarter

April	Conduct extended adult biomass cruise, collect samples for genetics & histology
May	Conduct annual PI meeting, complete written outreach materials
June	Submit FY14 work plan for review
June	Download acoustic array data
June	Complete data recovery portion of data management

FY13 4<sup>th</sup> Quarter

August	Submit annual report
September	Complete fatty acid analysis, complete scale analysis
September	Complete annual outreach efforts

FY14 1<sup>st</sup> Quarter (October 1, 13 to December 31, 13)

October	Submit synthesis to EVOS science council
October	Begin acoustic intensive study, Begin disease laboratory studies, Begin non-lethal sampling testing
October	Assess data submitted to data management
November	Conduct juvenile index survey, validation and sampling for energetics and disease, test non-lethal sampling systems

**Coordination/Collaboration:** Describe efforts undertaken during the reporting period to achieve the coordination and collaboration provisions of the proposal, if applicable.

This report covers several projects contained within the Herring Research and Monitoring program and represents one manner in which the projects are being coordinated. The activities in this program are also coordinated with those in the PWS Herring Survey program. Those projects in the HRM program that represent continuation of work in the PWS Herring Survey program were not funded in this first year to ensure only a single source of funding for the work being conducted. The HRM program is also coordinated with the Long-Term Monitoring program. There is shared data management efforts and coordination in cruise activity.

**Community Involvement/TEK & Resource Management Applications:** Describe efforts undertaken during the reporting period to achieve the community involvement/TEK and resource management application provisions of the proposal, if applicable.

Community involvement was sought through the outreach activities. Additional activities related to this program were conducted in the PWS Herring Survey program.

**Information Transfer:** List (a) publications produced during the reporting period, (b) conference and workshop presentations and attendance during the reporting period, and (c) data and/or information products developed during the reporting period. *NOTE: Lack of compliance with the Trustee Council's data policy and/or the project's data management plan will result in withholding of additional project funds, cancellation of the project, or denial of funding for future projects.*

We had the coordination meeting that was attended by the principal investigators. We have begun the process of getting data to the Alaska Ocean Observing System data servers.

**Budget:** Explain any differences and/or problems between actual and budgeted expenditures, including any substantial changes in the allocation of funds among line items on the budget form. Also provide any new information regarding matching funds or funds from non-EVOS sources for the project.

**NOTE:** Any request for an increased or supplemental budget must be submitted as a new proposal that will be subject to the standard process of proposal submittal, technical review, and Trustee Council approval.

Because of the change in the funding year to February instead of the proposed October start we need to adjust the budget for future years. This is most important for year 2 (FY13) and 3 (FY14) funding as project activities slated to start in October 2013 now fall in the year 2 budget instead of the year 3. A detailed budget for the five years is provided to show the funding needed in year 2 and that future budgets have been reduced to ensure the total budget remains the same.

The budget modifications are as follows:

**Pegau – Coordination**

- FY13 Add \$40,070 for Boswell subcontract
- Add \$15,600 for extra boat days
- Add \$12,130 for indirect
- FY14 Subtract \$40,700 for Boswell subcontract
- Subtract \$15,600 for boat days
- Subtract \$12,130 for indirect

**Bishop – tracking**

- FY13 Moved \$2,000 to Heintz fatty acid for NOAA’s John Eiler to participate in the tagging.

**Buckhorn – Intensive**

- FY13 Add \$21,000 personnel
- Add \$6,300 indirect
- FY14 Subtract \$21,000 personnel
- Subtract \$6,300 indirect

The revised detailed budgets can be found in the attached workbook. The overview showing the totals each year is provided below. This budget also includes the Herring Population Dynamics modeling project that was approved as an addition to the original HRM program.

<b>Budget Category:</b>	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED
Personnel	\$201,500	\$377,300	\$535,700	\$524,200	\$518,000	\$2,156,700
Travel	\$26,800	\$31,500	\$47,000	\$49,700	\$46,600	\$201,600
Contractual	\$336,960	\$544,799	\$406,088	\$367,616	\$362,857	\$2,018,320
Commodities	\$81,600	\$33,700	\$104,100	\$100,300	\$67,100	\$386,800
Equipment	\$187,200	\$0	\$0	\$0	\$0	\$187,200
Indirect Costs <i>(will vary by proposer)</i>	\$108,500	\$173,030	\$153,170	\$146,100	\$144,400	\$725,200
<b>SUBTOTAL</b>	\$942,560	\$1,160,329	\$1,246,058	\$1,187,916	\$1,138,957	\$5,675,820
General Administration (9% of subtotal)	\$84,665	\$102,663	\$114,104	\$106,996	\$102,673	\$511,101
<b>PROJECT TOTAL</b>	\$1,027,225	\$1,262,992	\$1,360,162	\$1,294,912	\$1,241,630	\$6,186,921

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*We appreciate your prompt submission of your annual report  
and thank you for your participation.*





**Proposal Title:** PWS Herring Research and Monitoring submitted under the BAA #AB1333F-11-RF-0016

**Submitted to:**

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**Proposed dates:**

October 2011 – September 2016

**Total Budget without general administration:** \$5,675,820

FY12	FY13	FY14	FY15	FY16
\$942,560	\$1,160,329	\$1,246,058	\$1,187,916	\$1,138,957

**Total Budget with general administration:** \$6,186,921

FY12	FY13	FY14	FY15	FY16
\$1,027,225	\$1,262,992	\$1,360,162	\$1,294,912	\$1,241,630

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W. Scott Pegau, Principal Investigator

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Nancy Bird, President, PWSSC

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Date

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Date

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This version of the proposal includes the original HRM proposal with the modeling component added.

## PROJECT PLAN

### I. NEED FOR THE PROJECT

#### *A. Statement of Problem*

Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the *Exxon Valdez* Oil Spill (EVOS) occurred. In the EVOS settlement herring were identified as an injured resource and they remain listed as an unrecovered species by the EVOS Trustee Council (EVOSTC). Understanding why herring have not recovered in Prince William Sound requires understanding potential bottlenecks in the herring life cycle. The identification of the limiting conditions to herring recovery requires a series of focused process studies combined with monitoring of the natural conditions that affect herring survival.

Described here are projects for a program that will enhance the current monitoring efforts of the Alaska Department of Fish and Game (ADF&G), and examine aspects of particular life stages to allow better modeling of herring populations. **The long-term goal of the program is to improve predictive models of herring stocks through observations and research.** While we do not anticipate that there will be a major change in our modeling ability in the next five years, we expect that the combination of monitoring and focused process studies will provide incremental changes over the next twenty years and result in a much better understanding of herring populations by the end of the program.

#### *B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities*

The proposed program addresses the goals and priorities outlined in the 1994 Restoration Plan (<http://www.evostc.state.ak.us/Universal/Documents/Publications/IHRP%20DRAFT%20-%20July%202010.pdf>) and in the FY 2012 invitation for proposals. In particular our program addresses the need to “Conduct research to find out why Pacific herring are not recovering” and “Monitor recovery”, listed on page 48 of the 1994 Restoration Plan. It will lead to the development of new tools to improve herring management. The latter will be accomplished by providing the information needed to develop or test biological and physical models of herring growth.

In November 2006, a Herring Steering Committee was formed and tasked with developing a focused Restoration Program that identifies strategies to address recovery and restoration of herring, recognizing that activities in the program must span an ecologically relevant time frame that accounts for herring population dynamics and life history attributes. A draft Integrated Herring Restoration Program (IHRP) was completed in the fall of 2008 and was further refined in July of 2010. The main goal

of the program is to determine what, if anything, can be done to successfully recover the Pacific herring in PWS. In order to determine what steps can be taken, the program examines the factors limiting recovery of herring in PWS, identifies and evaluates potential recovery options, and recommends a course of action for achieving restoration.

Based on the recommendations of the IHRP the Trustee Council has stated in the FY12 request for proposals that they have chosen Restoration Option #2, Enhanced Monitoring, as the focus for their research interests. The program described below aims to meet the goals of this option by utilizing a combination of monitoring efforts to provide more information about the existing stock and process studies to elucidate aspects of the herring life cycle necessary to move us towards an analytical modeling approach.

## II. PROJECT DESIGN

### ***A. Background:***

Pacific herring (*Clupea pallasii*) has a distribution in the eastern Pacific from the Beaufort Sea to Baja California, Mexico. They are pelagic forage fish that provide an important transfer of energy from phyto- and zooplankton to a suite of larger predators such as other fish, marine mammals, and birds. For more than 1500 years, herring species from around the world have been captured by subsistence and commercial fisheries for reduction to fish meal, consumption of meat and eggs, and bait for predatory sport fishes (Hay et al. 2001). Many herring stocks have experienced collapses, but unlike other fish species that decline due to fishing, herring are more likely to recover after reduced or zero levels of harvest (Hutchings 2000). In spite of repeated closures of the fishery in PWS the herring population has not recovered to pre-1993 numbers. While research over the last 16 years has been conducted to help pinpoint the cause(s) of the collapse and the lack of recovery, the conclusions are complex and at times conflicting. The mandate set by the EVOSTC is clear, that regardless of the cause of the decline it is imperative to work towards restoration of this important ecological and commercial fisheries stock.

As a forage fish, herring experience high levels of mortality at all life history stages, but certain stages may represent significant population-limiting bottlenecks that determine year class strength. Previous research (Sound Ecosystem Assessment (SEA) project; see (Cooney et al. 2001)) indicated that a population-limiting bottleneck in PWS herring may include mortality that occurs during the overwintering period among age-0 cohorts; consequently, this life stage represents the basis for the current EVOSTC herring research (Project 10100132 A-I).

Every winter, herring enter a starvation period in which they rely on their energy stores to survive through winter. Age-0 herring may be at a disadvantage compared to the older cohorts that are able to start feeding and building energy stores during the period when age-0 herring are eggs and then larvae. The age-0 cohort relies on energy stores for overwinter survival as zooplankton biomass decreases during the fall. Larger Age-1 and older herring tend to have a higher whole-body energy density (WBED) going into winter. Age-0 herring have lower WBEDs (~5.7 kJ/g wet) heading into winter than age-1

herring (~8.0 kJ/g wet) and age-2 herring (~9.4 kJ/g wet), but age-0 herring also have a lower decrease of WBED during winter compared to older age classes (Paul et al. 1998). Larger age-0 herring may have higher survival due to higher WBED and higher assimilation rates (Foy and Paul 1999). Gut content analysis indicate that age-0 herring prey items varied among seasons and among bays (Foy and Norcross 1999). Zooplankton samples were not collected during that study so it is difficult to determine if prey consumption was based upon preference or availability. However, they did find that the spatial and temporal variation in diet composition accounted for the differences in condition of age-0 herring sampled. The compromised overwinter survival among age-0 herring resulting from decreased energy content is further exacerbated by endemic diseases, which add additional bioenergetic demands. For example, *Ichthyophonus*-infected herring demonstrate a 30% reduction in total energy content compared to uninfected cohorts (Vollenweider et al. In press).

The overwintering survival of age-0 herring is just one of the potential factors limiting recruitment. Large gaps remain in our understanding of herring life history that we must fill if we are to better predict herring recovery. The EVOSTC website lists 174 projects intended to address factors contributing to the decline and failed recovery of PWS herring. This number is misleading in that many of these are the same project over several different years and others were part of large programs, such as the Apex Predator Experiment that had components related to herring, but were not focused on herring. There still remain many herring focused research projects, some of which are included in the current PWS Herring Survey program that includes a coordinated set of ten individual research projects. The program proposed here builds upon the needs identified in the EVOSTC Integrated Herring Restoration Program and is designed to complement previous research to improve our understanding of PWS herring stock.

## ***B. Goal and Objectives***

### **Goal: Improve predictive models of herring stocks through observations and research.**

This is the long-term goal of an anticipated twenty year program. The general approach will be to conduct monitoring of a limited number of variables combined with process study research. We will break the process study efforts into five-year increments. Within each increment we will focus on particular aspects of the herring life cycle to better predict how factors affecting that life stage influence overall herring stocks. We have identified several areas that require attention such as the larval life stage (least amount of existing information), stock structure (from modeling efforts), context of existing measurements (from synthesis), along with predation and competition questions. By no means is this list meant to be comprehensive. We will rely on a scientific advisory group (described later) to guide the efforts of each five-year effort and to recommend modifications during a five-year period if needed. The remainder of the discussion in this proposal is focused on the proposed efforts between FY12 and FY16.

We have sought input for the design of the first five year proposal from scientists with ADF&G, NOAA, the current PWS herring survey program, and other institutions. Based on that input we have arrived at the following objectives for the first five-year period.

## Objectives

- 1) *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.* The ASA model is currently used by ADF&G for estimating herring biomass (Hulson et al. 2008). The proposed monitoring efforts are designed to address this objective by either expanding the data available for the existing ASA model or by providing information about factors that determine the size of recruitment events.
- 2) *Inform the required synthesis effort.* Proper completion of a detailed synthesis means being able to access and manipulate different sources of data and information. We are proposing projects that make data available to all researchers.
- 3) *Address assumptions in the current measurements.* Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into context spatially and temporally. This effort will allow the design of the most accurate and efficient monitoring program.
- 4) *Develop new approaches to monitoring.* With technological advances we have the potential to improve our monitoring programs so they require less effort or reduce the need to collect fish.

Because we are at the beginning of a twenty-year effort, we want to maximize the value of any data collected. The objectives listed above are designed to ensure that research and monitoring efforts within the expected twenty-year program are most effective. The programs addressing the objectives provide the information necessary to evaluate existing efforts while continuing to move towards our long-term goal.

## ***C. Procedural and Scientific Methods***

Approach: Our iterative approach to addressing the long-term goal of this program “**to improve predictive models of herring stocks through observations and research**” involves testing the relative importance of factors that may be preventing the recovery of PWS herring. The relative importance of these factors will be identified through an integrated set of studies that include monitoring efforts, shorter field-based process studies focusing on particular aspects of the herring life cycle, and controlled laboratory-based studies intended to determine cause-and effect relationships. When combined, this approach is intended to inform more directed herring monitoring and modeling efforts by focusing on important population-limiting factors and providing empirical data for the current ASA model. The work outlined here will be informed by projects outlined in a separate long-term monitoring program, such as monitoring of basic oceanographic conditions, food availability, and predator populations. It also builds upon the existing EVOSTC funded PWS Herring Survey research program. The team lead (W. Scott Pegau) on the proposed work is the same team leader as on the PWS Herring Survey program, which allows the proposed work to be fully integrated with the existing work without unnecessary duplication.

The first component of the proposed work includes monitoring programs. They are designed to complement the existing ADF&G surveys that determine the spawning biomass, the mile-days of spawn,

and the age-sex-weight composition of the spawning stock. The ADF&G surveys are central to our understanding of when the PWS adult herring population is recovering. However, these surveys have limitations that this program addresses.

### **Monitoring Components:**

Monitoring components are designed to address objective #1 by either adding desired information that is not currently being collected by ADF&G or collecting information we believe will allow for advances in the ASA model. Below is a brief description of the proposed monitoring projects. An expanded description of the work to be done is provided in an appendix.

1. **Disease in the adult population** – Disease is now a component in the Age-Structure-Analysis model for Prince William Sound; however, it is not part of the ADF&G sponsored surveys. We will provide the disease information for the ASA model by determining annual prevalence and intensity data for the most virulent pathogens that are currently endemic in the PWS herring populations, including viral hemorrhagic septicemia (VHS), viral erythrocytic necrosis (VEN), and ichthyophoniasis. Monitoring efforts will consist of the annual collection and processing of sixty adult and sixty juvenile herring per site from three sites in PWS to test for disease. Diagnostic techniques for these pathogens will follow standard procedures described in the “Blue Book: Standard procedures for the detection and identification of select fish and shellfish pathogens (American Fisheries Society).” We will also examine efficacy of newly-developed procedures that may forecast the potential for future disease mortalities and simplify the disease surveillance efforts.
2. **Enhanced adult biomass surveys** – Current stock assessment efforts by ADF&G resource managers in PWS focus on the largest spawning aggregations. Additional spawning aggregations exist, but are not regularly surveyed by ADF&G because of funding and personnel limitations; therefore, their relative contributions to the biomass of the PWS metapopulation remain poorly understood. The Prince William Sound Science Center (PWSSC) has also conducted acoustic biomass surveys for the past two decades. We propose to extend the PWSSC acoustic surveys to help identify the relative contributions of these additional spawning aggregations over temporal and spatial scales. This will help establish more accurate estimates of the total herring biomass in PWS and provide an alert to changes in biomass in different regions. The PWSSC survey will overlap with the ADF&G survey to provide a comparative measure between the two studies and to improve the precision of the estimate.
3. **Juvenile biomass index surveys** – The current estimates of herring biomass in PWS is at the threshold for allowing a fishery. A large proportion of the fish in this estimate are the three and four-year old fish expected to recruit to the spawning biomass. The estimates of these new recruits are made with nearly no information about the actual number of juvenile fish in the Sound. The purpose of the juvenile biomass surveys will be to provide an index of the strength of age-0, -1, and -2 herring. This will provide a measure of the expected recruitment to the fishery and provide information needed to better quantify mortality at these early life stages.

Since this is a new effort we will be examining the utility of acoustic surveys and direct capture programs to determine the best method to develop an index.

4. **Age-0 condition** – The energetic state of juvenile, particularly age-0, herring provides an integrated measure of environmental conditions. By monitoring condition parameters of age-0 herring we will be able to better identify the role of environmental conditions in determining survival through this critical time period. This program links the herring and long-term monitoring programs. Understanding the role of bottom-up regulation of herring requires the basic physical and biological oceanographic measurements that are proposed in the long-term monitoring program.

The juvenile biomass index survey and the age-0 condition surveys both are designed to provide predictions of the strength of potential recruitment to the fishery. We anticipate that during the twenty-year period we may drop one of these programs once we determine the most accurate and cost effective approach.

### **Process Study Components:**

The process studies provide the ability to rapidly improve our understanding of the herring population in PWS. Because numerous gaps exist in our understanding of factors controlling the biomass and demographics of herring populations, and some knowledge is based on untested assumptions, the number of potential process studies is very large. We propose grouping projects into thematic areas that can be used to focus our efforts. In the first five-year period we are especially interested in providing the information necessary to ensure the best program moving forward into the future, and also to address issues that can make rapid improvements to the existing modeling efforts. To ensure the best program over the next twenty years we propose to address the four objectives listed earlier during this funding cycle. Below each objective is a brief description of proposed projects that address the objective. The projects are identified by a short name in italics. A more detailed description of the work to be done is included in an appendix.

***Objective 1.*** *Provide information to improve input to the age-structure-analysis (ASA) model, or test assumptions within the ASA model.*

The ASA model has a maturity schedule that according to ADF&G fisheries reports has changed over time and is different among regions. However, this maturity schedule has not been confirmed by direct observations; rather it has been allowed to vary in a limited manner to allow the ASA to provide the best fit to the input data. To address this issue we are proposing a study to examine the age at which herring first spawn and determine if there is evidence of some herring skipping potential spawning events.

*Primiparous fish:* Determination of age at first spawn has been accomplished via 1) analysis of differential growth increments on scales, and 2) histological analysis of egg development in ovaries. In Atlantic herring, the width of scale annuli has been used to identify years in which the fish did or did not spawn, where growth rings are relatively wide prior to their first spawning event (and during years of skip-spawn), and relatively narrow for years that spawning occurs (Engelhard and Heino 2005). Thus scales provide a spawning history for an individual fish. The presence of post-ovulatory follicles (POV)



after spawning indicates an individual fish has recently spawned while oocyte maturation identifies individuals about to spawn. By sampling at a time when both POV and maturing oocytes are present it is possible to discern immature, primiparous and repeat spawning individuals. While the histological method provides direct observation of the spawning history of individuals, it is unlikely that developing oocytes can be observed among spawners. Therefore, the histological analysis must occur some months after spawning (Saborido-Rey and Junquera 1998).

We propose to examine scales of female herring collected from spawning aggregates in PWS to identify the spawning history of each year class. We will also validate the scale technique by comparing the results of scale analysis with that of histological analysis of oocyte development. The validation will likely be used on fish sampled some time after spawning. In order to identify the optimal time we will iteratively sample ovaries in fish held in the lab after spawning. If scale analysis proves to be a viable means to assess age at first spawn and spawning frequency, it would be a relatively inexpensive monitoring tool that could be used to adjust the ASA model in real time.

*Genetic stock structure:* Understanding if there is one PWS herring stock or multiple stocks is important for proper management of fisheries. We propose to study the fine scale genetic structure in herring from PWS to determine if it may be a complicating factor in the recovery process. A previous genetic study of herring in the region indicated that the PWS herring population was genetically distinct from other stocks spawning outside the Sound (O'Connell et al. 1998), providing an impetus for additional work. Several recent studies have made advancements in herring research using microsatellite loci, and have detected fine-scale genetic differentiation among local regions of herring (Beacham et al. 2008; Andre et al. 2011; Wildes et al. in review). Each microsatellite locus contains multiple alleles making microsatellites ideal genetic markers for analyzing migratory fish with limited stock structure like herring. Based on our experience studying Pacific herring in Southeast Alaska using microsatellite markers (Wildes et al. in review), successful completion of this proposal will require (1) increasing the number of genetic samples per collection from the 50 used in the previous analysis (O'Connell et al. 1998) to 150 fish, (2) using an increased number of informative markers (from 5 to 15), (3) analyzing at least two years of collections to examine temporal stability, (4) comparing at least two year classes to examine the possibility of "spawning waves" as detected in some regions in Atlantic herring, and (5) spatial stability from collections from two different historical locations (east, west). Evaluation of temporal and spatial variation of herring population(s) in PWS using updated genetic protocols will provide important information about herring life history that will contribute to improving the application of the ASA model.

*Herring population dynamics modeling:* Improving our ability to predict the herring population requires assessing the current model used for management and determining if alternate models may have greater predictive skill. The connection between field observations and achieving the goal of the program also requires modeling capabilities. This component will; a) determine which datasets provide the most informative information for the ASA model; b) predict levels of future recruitment, and autocorrelation in recruitment, using information from other herring populations and other species of clupeids; and c) synthesize the data collected from the monitoring program into a holistic model of herring dynamics, to determine which life stages the observational program should focus on.

**Objective 2. Inform the required synthesis effort.**

This objective includes efforts to improve access to a wide array of data sources for inclusion in the synthesis efforts. Many of the projects described under Objective 3 will also address this objective.

*Data visualization:* A data management approach is described later in this proposal; however, we feel it is important that the data management efforts also contribute to our ability to conduct the required synthesis. In year one we plan to focus efforts on integrating existing ADF&G herring data and other important ancillary data sets from the spill affected region (Prince William Sound, Cook Inlet, and potentially Kodiak) into the Alaska Ocean Observing System's (AOOS) data delivery and visualization system. Much of the herring data has been gathered together in projects funded by EVOSTC and the North Pacific Research Board (NPRB). However, the herring portal is currently neither readily available nor regularly updated, and data for herring populations in Cook Inlet have not been incorporated into the portal. We will transfer those data into the AOOS data management and visualization system to allow easier access and to allow the data to be visualized along with other oceanographic conditions, such as water temperature or chlorophyll concentrations. While we do not anticipate that it will be an onerous task to incorporate the existing data into the system, the ability to combine that information with other disparate data types will require some effort. A portion of the effort will involve collection and incorporation of data sets that are not currently part of the AOOS collection. By working with the AOOS data system we will be able to dovetail with other sources of funding that will help with the collection of historical data or in improving data visualization and access.

*Herring scale analysis:* A very valuable source of information for many PWS herring studies includes approximately 200,000 herring scales (including ancillary data including collection location, date, length, weight, and sex) that are currently maintained in a collection at the Cordova ADF&G office. Unfortunately, only a small portion of these data are converted to an electronic format. We are proposing a project that will examine the growth history contained in scales from PWS. This information will be used to improve our understanding of any temporal and age-specific growth patterns that result in observed changes in size at age. Spatial patterns may also be examined given sufficient sample sizes. Project data can be used to model changes in growth in relation to environmental and population indices.

There is also potential for this information to help identify when fish first spawn as described in the project under Objective 1. There are many more scales than can be analyzed by either of these individual projects and we will ensure that the information collected in each effort can be combined to increase the statistical power of both sets of analyses. We believe that retrospective studies, such as this one, will be extremely useful in improving the quality of the required synthesis.

**Objective 3. Address assumptions in the current measurements.**

Many of the existing studies are based on historical or logistical constraints. We are proposing research necessary to put the existing measurements into spatial and temporal context. This effort will allow the design of the most accurate and efficient monitoring program.

*Herring condition intensive:* The currently-funded herring monitoring program is designed with coarse temporal and spatial resolution with only two sampling events per year occur at narrowly defined sampling sites in PWS. Greater temporal and spatial coverage is required to impart greater meaning. In the case of temporal variation of herring condition it would be useful to understand (1) how the kinetics of overwinter starvation are affected by inter-annual differences in the initiation of the early winter fasting period (2) the timing of recovery from winter starvation. The latter is important because the overwinter mortality model currently predicts that as little as 1 % of the November population of age-0 herring would survive to May given a continuation of starvation after March. Data from the SEA project suggest that the age-0 herring are in very poor condition as late as May. In the case of spatial variation of herring condition it would be useful to know how sensitive the herring mortality model is to immigration into and emigration from areas immediately adjacent to where herring are sampled at the time of our November and March surveys.

We propose to examine herring condition on a monthly basis for a nine month period. This design will better resolve the time period that fish meet the assumption of the age 0 mortality model that is being developed to predict overwintering mortality. The primary assumptions are that the fish have a period when they are not feeding sufficiently, and the energy lost by the fish has a linear relationship with time. Greater temporal resolution than the current twice a year sampling plan is required to confirm if and when these conditions exist. We propose to collect fish for both the energetics and growth work to identify how the measured variables change through time to improve our interpretation of those measurements and ensure we sample at the most appropriate times.

*Fatty acid analysis:* Monitoring of age-0 herring has been suggested as an important component of the EVOSTC herring program, but the appropriate spatial scale to monitor is unknown. The juvenile condition and interpretation of acoustic measurements require a basic understanding of the relative contributions of immigration and emigration. The current program assumes age-0 herring remain in their nursery bays over winter. If true, then age-0 monitoring can utilize a series of index bays to evaluate the relative health of herring cohorts. Observations of differences among bays in terms of age-0 condition and marine conditions can provide a basis for identifying environmental conditions which lead to improved recruitment to age-1. However, if age-0 fish move about PWS in winter, then measurements of fish condition are limited to inter-annual variation, severely constraining our ability to identify the conditions contributing to the recruitment of large year classes. Thus the current herring monitoring program requires validation of the assumption that age-0 herring remain in their nursery bays over winter.

We propose to test this assumption by monitoring the fatty acid composition of age-0 herring over winter. Herring foraging on different prey fields likely have different fatty acid compositions because the fatty acid composition of depot lipids derives from diets. Differences in the prey fields in different bays should produce differences in the fatty acid compositions of herring in those bays. During periods of food deprivation, fish fatty acid compositions are conserved. Therefore, the fatty acid composition of age-0 herring in fall can act as a natural tag for identifying migration. We hypothesize that migration of herring will result in increasing similarity of herring fatty acid compositions. Changes in fatty acid

composition due to winter feeding are likely to be minimal because age-0 herring experience energy deficits in winter, proscribing lipid storage. Consequently, if the fatty acid composition of age-0 herring in given bays is constant over winter then migration must be limited.

*Acoustic consistency:* Hydroacoustic surveys of juvenile herring nursery areas in PWS have been conducted during fall and late-winter for the last several years. The objectives of this effort have been to improve understanding of habitat utilization by juvenile herring, especially age-0, and to help identify candidate sites that could be potentially used for supplementation efforts. The number of locations surveyed have varied from 5-9, including the 4 SEA bays. However, each seasonal effort has conducted only a single night survey in each of these locations. Thorne (2010) examined seasonal changes from fall 2006 to spring 2009. He showed that apparent overwinter mortality of age 0 herring appeared to be greatest in Simpson Bay and least in Whale Bay. However, he also pointed out that the differences over winter could also be the result of emigration. Not only might age-0 herring move among bays during the winter, but movement into and out of bays may be progressive during a season. Of concern is that age-0 herring may not have fully recruited into the bays by the time of the fall survey, or have migrated out before the spring survey. Another potential source of variability could be the stage of the moon. Ambient light is known to affect fish distributions. On many occasions, age-0 herring aggregations were readily identified by their distinct distribution: a diffuse layer near the surface, near the shore and near the heads of bay. On other occasions, this distinctive distribution was absent even though age 0 herring were present. The change might have been the result of different ambient light regimes. The accuracy of both annual and seasonal comparisons depends on whether the single-night observations are representative of age-0 herring abundance. Such information is especially critical if hydroacoustic surveys are needed to provide an index of future age-0 herring abundance.

We propose to address these uncertainties with a set of fall and late winter/spring intensive surveys. In each case, we propose three consecutive nightly surveys of each of two bays on four separate occasions, spaced at 2-week intervals. The fall series will start mid-October and extend to the first week of December. The late winter/spring series will begin the 3<sup>rd</sup> week of February and extend into the 2<sup>nd</sup> week of April. Such a design will address daily, weekly, and monthly variability, including moon phase. We propose to conduct the surveys in two bays sufficiently adjacent to cover each bay each night, such as Simpson Bay and Windy Bay or St. Matthews Bay and Port Gravina. In addition to the hydroacoustic surveys on 3 successive nights, we propose a single night of direct capture effort in each location for each of the survey weeks.

*Hydroacoustic validation:* We recognize that a major deficit in our existing program is the lack of an effective means of validating the hydroacoustic signal. Fortunately, if we can establish through ground truth efforts (e.g. direct capture of ensonified fish, camera surveys) that certain patterns in echograms can be interpreted as different year classes of herring, and then we may be able to reanalyze historical acoustic measurements to better understand changes in juvenile herring populations.

In Prince William Sound, juvenile herring acoustic surveys have been conducted at the beginning (November) and end (March) of every winter since March 2007. A variety of methods have been used

with limited success to ground truth these surveys. Small mid-water trawls used during fall 2007 and fall 2009 cruises failed to catch fish. In most cases, these trawls were towed 1 day after the acoustic survey and always from a different vessel. Trawling speeds were typically 2-3 knots, producing a high level of net avoidance by the targeted fish. Variable mesh gill nets have also been used to validate acoustic surveys; however, gillnets select for faster swimming fish (Thorne et al. 1983) and in PWS, gillnet deployments have resulted in very small catch rates of juvenile herring.

Pelagic trawls are the recommended method for validating species composition and for obtaining information on length frequency distribution, age, and other biological information (Simmonds et al. 1992, McClatchie et al. 2000, Adams et al. 2006, NOAA 2009). In the proposed program we plan to use a low-resistance, light-weight mid-water trawl capable of increased towing speeds (3-4 knots) as a direct capture method for collecting the number of fish necessary to provide validation. In order to provide accurate data on ensouled fish, the trawl will be towed simultaneous with acoustic surveys for herring and from the same research vessel. We also propose to examine non-lethal approaches such as imaging sonar and camera systems for validating the interpretation of the acoustic signal. Validation efforts will be coordinated with acoustic surveys to provide a rapid assessment of the fish assemblages observed during the acoustic survey.

*Disease studies:* Mortality from infectious and parasitic diseases has been identified as a leading hypothesis accounting for the decline and failed recovery of PWS herring (Marty et al. 1998; Marty et al. 2003; Marty et al. 2010); unfortunately, the location and timing of the acute and / or chronic mortalities remain unaddressed because of difficulties inherent to sampling in marine systems. However, recent empirical studies provide insights into seasonal periods that are critical to disease processes, based on water temperatures and herring behavioral patterns. For example, the probability of viral hemorrhagic septicemia (VHS) epizootics increase as water temperature decreases, because virulence, magnitude and duration of viral shedding, and VHSV persistence in infected hosts increase as the temperature decreases (Hershberger unpublished data). Similarly, the infectivity of *Ichthyophonus* to Pacific herring is inversely related to temperature, with infection prevalence decreasing from 76%, 54%, and 24% at temperatures of 9.3°C, 12°C, and 15.3°C, respectively.

In association with sampling from other components of this program, we will investigate the seasonality of these diseases by focusing disease surveys during the coldest periods of the year, when *Ichthyophonus* infectivity is highest and VHS is likely to have its greatest impacts. An additional risk factor for VHS mortality includes periods of high aggregation when effective fish-to-fish transmission is most likely to occur (Hershberger et al. 2010; Hershberger et al. submitted); this risk factor is enhanced during cold water periods, when viral shedding from carrier individuals is greatest. Therefore, field disease surveillance efforts will be focused on the overwinter and spring-spawning periods. Additionally, controlled laboratory studies will be performed to further understand cause-and-effect disease relationships and to further develop predictive tools that forecast the potential for disease-related mortality (described in Appendix 1).

**Objective 4.** *Develop new approaches to monitoring.*

The EVOSTC FY12 request for proposals points out the need for evaluating new technology throughout the program. As described earlier we are looking to use newer genetics tools to examine stock structure, but there are several other projects that examine the development or application of new technologies. We also are proposing to upgrade the hydroacoustic system used in our surveys to provide the benefits associated with recent advances in acoustic technologies.

*Herring tagging:* We propose to utilize the existing Pacific Ocean Shelf Tracking (POST) tracking array currently deployed in Port Gravina and the arrays planned for deployment in 2011 across the major entrances and passages to Prince William Sound by conducting a pilot study examining the utility of acoustic tags for tracking adult herring. Specifically, we will examine if and when adult herring migrate out from and back into Prince William Sound. The ability to track herring is critical to answer many questions including those about stock structure, migration habits, and the occurrence of skip-spawning. By understanding the capabilities of this technology it will help guide our choice of future research emphasis that may depend on a mature tagging technology.

*Disease forecasting:* High-throughput techniques intended to forecast the potential for future herring mortalities caused by viral hemorrhagic septicemia are currently being developed, optimized, and validated. The techniques are based on the well-demonstrated concept that survivors of prior VHS exposure demonstrate resistance to the disease after subsequent exposure to the virus. Therefore, the potential for future VHS epizootics and resulting fish kills can be enumerated if we can determine the prior exposure history and subsequent levels of herd immunity conferred to wild herring populations; whereby previously-exposed populations would have high immunity and a resulting low potential for future VHS impacts. We have successfully developed an enzyme-linked immunosorbent assay (ELISA) that quantifies the prior exposure history of herring populations by detecting levels of circulating antibodies that are specific to VHSV. We are in the final phases of ELISA optimization and validation. This tool will be incorporated into the annual herring assessments to determine the potential for future VHS epizootics in the PWS populations. Additionally, we will continue to develop further disease forecasting tools for VHS and other primary diseases of PWS herring, including ichthyophoniasis and viral erythrocytic necrosis.

*Non lethal sampling:* Interpretation of the acoustic signal, for species or biomass, requires information on the fish distributed within the ensonified volume. We currently rely on direct capture techniques to sample the fish to determine species and size characteristics. New capabilities in optical and acoustic imaging have been demonstrated as promising tools for acquiring the required demographic information on fish in a non-invasive manner. We propose to examine two techniques, one optical and the other acoustic, to evaluate their utility for verification of the hydroacoustic survey data. At the completion of an acoustic survey we will return to locations to reacquire features of interest and then lower a remotely operated vehicle (ROV) and/or imaging sonar to determine the species and/or size composition of the fish observed in the acoustical survey. Alternatively, we may be able to tow the imaging systems at a fixed depth during the survey to provide transect information. The acoustical technique will use either a DIDSON or ARIS imaging sonar and we intend to use an ROV as a vehicle for

the optical system. The advantage of using an ROV over a simpler camera system is that it can be used for other purposes, such as acoustic tracking station retrieval and examining herring use of ice habitat.

### ***D. Coordination and Oversight***

This proposal is structured to be a collaborative effort being led by the Prince William Sound Science Center. Program coordination will primarily be through e-mail and phone communications. Annual meetings are planned in Cordova, tentatively in May, for all investigators to share information between themselves and with the community. These in-person meetings are vital to ensure proper communication among programs.

Dr. Pegau will act as the team leader and be responsible for ensuring a coordinated and focused research program that leverages other assets whenever possible. He will be responsible for ensuring proper scientific oversight of individual projects and reporting to the EVOSTC. He will lead the development of annual work plans and the synthesis of findings from these programs. He will be responsible for coordinating the efforts of the herring research program with those of the Long-term Monitoring program.

Dr. Pegau currently is the coordinator of the existing EVOSTC funding PWS Herring Survey program. This program consists of ten individual projects that provide a coordinated examination of juvenile herring in Prince William Sound. This proposal is heavily influenced by the early findings from that effort. Dr. Pegau also serves as the Research Program Manager for the Oil Spill Recovery Institute (OSRI). In that capacity he is responsible for developing annual work plans, ensuring proper reporting, making reports available, developing partnerships to leverage funding, and to ensure outreach of OSRI activities. All activities that provide experience delivering the team leader duties outline in the request for proposals.

One of his duties is to ensure proper scientific oversight of the research programs. To accomplish this we will be setting up a four-person scientific oversight panel that will help guide the program and ensure the research is relevant to the long-term goal. The team will consist of people representing Alaska Department of Fish and Game, the National Oceanic and Atmospheric Administration, academia, and the local fishing community. There will be annual Principal Investigator meetings in Cordova each year to provide updates to the oversight panel, improve coordination between projects, and provide outreach and public input opportunities. This meeting will be in the spring so that there is opportunity to provide input on the development of the next year's work plan. In an effort to be proactive in the scientific oversight we sought input on the development of this proposal from ADF&G, NOAA, Cordova District Fishermens United (CDFU), and others. Team development and input on research direction was also sought at the 2011 Alaska Marine Science Symposium.

The wide array of projects that make up this program required careful integration to ensure the maximum collaboration between projects. Not all projects are directly connected to each other, but are connected through the objectives of the program. The full benefits of the linkages will be seen at the points where synthesis efforts occur. Direct project overlap occurs in the area of logistics. We intend to have the acoustic surveys, direct capture, and non-lethal collection components sharing a vessel. The

direct capture and non-lethal collection are intended to provide validation to the acoustics. The direct capture component will be responsible for providing fish to the RNA condition, energetic condition, disease research, fatty acid indicators, and genetic stock indicator projects. Another direct project overlap occurs between the herring scale analysis and primiparous herring projects, which will share growth information as determined from the scales. The combined efforts will lead to a greater number of scales becoming digitized and improving the statistics for both projects. All projects will also interact with the data management efforts to ensure the data is properly archived and maintained.

Indirect project overlap occurs between projects through the scheduling. Projects like the genetic stock indicators are pushed back in the cycle to ensure that the methodologies used by the direct capture program are mature enough to ensure collection of the required samples. Non-lethal collection is also later in the program to ensure new direct capture techniques are fully tested. Fish collected from the RNA and energetics intensive studies will also be used by the fatty acid indicator project. The acoustic tagging project is early in the program to take advantage of the acoustic receiver array that is in place and has a limited life span. Some projects like the disease research component also start later in the program because of coordination with the existing herring monitoring program. We worked hard to ensure that there isn't duplication between the proposed program and the existing program. One apparent exception is the RNA and energetic condition intensives. By moving these projects early in the program we intend to fill what is seen as a major gap in the existing program and hopefully more quickly resolve the information value that each project provides.

Coordination with the EVOSTC Long-term Monitoring program is critical to the success of the herring program. The ability to develop a predictive tool using the juvenile condition component requires an understanding of when feeding may occur and hence the need to coordinate with the oceanographic monitoring component. Predation by whales, fish, and birds are also considered potential factors inhibiting the recovery of herring. In that regard we will be looking to the monitoring program for information on the changes in the predator population base. That information will be critical if the herring program chooses to focus on predation during future efforts. The forage fish component and our efforts to develop an index of juvenile herring populations must inform each other. We expect that our hydroacoustic surveys and direct capture efforts will help provide measures of total fish biomass as well as forage fish populations. We will also work together to identify historical data that both programs would benefit from as part of the data management efforts. Throughout the proposal writing effort, the herring and long-term monitoring efforts led by Kris Holderied have been working together to identify how the two programs can inform and complement each other.

Other important programs for coordinating with are the existing PWS herring survey program and existing ADF&G herring research. This program has been developed with input from both of these programs and the focus of this proposal is extending the interpretation of the data from those two programs. The Herring Survey program will still be operating in FY12 and FY13. There are field observations scheduled in FY12 and in FY13 funds are strictly for analysis and report writing. Included in the report writing is a synthesis of previous and current research. This report will be finished in FY13 and be the basis for the synthesis required under this request for proposals.



## ***E. Research Team Roles***

This proposed program is made up from several projects led by Principal Investigators from a number of institutions. We provide a brief description of the role of each Principal Investigator. Curriculum Vitae for the Principal Investigators are provided at the end of the proposal.

Dr. W. Scott Pegau (PWSSC) is to provide coordination of the projects and will also work with the ROV based validation approach and support the study of how herring growth determined from the scale analysis may be connected to environmental conditions.

Dr. Paul Hershberger (USGS) will lead the disease related research components including monitoring for the presence of disease and development of new techniques for monitoring for disease.

Dr. Ron Heintz and Johanna Vollenweider (NOAA) will conduct the research on juvenile condition, fatty acid analysis, genetic stock structure studies, and detection of primiparous fish.

Dr. Jeffrey Guyon and Sharon Wildes (NOAA) will lead the research on identifying stock structure through genetic markers.

Steve Moffitt (ADF&G) will lead the effort to digitize herring scales for the purpose of determining the annual growth intervals.

Dr. Thomas Kline Jr. (PWSSC) will lead the effort for monitoring and research related to energetic condition of age 0 herring.

Dr. Mary Anne Bishop (PWSSC) will lead the direct capture efforts needed for validation of hydroacoustic measurements and disease and condition studies. She will also co-lead the effort to test acoustic tagging in wild herring with Dr. Sean Powers (University of South Alabama).

Dr. Michele Buckhorn (PWSSC) will lead the hydroacoustic surveys for adult and juvenile herring.

Rob Bochenek (Axiom) will lead the data management and visualization efforts.

Dr. Kevin Boswell (LSU) will lead the efforts to test visible and acoustic imaging systems for validation of hydroacoustic measurements.

Dr. Trevor Branch (UW) will lead the modeling efforts.

## ***F. Data Management***

The PWS Herring Survey program has a web presence at <http://www.pwssc.org/herringsurvey/index.shtml> where basic information about each program can be found and links to the annual reports on the EVOSTC website. We propose to continue to use this as a place to make documents associated with the herring program accessible. We propose to work with the Alaska Ocean Observing System (AOOS) and their data management team at Axiom Consulting for data

management and visualization efforts. This allows us to benefit from the funding committed to data management by the AOOS.

The proposed effort includes bringing the existing PWS herring portal data fully into the AOOS data visualization and management framework, along with recovery of other important historical herring and ancillary data sets. Data management plans will also be developed for each research study to ensure that detailed metadata is drafted and that data generated by projects is discoverable, understandable and ultimately usable by other researchers and interested parties. The first year efforts are expected to focus on visualization with increased efforts in the second year developing tools to aid researchers in making their data available. The data submission tools will build upon tools for data management currently being developed for PWSSC researchers under OSRI funding.

### ***G. Outreach and Community Involvement***

We will hold annual Principal Investigator meetings in Cordova during the spring and the public will be encouraged to attend and provide feedback. We will work with Cordova District Fishermen United to gather input on the programs from the fishing community. We will also be working with them on sample collection efforts. We will also use the Cordova meeting as one of our opportunities to keep the public informed of our activities. We plan to use the herring survey website (<http://www.pwssc.org/herringsurvey/>) as another tool for keeping people informed. Included on the website is contact information to reach the Principal Investigators and we intend to change the site to emphasize that we would like input on the programs. The description of more directed outreach efforts follows.

We propose to build off our successes in the existing PWS Herring Survey Program outreach efforts. One of our primary outreach tools is through the development of project profiles. These are one page descriptions of the various projects and their findings. They are designed with the general public as the primary audience. These are the basis for information on the herring website and for articles in the Delta-Sound Connections, a broadly distributed annual paper describing research in PWS and Copper River Delta. Additionally Field Notes radio programs will be developed each year. These radio programs are aired by KCHU, the PWS public radio station. We are proposing to develop three such programs each year focusing on different aspects of the program. Furthermore we propose to support the PWSSC community lecture series. This lecture series is held weekly through the winter and is transmitted to Valdez through the Prince William Sound Community College. We expect that at minimum of three projects each year will provide lectures on their results through this series. Results from the research will also be incorporated into classroom and summer camp activities. These camps involve youth from around Prince William Sound and the Anchorage area.

The first year of this program overlaps with the existing PWS Herring Survey Program. Our outreach program will use the overlap period to focus on being able to expand the coverage of the outreach efforts. The intention is to provide activities that groups outside our delivery area will utilize without

direct funding from this program. To increase the geographic impact of the programs we propose to modify the current PWS herring school-year and summer activities so that the focus is on how a fishery (PWS herring) is affected by changes in the ecosystem. The resultant activities will focus on the ecosystem, which is more transferable, than on a particular fish population. At the same time it will continue to use PWS herring as the central example, which maintains its relevance to this program. The second activity that will take place in the first year is to market the revised programs to other marine education programs in the state. It is important to actively market the activities if we expect them to be utilized by other groups.

## H. Description of Study Area

The study area includes all of Prince William Sound. However, most of the projects will focus on the four bays (Zaikof, Whale, Eaglek, and Simpson) that were extensively studied during the Sound Ecosystem Assessment study and PWS Herring Survey program (Figure 1). This allows the work to build upon the historical research completed in those bays. These bays also cover four different quadrants of the Sound. We anticipate a potential build out to include other bays or contraction based on the results from the synthesis. As part of the synthesis effort we will be reviewing the question “What is the appropriate sampling distribution?” as applied to the questions of juvenile herring condition and providing an index of juvenile abundance.

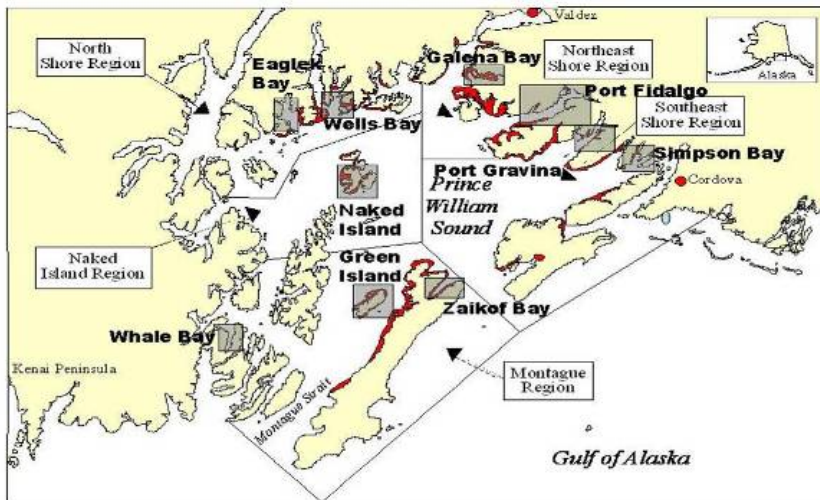


Figure 1. PWS study area, including the four SEA bays (Whale, Zaikof, Eaglek, and Simpson, as well as other bays historically important for juvenile herring).

## III. SCHEDULE

### A. Measurable Project Tasks

FY12 1<sup>st</sup> Quarter (October 1, 11 to December 31, 11)

October                      Begin juvenile condition intensive, primiparous fish, and herring scale analysis

October	Purchase acoustic tags
October	Acquire herring for laboratory study
November	Tag adult herring
November	Get investigators accounts in AOOS Ocean Workbench data management system
December	Develop criteria for selection of scales to be processed
FY12 2 <sup>nd</sup> Quarter	
January	Annual Marine Science Symposium
January	Begin fasting herring in laboratory, provide herring for fatty acid analysis, prioritize data sets to be recovered
March	Conduct trial scale processing, finalize scale processing design
March	Complete ordering acoustic and ROV equipment
March	Download acoustic array data
March	Obtain samples for fatty acid analysis, end fasting study, complete laboratory histological analysis
FY12 3 <sup>rd</sup> Quarter	
May	Conduct annual PI meeting
June	Submit FY13 work plan for review
June	Collect histology samples (timing depends on results of laboratory study)
June	Download acoustic array data, complete sampling for juvenile intensive
FY12 4 <sup>th</sup> Quarter	
August	Submit annual report
September	Complete annual outreach efforts
FY13 1 <sup>st</sup> Quarter (October 1, 12 to December 31, 12)	
October	Begin fatty acid analysis
November	Conduct juvenile index survey, validation and sampling for energetics and disease
November	Tag adult herring
FY13 2 <sup>nd</sup> Quarter	
January	Annual Marine Science Symposium
January	Update Ocean Workbench system
March	Conduct spring juvenile collection
March	Download acoustic array data
FY13 3 <sup>rd</sup> Quarter	
April	Conduct extended adult biomass cruise, collect samples for genetics & histology

May	Conduct annual PI meeting, complete written outreach materials
June	Submit FY14 work plan for review
June	Download acoustic array data
June	Complete data recovery portion of data management
FY13 4 <sup>th</sup> Quarter	
August	Submit annual report
September	Complete fatty acid analysis, complete scale analysis
September	Complete annual outreach efforts
FY14 1 <sup>st</sup> Quarter (October 1, 13 to December 31, 13)	
October	Submit synthesis to EVOS science council
October	Begin acoustic intensive study, Begin disease laboratory studies, Begin non-lethal sampling testing
October	Assess data submitted to data management
November	Conduct juvenile index survey, validation and sampling for energetics and disease, test non-lethal sampling systems
FY14 2 <sup>nd</sup> Quarter	
January	Annual Marine Science Symposium
March	Complete histology study, complete acoustic intensive
March	Conduct spring juvenile collection
Winter	EVOS sponsored workshop with Herring and Long-term monitoring programs
FY14 3 <sup>rd</sup> Quarter	
April	Conduct extended adult biomass cruise, collect samples for genetics, submit fatty acid report
May	Conduct annual PI meeting, complete written outreach materials
June	Submit FY15 work plan for review
FY14 4 <sup>th</sup> Quarter	
August	Submit annual report
September	Complete acoustic tagging project, Complete non-lethal sample testing
September	Complete annual outreach efforts
FY15 1 <sup>st</sup> Quarter (October 1, 14 to December 31, 14)	
October	Assess data submitted to data management
November	Conduct juvenile index survey, validation and sampling for energetics and disease
FY15 2 <sup>nd</sup> Quarter	

January	Annual Marine Science Symposium
March	Conduct spring juvenile collection
FY15 3 <sup>rd</sup> Quarter	
April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting, complete written outreach materials
May	Submit five-year plan for FY17-22 and work plan for FY16
FY15 4 <sup>th</sup> Quarter	
August	Submit annual report
September	Complete genetics analysis, Complete acoustics intensive
September	Complete annual outreach efforts
FY16 1 <sup>st</sup> Quarter (October 1, 15 to December 31, 15)	
October	Assess data submitted to data management
November	Conduct juvenile index survey, validation and sampling for energetics and disease
FY16 2 <sup>nd</sup> Quarter	
January	Annual Marine Science Symposium
March	Conduct spring juvenile collection
FY16 3 <sup>rd</sup> Quarter	
April	Conduct extended adult biomass cruise
May	Conduct annual PI meeting, complete written outreach materials
June	Submit work plan for FY17
FY16 4 <sup>th</sup> Quarter	
August	Submit annual report
September	Complete annual outreach efforts

## IV BUDGET

See attached workbook.

### **Budget Justification:**

Year 1: Year one funding has a low request for personnel because we are utilizing the overlap with the existing PWS Herring Survey Program to be able to reduce the costs of the proposed programs. Salary requests are primarily associated with the herring scale analysis, condition intensive, and herring tagging projects. Travel is for meeting with collaborators and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, and sample analysis. Much of the funding to NOAA is to be spent through contracts. The supplies request includes normal cruise and laboratory items, but is dominated by the purchase of acoustic tags for the herring tagging project. The equipment in year one includes new hydroacoustic system and processing software, trawl winches, a catch monitor, and a ROV for optical detection of fish.

Year 2: In this year our salary request increases as the proposed monitoring programs come fully on line and we do not have overlap with the existing herring program except in the synthesis development component. Salary requests are primarily from PWSSC with additional request from the scale analysis project. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, sample analysis, and NOAA contractual work. The supplies request includes normal cruise and laboratory items.

Year 3: Two factors lead to the increased request in salary. The first is that in this year there is a set of intensive acoustic studies that require additional personnel time. The second is that the USGS led disease research project begins in this year. Additional salary support is requested for the proposed monitoring programs. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, sample analysis, and NOAA contractual work. The contract with Louisiana State University is budgeted in this year. The supplies request includes normal cruise and laboratory items. The laboratory portions of the disease research program contribute to the increased level of supplies needed beginning in this year.

Year 4: The salary support requested is primarily for the disease research and the monitoring programs. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. The decrease in contractual funding request is associated with the end of contract heavy projects and a focus on monitoring and analysis. Contracts are primarily for the data management, vessel charters, and sample analysis. The supplies request includes normal cruise and laboratory items.

Year 5: The salary support requested is primarily for the disease research and the monitoring programs. Travel is for meeting with collaborators, attending scientific meetings, and bringing people to Cordova for cruises. Contracts are primarily for the data management, vessel charters, and sample analysis. The supplies request includes normal cruise and laboratory items.

## V. CURRICULUM VITAS

### BIOGRAPHICAL SKETCH

W. Scott Pegau

Oil Spill Recovery Institute  
Box 705  
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ph: 907-424-5800 x222  
email: wspegau@pwssc.org

#### **Education:**

1990 B.S., Physics, University of Alaska, Fairbanks  
1996 Ph.D, Oceanography, Oregon State University

#### **Professional Experience:**

1987-1990 Research Assistant, University of Alaska, Fairbanks  
1990-1996 Graduate Research Assistant, Oregon State University  
1996-1997 Research Associate (Post Doc), Oregon State University  
1997-1999 Faculty Research Associate, Oregon State University  
1999-2010 Assistant Professor, Oregon State University  
2002-2003 Senior Scientist, Kachemak Bay Research Reserve  
2003-2007 Research Coordinator, Kachemak Bay Research Reserve  
2007-present Research Program Manager, Oil Spill Recovery Institute

#### **Research Interests:**

To develop novel oil spill detection and tracking approaches. Understanding the fate and behavior of oil spilled in cold water environments. Development of response options for oceans with sea ice present. Circulation in Prince William Sound, Cook Inlet and the Gulf of Alaska and the associated larval transport. Relationship between oceanographic conditions and fisheries. Application of remote sensing for understanding coastal processes.

I am working to improve technologies for responding to oil spills in arctic and subarctic waters. I am also currently involved in the ONR Radiance in a Dynamic Ocean (RaDyO) project collecting optical instruments on an AUV.

#### **Publications**



### ***Some recent publications***

- Montes-Hugo, M. A., K. Carder, R. J. Foy, J. Cannizzaro, E. Brown, and S. Pegau, Estimating phytoplankton biomass in coastal waters of Alaska using airborne remote sensing, *Remote Sens. Environ.* **98**, 481-493, 2005.
- Wijesekera, H. W., W. S. Pegau, and T. J. Boyd, The effect of surface waves on the irradiance distribution in the upper ocean, *Optics Express*, **23**, 9267-9264, 2005.
- Pegau, W. Scott, Inherent optical properties of the central Arctic surface waters, *J. Geophys Res*, **107**, doi. 10.1029/2000JC000382, 2002.
- Bartlett, J. S., M. R. Abbott, R. M. Letelier, and W. S. Pegau, Analysis of a method to estimate chlorophyll-a concentration from irradiance measurements at varying depths, *J. Atmos. Ocean. Tech.*, **18**, 2063-2073, 2001.
- Chang G. C., T. D. Dickey, O. M. Schofield, A. D. Weidemann, E. Boss, W. S. Pegau, M. A. Moline, and S. M. Glenn, Nearshore physical forcing of bio-optical properties in the New York Bight. *J. Geophys. Res.*, **107**, 10.1029/2001JC001018, 2002.
- Pegau, W. S., and C. A. Paulson, The albedo of Arctic leads in summer, *Annals of Glaciology*, **33**, 221-224, 2001.
- Skyllingstad, E. D., C. A. Paulson, and W. S. Pegau, Simulation of turbulent exchange processes in summertime leads, *J. Geophys. Res.*, **110**, doi:10.1029/2004JC002502, 2005.
- Boss, E., R. Collier, G. Larson, K. Fennel, and W. S. Pegau, Measurements of spectral optical properties and their relation to biogeochemical variables and processes in Crater Lake National Park, OR. *Hydrobiologia*, DOI 10.1007/s10750-006-2609-3, 2007.
- Skyllingstad E. D., C. A. Paulson, W. S. Pegau, M. G. McPhee, T. Stanton, Effects of keels on ice bottom turbulence exchange, *J. Geophys. Res.*, **108**, 3372, 2003.
- Pegau, W.S., and R. Potter, *Visible remote sensing of the Gulf of Alaska*, Gulf Ecosystem Monitoring and Research final report Project G030685, pp. 51, 2004.

### **Collaborators**

A. H. Barnard (Wetlabs), T. Boyd (OSU), G. C. Chang (UCSB), S. Saupe (CIRCAC), M. Twardowski (WETLabs), H. Wijesekera (OSU/NSF)

## **ABBREVIATED RESUME**

**Paul K. Hershberger, Ph.D.**

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### **Professional Interests**

Disease ecology and processes affecting the health and survival of wild fishes

Effects of multiple stressors on the health and survival of wild fishes

Climatic/oceanic factors affecting populations of wild fishes

### **Membership in Professional Organizations**

American Fisheries Society (AFS), and Fish Health Section (FHS)

International Society of Aquatic Animal Epidemiology (ISAAE)

Pacific Northwest Society of Environmental Toxicology and Chemistry (PNW SETAC)

American Society of Limnology and Oceanography (ASLO)

### **Recent Positions**

2010 – Present: Affiliate Associate Professor: School of Aquatic and Fishery Sciences, University of Washington.

2004 – 2010: Affiliate Assistant Professor: School of Aquatic and Fishery Sciences, University of Washington.

2003 – Present: Research Fishery Biologist and Station Leader: USGS- Marrowstone Marine Field Station

1999-2003: Faculty Research Associate - University of Washington

2003: Co-Instructor, UW – Friday Harbor Labs: FISH-499B "Emerging Diseases and Latent Infections in Aquatic Organisms"

2001: Instructor, UW – School of Aquatic and Fishery Sciences: FISH 404 "Diseases of Aquatic Organisms"

2001: Co-Instructor, UW – Friday Harbor Labs: FISH 499B: "Latent Viruses in Marine Fish,"

2000: Co-Instructor, UW – Friday Harbor Labs: FISH-499B: "Marine Fish Disease Research"

### **Education:**

Ph.D. Fisheries, University of Washington 1998

M.S. Fisheries, University of Washington 1995

B.S. Chemistry & Biology, Northland College (Magna Cum Laude) 1993

### **Recent Awards and Honors:**

2008: USGS STAR Award

2004: USGS Exemplary Act Award

2004: USGS STAR Award

2001: Most significant paper of the year 2001: Journal of Aquatic Animal Health

### **Five Selected Publications Relevant to this Proposal:**

- Vollenweider, J.J., J. Gregg, R.A. Heintz, P.K. Hershberger. *In Press*. Energetic cost of *Ichthyophonus* infection in juvenile Pacific herring (*Clupea pallasii*). *Parasitology Research*.
- Gregg J, J Vollenweider, C Grady, R Heintz, P Hershberger. *In Press*. Effects of environmental temperature on the kinetics of ichthyophoniasis in juvenile Pacific herring (*Clupea pallasii*). *Parasitology Research*
- Grady, C.A., J.L. Gregg, R.M. Collins, P.K. Hershberger. 2011. Viral Replication in Excised Fin Tissues (VREFT) corresponds with prior exposure of Pacific herring, *Clupea pallasii* (Valenciennes), to viral hemorrhagic septicemia virus (VHSV). *Journal of Fish Diseases* 34: 34-12.
- Hershberger PK, JL Gregg, CA Grady, L Taylor, JR Winton. 2010. Chronic and persistent viral hemorrhagic septicemia virus infections in Pacific herring. *Diseases of Aquatic Organisms* 93: 43-49.
- Hershberger P, J Gregg, C Grady, R Collins, J Winton. 2010. Kinetics of viral shedding provide insights into the epidemiology of viral hemorrhagic septicemia in Pacific herring. *Marine Ecology Progress Series* 400: 187-193.

### **Five Additional Selected Publications**

- Hart L, GS Traxler, KA Garver, J Richard, JL Gregg, CA Grady, G Kurath, PK Hershberger. 2011. Larval and juvenile Pacific herring *Clupea pallasii* are not susceptible to infectious hematopoietic necrosis under laboratory conditions. *Diseases of Aquatic Organisms* 93: 105-110.
- Hershberger, P.K., B.K. van der Leeuw, J.L. Gregg, C.A. Grady, K. Lujan, S. Gutenberger, M. Purcell, J.C. Woodson, J.R. Winton, M. Parsley. 2010. Amplification and transport of an endemic fish disease by an invasive species. *Biological Invasions* 12: 3665-3675.
- Kocan R, H Dolan, P Hershberger. *In Press*. Diagnostic methodology is critical for accurately determining the prevalence of *Ichthyophonus* infections in wild fish populations. *Journal of Parasitology*.
- Hershberger PK, JL Gregg, CA Grady, RM Collins, JR Winton. 2010. Susceptibility of three stocks of Pacific herring to viral hemorrhagic septicemia. *Journal of Aquatic Animal Health* 22: 1-7.
- Kocan, R. M., J. L. Gregg, P. K. Hershberger. 2010. Release of infectious cells from epidermal ulcers in *Ichthyophonus* sp. – infected Pacific herring (*Clupea pallasii*): evidence for multiple mechanisms of transmission. *Journal of Parasitology* 96: 348-352.

### **Recent Collaborators and Co-Authors:**

J Winton (USGS), E. Emmenegger (USGS), N. Elder (USGS), D. Elliott (USGS), J. Gregg (USGS), J. Hansen (USGS), R. Kocan (UW-SAFS), G. Kurath (USGS), M. Parsley (USGS), L Hart (USGS), S. LaPatra (Clear Springs Foods), M. Purcell (USGS), G. Traxler (DFO), K. Garver (DFO), J Lovy (HCRS), S. Gutenberger (USFWS), R. Heintz (NOAA).

## *Curriculum vitae*

### Ron A. Heintz

Fishery Research Biologist  
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#### **EDUCATION:**

B.S. Ecology Ethology and Evolution, June 1979, University of Illinois, Urbana May 1979  
M.S. Fisheries Biology, May 1987, University of Alaska, Juneau May 1985  
PhD: Fisheries Biology, University of Alaska, Fairbanks. May 2009

#### **PROFESSIONAL MEMBERSHIPS:**

American Fisheries Society  
American Institute of Biological Scientists  
American Association for the Advancement of Science

#### **EMPLOYMENT AND STUDY FOCUS:**

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory since 1985.

##### **Since 2000**

Leads AFSC Nutritional Ecology Laboratory program investigating the nutritional status and trophic relationships of marine forage species.

##### **Prior to 2000**

Examined the effects of crude oil exposure during embryogenesis on the life history of fish.

#### **AUTHORSHIP**

Authored 10 peer reviewed publications as lead author and 25 as co-author  
Bibliography since 2005 is attached  
MS Thesis; *Use of space and forage by Dolly Varden char in Osprey Lake*  
PhD Dissertation: *Effects of adult salmon carcasses on juvenile salmonids.*

#### **PRINCIPLE FINDINGS:**

- The most environmentally persistent PAHs are also the most toxic to sensitive life stages
- Embryonic exposure to crude oil results in life long effects in pink salmon
- Fish populations chronically exposed to sublethal PAH loads have reduced fitness
- Fatty acids can be used to discriminate the energy sources consumed by predators
- The amount of energy available to consumers has a direct influence on life history strategy
- The critical size hypothesis works because the smallest individuals are most likely predated
- Fall energy reserves predict recruitment of age 0+ pollock to age 1+
- Humpback whales predation may account for lack of recovery of depressed herring stocks

#### **CURRENT COLLABORATIONS**

ADFG: Shawna Kaparovich,  
UAF: Nicola Hillgruber, Elizabeth Siddon, Alexei Pinchuk  
USGS: Paul Hershberger  
NOAA AFSC: Thomas Hurst, Ben Laurel, Janet Duffy-Anderson, Mike Sigler, Ed Farley  
UAS: Jan Straley

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2. Hunt Jr., G. L., K. O. Coyle, L. Eisner, E. V. Farley, R. Heintz, F. Mueter, J. M. Napp, J. E. Overland, P. H. Ressler, S. Salo and P.J. Stabeno. InPress. Climate impacts on eastern Bering Sea food webs: A synthesis of new data and an assessment of the oscillating control hypothesis. ICES Journal of Marine Science. Accepted February 17, 2011.
3. Vollenweider, J. J., **R. A. Heintz**, L. Schaufler and R. Bradshaw. Submitted. Influence of habitat on the seasonal cycles in whole-body proximate composition and energy content of forage fish. Marine Biology. 158(2):413-427. DOI 10.1007/s00227-010-1569-3
4. **Heintz, R.** and J. J. Vollenweider. 2010. The influence of size on the sources of energy consumed by overwintering walleye pollock (*Theragra chalcogramma*). Journal of Experimental Marine Biology and Ecology 393:43-50.
5. Cox, M.K., **R. A. Heintz** and K. Hartman. Sources of error in bioelectrical impedance analysis measures of resistance and reactance in fish. Fishery Bulletin 109:34-47.
1. **Heintz, R. A.**, M. S. Wipfli and J. P. Hudson. 2010. Identification of marine-derived lipids in juvenile coho salmon (*Oncorhynchus kisutch*) and aquatic insects using fatty acid analysis. Transactions of the American Fisheries Society 139:840-854.
2. Wipfli, MS, JP Hudson, JPCaouette, N. L. Mitchell, J.L. Lessard, **R. Heintz** and D.T. Chaloner. 2010. Salmon carcasses increase stream productivity more than inorganic fertilizer pellets: A test on multiple trophic levels in streamside experimental channels. Transactions of the American Fisheries Society 139:824-839.
3. Marty, G. D. and **R. Heintz**. 2010. Ruptured yolk sacs and visceral fungi in emergent pink salmon alevins: histopathology and relation to marine survival. Diseases of Aquatic Organisms 88:115-126.
4. Cox, M. K. and **R. A. Heintz**. 2009. The use of phase angle (PA) as a new condition index for live and dead fish. Fishery Bulletin 107:477-487.
5. Moles, A., and **R. A. Heintz**. 2007. Parasites of forage fishes in the vicinity of Steller Sea Lion (*Eumetopias jubatus*) habitat in Alaska. Journal of Wildlife Diseases 43(3):366-375.
6. **Heintz, R. A.** 2007. Chronic exposure to polynuclear aromatic hydrocarbons in natal habitats leads to decreased equilibrium size, growth and stability of pink salmon populations. Integrated Environmental Assessment and Management. 3(3):351-363.
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13. Barron, M. G., and coauthors. 2005. Assessment of the phototoxicity of weathered Alaska North Slope crude oil to juvenile pink salmon. Chemosphere 60:105-110.

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**EDUCATION:**

B.S. Marine Biology, Chemistry Minor, June 1998, University of North Carolina, Wilmington  
M.S. Fisheries Biology, May 2005, University of Alaska Fairbanks

**PROFESSIONAL MEMBERSHIPS:**

American Fisheries Society  
Marine Mammal Society

**EMPLOYMENT AND STUDY FOCUS:**

**1999 – Present ZPIII – Fisheries Research Biologist**

NOAA Fisheries, Auke Bay Laboratories  
Nutritional Ecology Laboratory  
Juneau, Alaska  
Investigating the nutritional status and trophic relationships of marine forage species.

**PUBLICATIONS:**

- Vollenweider J**, Gregg J., Heintz R.A., Hershberger P. (In Press) Energetic cost of Ichthyophonous infection in juvenile Pacific herring (*Clupea pallasii*). Journal of Parasitology.
- Vollenweider J**, Heintz R. (In Press) Seasonal variation in whole-body proximate composition and energy content of forage fish in southeastern Alaska. Journal of Marine Biology.
- Gregg J.L., **Vollenweider J.**, Grady C.A., Heintz, R.A., Hershberger, P. (In Press) Effects of environmental temperature on the kinetics of ichthyophoniasis in juvenile Pacific herring (*Clupea pallasii*). Journal of Parasitology.
- Csepp D., **Vollenweider J.**, Sigler M. (In Press) Seasonal abundance and distribution of pelagic and demersal fishes in southeastern Alaska. Fisheries Research.
- Wildes S, **Vollenweider J**, Guyon J. (Submitted) Genetic stock structure of Pacific herring (*Clupea pallasii*) in Lynn Canal, Southeast Alaska. Fish Bull.
- Churnside, J.H., Brown, E.D., Parker-Stetter S., Horne J.K., Hunt G.L., Hillgruber N., Sigler M.F., **Vollenweider J.** (In Press) Airborne remote sensing of a biological hot spot in the southeastern Bering Sea. Remote Sensing.
- Heintz R, **Vollenweider J.** (2010) Influence of size on the sources of energy consumed by overwintering walleye pollock (*Theragra chalcogramma*). J Exp Mar Biol Ecol 393(1-2):43-50
- Boswell K, **Vollenweider J.** (In Draft) Comparison of acoustic methods of fish biomass estimation.
- Sigler M, Tollit D, **Vollenweider J**, Thedinga J, Csepp D, Womble J, Wong M, Rehberg, M, Trites A. 2009. Foraging response of a marine predator, the Steller sea lion, to seasonal changes in prey availability. Marine Ecology Progress Series. 388:243-242.
- Schaufler L, **Vollenweider J**, Moles A. 2008. Changes in the lipid class and proximate compositions of coho salmon (*Oncorhynchus kisutch*) smolts infected with the nematode parasite *Philonema agubernaculum*. Comp. Biochem. Physiol. 149B:148-152.

Ormseth OA, Conners L, Guttormsen M, **Vollenweider J**. 2008. Forage fishes in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, Appendix 2, p. 657-702. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252. FY09

**Vollenweider J**, Womble J, Heintz R. 2006. Estimation of seasonal energy content of Steller sea lion (*Eumetopias jubatus*) diet, p. 155-176. In A. W. Trites, S. K. Atkinson, D. P. DeMaster, L. W. Fritz, T. S. Gelatt, L. D. Rea, and K. M. Wynne (eds.), Sea Lions of the World. Alaska Sea Grant College Program Publication AK-SG-06-01, University of Alaska Fairbanks, Fairbanks, Alaska.

#### **CURRENT PROJECTS:**

**Vollenweider J**, Heintz R, Hershberger P. Do energy limitations cause overwinter mortality of young-of-the-year and juvenile Pacific herring (*Clupea pallasii*)? Funded by the Exxon Valdez Oil Spill Trustee Council.

**Heintz R, Vollenweider J**. PWS Herring Survey: Value of growth and energy storage as predictors of winter performance in YOY herring in PWS. Funded by the Exxon Valdez Oil Spill Trustee Council.

Cox K, **Vollenweider J**, Heintz R, Hershberger P. Bioenergetic models for Pacific herring; create or borrow? Funded by the Exxon Valdez Oil Spill Trustee Council.

Boswell K, **Vollenweider J**. (*In Draft*) Contrasting biomass estimates of schooling herring derived with an imaging sonar and traditional echosounder.

Boswell K, **Vollenweider J**. Winter herring biomass in Lynn Canal and Sitka Sound, Alaska.

**Vollenweider J**, Heintz R, Hudson J. Overwinter energetics of juvenile capelin. Funded by NOAA Essential Fish Habitat Funds.

Ron Heintz, John Moran, **Johanna Vollenweider**, Jan Straley, Terrence Quinn, Suzie Teerlink and Stan Rice. Impacts of Whale Foraging on Three Herring Populations in Alaska (Prince William Sound, Lynn Canal, Sitka Sound). Funded by the Exxon Valdez Oil Spill Trustee Council.

#### **RECENT COLLABORATORS:**

Boswell, Kevin. Louisiana State University, LA

Cox, Keith. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK

Csepp, Dave. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK

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Heintz, Ron. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK

Hershberger, Paul. USGS, Marrowstone Marine Field Station, Nordland, WA

Hilgruber, Nicola. University of Alaska Fairbanks, Juneau, AK

Hudson, John. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK

Kline, Tom. Prince William Science Center, Cordova, AK

Moffit, Steve. Alaska Dept. of Fish and Game, Cordova, AK

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Sigler, Mike. NOAA Fisheries, Auke Bay Laboratories, Juneau, AK

Straley, Jan. University of Alaska Southeast, Sitka, AK

Wildes, Sharon. NOAA Fisheries, Alaska Fisheries Science Center, Seattle, WA

Womble, Jamie. University of Alaska Fairbanks, Juneau, AK

**Jeffrey R. Guyon**

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**EDUCATION:**

Jun 1983 - May 1987 B.S. in Mathematics, U.S. Coast Guard Academy, New London, CT  
Aug 1993 - Aug 2000 Ph.D. in Biochemistry, University of Notre Dame, Notre Dame, IN

**EMPLOYMENT AND WORK EXPERIENCE:**

May 1987 - Jun 1993 U.S. Coast Guard, Officer  
Aug 1993 - Aug 1997 Graduate student, University of Notre Dame, South Bend, IN  
Aug 1997 - Aug 2000 Completed thesis work as a graduate student at Massachusetts General Hospital, Boston, MA  
Aug 2000 - Dec 2004 Post-doctoral fellowship, laboratory of Louis M. Kunkel at the Children's Hospital Boston/Harvard Medical School, Boston, MA  
Jan 2005 - Jun 2007 Instructor, Children's Hospital/Harvard Medical School, Boston, MA  
Jul 2007 - Jun 2008 Fisheries Geneticist, AK Department of Fish and Game, Anchorage, AK  
Jul 2008 - Apr 2010 Supervisory Research Geneticist, NMFS Auke Bay Laboratories  
Apr 2010 - present Program Manager, Genetics Program, NMFS Auke Bay Laboratories.

**RECENT GRANT SUPPORT:**

May 2007 - Mar 2011 Genetic Analysis of Immature Bering Sea Chum (AYKSSI) . Jul 2009 -  
Jun 2010 Genetic Analysis of 2008 Chinook Bycatch (AKSSF)  
Jul 2009 - Mar 2011 2009 N Boundary Sockeye Districts 101/4 (AKSSF)  
Oct 2009 - Dec 2010 Genetic Analysis of Immature Chum Salmon from the 2006-7 BASIS  
Cruises (BSFA)  
Jul 2010 - Mar 2011 Homogeneity of Chinook in Trawls (AKSSF)  
Jul 2010 - Sep 2012 Shared Chum Salmon Baseline Development (AKSSF and AYKSSI)  
Nov 2010 - Jun 2012 2010 Northern Boundary Area Sockeye Salmon Genetic Stock  
Identification (Northern Fund)

**SCIENCE PUBLICATIONS:**

1. Guyon, J.R., Narlikar, G.J., Sif, S. and R.E. Kingston RE. 1999. Stable remodeling of tailless nucleosomes by the human SWI-SNF complex. *Mol. Cell. Biol.* **19**:2088-97.
2. Shao, Z., Raible, F., Mollaaghababa, R., Guyon, J.R., Wu, C.T., Bender, W. and R.E. Kingston. 1999. Stabilization of chromatin structure by PRC1, a Polycomb complex. *Cell* **98**:37-46.
3. Kwon, J., Morshead, K.B., Guyon, J.R., Kingston, R.E. and M.A. Oettinger. 2000. Histone acetylation and hSWI/SNF remodeling act in concert to stimulate V(D)J cleavage of nucleosomal DNA. *Mol Cell.* **6**:1037-48.
4. Guyon, J.R., Narlikar, G.J., Sullivan, E.K. and R.E. Kingston. 2001. Stability of a human SWI-SNF remodeled nucleosomal array. *Mol. Cell. Biol.* **21**:1132-44.
5. Sullivan, E.K., Weirich, C.S., Guyon, J.R., Sif, S., and R.E. Kingston. 2001. Transcriptional activation domains of human heat shock factor 1 recruit human SWI/SNF. *Mol. Cell. Biol.* 2001. **21**:5826-37.
6. Mizuno, Y., Thompson, T.G., Guyon, J.R., Lidov, H.G., Brosius, M., Imamura, M., Ozawa, E., Watkins, S.C. and L.M. Kunkel. 2001. Desmuslin, an intermediate filament protein that interacts with alpha-dystrobrevin and desmin. *Proc. Natl. Acad. Sci. USA* **98**:6156-61.
7. Spencer, M.J., Guyon, J.R., Sorimachi, H., Potts, A., Richard, I., Herasse, M., Chamberlain, J., Dalkilic, I., Kunkel, L.M., and J.S. Beckman. 2002. Stable expression of calpain-3 from a muscle



- transgene *in vivo*: Immature muscle in transgenic mice suggests a role for calpain-3 in muscle degeneration. *Proc. Natl. Acad. Sci. USA* **99**:8874-9.
8. Guyon, J.R., Mosley, A.N., O'Brien, K.F., Volinski, J.M., Zhou, Y., Davidson, A.J., Sheng, X., Chiang, K., Zon, L.I. and L.M. Kunkel. 2003. The dystrophin associated protein complex in zebrafish. *Hum. Mol. Genet.* **12**:601-15.
  9. Guyon, J.R., Kudryashova, E., Potts, A., Dalkilic, I., Brosius, M., Thompson, T.G., Beckmann, J.S., Kunkel, L.M. and M.J. Spencer. 2003. Calpain 3 cleaves filamin C and regulates its ability to interact with gamma and delta sarcoglycans. *Muscle Nerve.* **28**:472-83.
  10. Mizuno, Y., Guyon, J.R., Watkins, S.C., Mizushima, K., Sasaoka, T., Imamura, M., Ozawa, E., Kunkel, L.M. and K. Okamoto. 2004.  $\alpha$ -synemin localizes to regions of high stress in human skeletal myofibers. *Muscle Nerve.* **30**:337-46.
  11. Guyon, J.R., Mosley, A.N., Jun, S.J., Montanaro, F., Steffen, L.S., Zhou, Y., Montanaro, F., Nigro, V., Zon, L.I. and L.M. Kunkel. 2005.  $\alpha$ -Sarcoglycan is required for early zebrafish muscle organization. *Exp Cell Res.* **304**:105-15
  12. Steffen, L.S., Guyon, J.R., Vogel, E.D., Zhou, Y., Weber, G.J., Zon, L.I. and L.M. Kunkel. 2007. The zebrafish runzel muscular dystrophy is linked to the titin gene. *Dev. Biol.* **309**:180-92.
  13. Langenau, D.M., Keefe, M.D., Storer, N.Y., Guyon, J.R., Kutok, J.L., Le, X., Houvras, Y., Goessling, W., DiBiase, A., Neuberger, D., Kunkel, L.M., and L.I. Zon. 2007. Effects of RAS on the genesis of embryonal rhabdomyosarcoma. *Genes Dev.* **21**:1382-95.
  14. Mizuno, Y., Guyon, J.R., Ishir, A., Hoshino, S., Ohkoshi, N., Tamaoka, A., Okamoto, K. and L.M. Kunkel. 2007.  $\alpha$ -synemin expression in cardiotoxin-injected rat skeletal muscle. *BMC Musculoskelet Disord.* **8**:40.
  15. Mizuno, Y., Guyon, Okamoto, K. and L.M. Kunkel. 2007.  $\alpha$ -Synemin expression in brain. *Muscle Nerve.* **36**:497-504.
  16. Steffen, L.S., Guyon, J.R., Vogel, E.D., Beltre, R., Pusack, T.J., Zhou, Y., Zon, L.I. and L.M. Kunkel. 2007. Zebrafish orthologs of human muscular dystrophy genes. *BMC Genomics.* **8**:79.
  17. Guyon, J.R., Goswami, J., Jun, S.J., Thorne, M., Howell, M., Pusack, T., Kawahara, G., Steffen, L.S., Galdzicki, M. and L.M. Kunkel (2009). Genetic isolation and characterization of a splicing mutant of zebrafish dystrophin. *Hum Mol Genet.* **18**:202-11.
  18. Mizuno, Y., Guyon, J.R., Okamoto, K., and L.M. Kunkel. (2009). Expression of synemin in the mouse spinal cord. *Muscle Nerve* **39**:634-41.
  19. Sohn, R.L., Huang, P., Kawahara, G., Mitchell, M., Guyon, J., Kalluri, R., Kunkel, L.M., and E. Gussoni. (2009). A role for nephrin, a renal protein, in vertebrate skeletal muscle cell fusion. *Proc Natl Acad Sci U S A* **106**:9274-9.
  20. Kawahara, G., Guyon, J.R., Nakamura, Y., and Kunkel, L.M. (2010) Zebrafish models for human FKRP muscular dystrophies. *Human Molecular Genetics* **19**: 623-633.
  21. Molecular Ecology Resources Primer Development, C., An, J., Bechet, A., Berggren, Å., Brown, S.K., Bruford, M.W., Cai, Q., Cassel-Lundhagen, A., Cezilly, F., Chen, S.-L., *et al.* (2010). Permanent Genetic Resources added to Molecular Ecology Resources Database 1 October 2009–30 November 2009. *Molecular Ecology Resources* **10**: 404-408.
  22. Wildes, S.L., Vollenweider, J., Nguyen, H., and J.R. Guyon. Genetic stock structure of Pacific herring (*Clupea passasi*) in the eastern Gulf of Alaska. *Under review.*
  23. Alexander, M.S., Kawahara, G, Kho, A.T., Howell, M.H., Pusack, T.J., Myers, J.A., Montanaro, F., Zon, L.I., Guyon, J.R., and L.M. Kunkel. Isolation and transcriptome analysis of adult zebrafish cells enriched for skeletal muscle progenitors. *Muscle Nerve.* *In press.*

## CURRICULUM VITAE

**Sharon Wildes**

**Current Position:** Research Fisheries Geneticist

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### **Education:**

B. S., Biology, emphasis on Genetics, Hiram College, Hiram, Ohio, 1987.

Graduate Coursework at University of Alaska

Russian Language I and II, 1992, 1993

Fisheries Genetics, 1992

Vascular Plants of Southeast AK, 1991

Natural History of Alaska, 1990

Graduate Coursework at Case Western Reserve University

Spanish I and II, 1986, 1987.

Mammalian Physiology, 1988

### **Employment:**

Research Assistant, Cleveland Metro General Hospital and Case Western Reserve University, 1987-1989. Investigated human neuropathological afflictions.

Research Geneticist, Auke Bay Labs, 1990-present. Population genetics, stock composition analyses, species identification.

### **Service:**

Juneau Federal Employee of the year 1995.

Chair and proceedings editor, 19<sup>th</sup> N.E. Pacific pink and chum workshop 1999.

Science Outreach- Elementary to University- 1987-present.

### **Current Research Activities:**

Fine scale population genetic structure of Pacific Herring (*Clupea pallasii*) using microsatellite markers.

mtDNA barcoding of pacific sand lance and analysis of sequence data for species identification.

Species identification of rougheye/shortraker rockfish complex using SNP and microsatellite markers.

**Publications:**

**Wildes, S.L.**, J.J. Vollenweider, H.V. Nguyen and J.R. Guyon. 2010. Genetic stock structure of Pacific herring (*Clupea pallasii*) in the eastern Gulf of Alaska. Pending minor revision, Fishery Bulletin.

Orr, J. W., and **S. L. Hawkins**. 2008. Species of the rougheye rockfish complex: resurrection of *Sebastes melanostictus* (Matsubara, 1934) and a redescription of *Sebastes aleutianus* (Jordan and Evermann, 1898) (Teleostei: Scorpaeniformes). Fishery Bulletin 106(2):111-134.

**Hawkins, S.L.**, L., J. Heifetz, C. M. Kondzela, J. E. Pohl, R. Wilmot, O. N. Katugin, and V. N. Tuponogov (2005). Genetic variation of rougheye rockfish (*Sebastes aleutianus*) and shortraker rockfish (*S. borealis*) inferred from allozymes. Fish. Bull. 103:524-535.

**Hawkins, S. L.**, and R. L. Wilmot (2004). Even-year pink salmon Pacific Rim allozyme baseline and origin of juveniles from Gulf of Alaska coastal waters, 2003. NPAFC technical report No. 5:110.

**Hawkins, S. L.**, N. V. Varnavskaya, E.A. Matzak, V. V. Efremov, C. M. Guthrie III, R. L. Wilmot, H. Mayama, F. Yamazaki, and A. J. Gharrett (2002). Population structure of odd-broodline Asian pink salmon and its contrast to the even-broodline structure. Journal of Fish Biology 60, 370-388.

Noll, C., N. V. Varnavskaya, E. A. Matzak, **S. L. Hawkins**, V. V. Midanaya, O. N. Katugin, C. Russell, N. M. Kinas, C. M. Guthrie III, H. Mayama, F. Yamazaki, B. P. Finney, A. J. Gharrett (2001). Analysis of contemporary genetic structure of even-broodyear populations of Asian and western Alaskan pink salmon, *Oncorhynchus gorbuscha*. Fish. Bull. 99:123-138.

**Collaborators/coauthors within last 4 years:**

Canino, Dr. Mike, Alaska Fisheries Science Center, Seattle, WA

Guthrie, Charles, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK

Guyon, Dr. Jeffery, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK

Heifetz, Dr. Jon, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK

Kai, Dr. Yoshiaki, Kyoto University, Japan

Katugin, Dr. Oleg, Russian Academy of Science, Vladivostok, Russia

Knoth, Brian, Alaska Fisheries Science Center, Kodiak, AK

Kondzela, Dr. Christine, Alaska Fisheries Science Center, Auke Bay Lab, Juneau, AK

Orr, Dr. Jay, Alaska Fisheries Science Center, Seattle, WA

Schwenke, Piper, Northwest Fisheries Science Center, WA

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### **Professional Background:**

**Prince William Sound/Copper River Research Project Leader**, Alaska Department of Fish and Game, August 2000 to present. Duties: Develop, implement, and evaluate research projects on Pacific herring, Pacific salmon, and eulachon in Prince William Sound and the Copper River. Specific duties include setting spawning escapement goals, preseason forecasts, evaluation of harvest policies, assessment of runs inseason, and local area network supervision. Supervise one full-time Fishery Biologist II and two 11-month seasonal Fishery Biologist I's. Current supervisor: Mr. Lowell Fair, Regional Research Biologist.

**Prince William Sound/Copper River Assistant Research Project Leader**, Fishery Biologist II, Alaska Department of Fish and Game, November 1991 to August 2000. Duties: Responsible for sampling, compilation, and analysis of age, sex, size, and stock composition data; and salmon catch and escapement reporting. Responsible for assisting with inseason assessment of Pacific salmon and Pacific herring abundance. Supervise five seasonal employees and responsible for five project budgets. Supervisors: Mr. John Wilcock and Mr. Mark Willette, Area Research Biologists

**Assistant Project Leader**, Fishery Biologist II, Alaska Department of Fish and Game, July 1991 to November 1991. Planned work and supervised five employees in collecting and compiling pink and chum salmon fry/egg abundance and mortality data. Assisted with data analysis and damage assessment report writing. Supervisor: Mr. Sam Sharr, Area Research Biologist

### **Education:**

B.S. Wildlife Management, University of Alaska Fairbanks, 1989.

### **Selected Publications:**

Bue, B.G., S. Sharr, S.D. Moffitt, and A. Craig. 1996. Effects of the *Exxon Valdez* oil spill on pink salmon embryos and preemergent fry. Pages 619-627 in S.D. Rice, R. B. Spies, D. A.

- Wolfe, and B. A. Wright, editors. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18.
- Craig, A., S. Sharr, and S. Moffitt. 1995. A compilation of historical preemergent fry and egg deposition survey data from Prince William Sound, 1961-1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Regional Information Report No. 2A-95-49, Anchorage.
- P-J.F. Hulson, S.E. Miller, T. J. Quinn II, G.D. Marty, S.D. Moffitt, and F. Funk. 2008. Data conflicts in fishery models: incorporating hydroacoustic data into the Prince William Sound Pacific herring assessment model. *ICES Journal of Marine Science*, 65: 25–43.
- Lambert, M.B., D.J. Degan, A.M. Mueller, J.J. Smith, S. Moffitt, B. Marston, and N. Gove. 2002. Assessing methods to index inseason salmon abundance in the lower Copper River, 2002 Annual Report. USFWS Office of Subsistence Management, Fisheries Resource Monitoring Program, Annual Report No. FIS01-021, Anchorage, Alaska.
- Marty, G.D., P-J.F. Hulson, S.E. Miller, T. J. Quinn II, S.D. Moffitt, and R.A. Merizon. 2010. Failure of population recovery in relation to disease in Pacific herring. *Dis Aquat Org Vol.* 90: 1–14.
- Marty, G.D., T.R. Meyers, and S.D. Moffitt. 2002. Effects of disease on recovery of Pacific herring in Prince William Sound, Alaska, Fall 2000 and Spring 2001. *Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 01462)*, Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage, Alaska.
- Moffitt, S., B. Marston, and M. Miller. 2002. Summary of eulachon research in the Copper River Delta, 1998-2002. Report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Commercial Fisheries Division. Regional Information Report No. 2A02-34, Anchorage.

**Recent collaborators:**

Rob Bochenek, Axiom Consulting and Design, Anchorage  
Don Degan – Aquacoustics  
Fritz Funk - Unaffiliated  
Peter-John Hulson – University of Alaska Fairbanks  
Michael Lambert – Native Village of Eyak  
Michael Link – LGL Consulting  
Dr. Gary Marty – University of California Davis  
Sara Miller – University of Alaska Fairbanks  
Dr. Terry Quinn – University of Alaska Fairbanks  
Jason Smith – LGL Consulting

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**Education**

1991 Ph.D. in Oceanography, University of Alaska, Fairbanks  
1983 M.S. in Fisheries, University of Washington, Seattle  
1979 B.S. in Fisheries, University of Washington, Seattle  
1976 B.S. in Oceanography, University of Washington, Seattle  
1972-74 Coursework at Sophia University, Tokyo

**Professional Experience**

1994-2011 Research Scientist, Prince William Sound Science Center  
1995-2011 Diving Safety Officer, Prince William Sound Science Center Scientific Diving Program

**Exxon Valdez Oil Spill Trustee Council Projects**

Prince William Sound Herring Survey: Pacific Herring Energetic Recruitment Factors (10100132-C: current)  
Prince William Sound Herring Forage Contingency (07-090811: 2007-2009)  
Nutrient Based Resource Management (040712: 2004-2007)  
Prince William Sound Ecology Synthesis (03065: 2003)  
Prince William Sound Isotope Ecology Dissemination (00541: 2000)  
Prince William Sound Food Webs: Structure and Change (99-01393:1999-2001)  
Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined with Natural Stable Isotope Tracers (98-99311: 1998-1999)  
Sound Ecosystem Assessment (SEA): Food Webs of Fish (95-98320-I: 1995-1998)  
Sound Ecosystem Assessment (SEA): Food Web Dependencies (94320-I: 1994)

**Five Project Related Research Papers**

1. Kline, T.C., Jr. 2010. Stable carbon and nitrogen isotope variation in the northern lampfish and *Neocalanus*, marine survival rates of pink salmon, and meso-scale eddies in the Gulf of Alaska. *Progr. Oceanogr.* 87:49-60.
2. Kline, T.C., Jr. 2009. Characterization of carbon and nitrogen stable isotope gradients in the sub-Arctic Pacific Ocean using terminal feed stage copepodite V *Neocalanus cristatus*. *Deep-Sea Res. II* 56:2537-2552.

3. Kline, T.C. Jr., J.L. Boldt, E.V. Farley, Jr., L.J. Haldorson, and J.H. Helle. 2008. Pink salmon (*Oncorhynchus gorbuscha*) marine survival rates reflect early marine carbon source dependency. *Progr. Oceanogr.* 77:194-202
4. Kline, T.C., Jr. 2001. The trophic position of Pacific herring in Prince William Sound Alaska based on their stable isotope abundance. *In:* F. Funk, J. Blackburn, D. Hay, A.J. Paul, R. Stephenson, R. Toresen, and D. Witherell (eds.), *Herring: Expectations for a New Millennium*. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks. p. 69-80.
5. Kline, Thomas C., Jr. 1999. Temporal and Spatial Variability of  $^{13}\text{C}/^{12}\text{C}$  and  $^{15}\text{N}/^{14}\text{N}$  in pelagic biota of Prince William Sound, Alaska. *Can. J. Fish. Aquat. Sci.* 56 (Suppl. 1) 94-117.

#### **Five Other Research Papers**

1. Kline, T.C. Jr. 2008. Ontogenetic, temporal, and spatial variation of feeding niche in an unexploited population of walleye pollock (*Theragra chalcogramma*). *In:* G.H. Kruse, K. Drinkwater, J.N. Ianelli, J.S. Link, D.L. Stram, V. Wespestad, and D. Woodby (eds), *Resiliency of gadid stocks to fishing and climate change*. University of Alaska Sea Grant, Fairbanks. AK-SG-08-01. pp. 251-269.
2. Kline, T.C., Jr. 2007. Rockfish trophic relationships in Prince William Sound, Alaska, based on natural abundance of stable isotopes. *In:* J. Heifetz, J. DeCosimo, A. Gharrett, M. Love, V. O'Connell, and R. Stanley (eds) *Biology, Assessment, and Management of Pacific Rockfishes*. University of Alaska Sea Grant, Fairbanks. AK-SG-07-01. pp. 21-37.
3. Kline, T.C., Jr., C.A. Woody, M.A. Bishop, S.P. Powers, and E.E. Knudsen. 2006. Assessment of marine-derived nutrients in the Copper River Delta, Alaska using natural abundance of the stable isotopes of nitrogen, sulfur, and carbon. *In:* C.A. Woody (ed.), *Sockeye Salmon Ecology, Evolution, and Management*. American Fisheries Society, Symposium 54:51-60.
4. Kline, T.C., Jr. 2003. Implications of Trophic Level when Assessing the Role of Salmon-Derived Nutrients for Lacustrine Juvenile Sockeye Salmon Ecology using the Natural Abundance of  $^{15}\text{N}/^{14}\text{N}$ . *In:* J. Stockner (ed.). *Restoring Nutrients to Salmonid Ecosystems*. American Fisheries Society, Bethesda. p.229-236.
5. Kline, T.C. Jr. and T.M. Willette. 2002. Pacific salmon (*Oncorhynchus*) early marine feeding patterns based on  $^{15}\text{N}/^{14}\text{N}$  and  $^{13}\text{C}/^{12}\text{C}$  in Prince William Sound, Alaska. *Can. J. Fish. Aquat. Sci.* 59: 1626–1638.

#### **Recent Collaborators (Since 2006)**

Cooney, R., Haldorson, L., Whitledge, T. (U. AK Fairbanks); Welker, J. (U. AK Anchorage); Bishop, M., Buckhorn, M., Campbell, R., Gay, S., Pegau, S., Thorne, R. (PWSSC); Brenner, R., Moffitt, S. (AK Dept. Fish and Game); Knudsen, E., Woody, C., Hershberger, P. (USGS); Farley, E., Helle, J., Vollenveider, J., Heintz, R., Canino, M. (NMFS/NOAA); Patrick, V. (U. MD); Kiefer, D. (U. So. CA); Boldt, J., Hay, D. (DFO, Canada), Brown, E. (unaffiliated).

#### **Graduate and Post-Graduate Advisors**

Chew, K. (M.S., Univ. Washington), Goering, J. (Ph. D., Univ. Alaska Fairbanks), Kelley, J. (Post-doctoral, Univ. Alaska Fairbanks)

#### **Graduate and Post-Graduate Advisees**

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## **EDUCATION**

Ph.D. Wildlife Ecology, 1988 University of Florida, Gainesville  
M.S. Wildlife & Fisheries Sciences, 1984 Texas A & M University, College Station  
B.B.A. Real Estate & Urban Land Economics, 1974 University of Wisconsin, Madison

## **RECENT PROFESSIONAL EXPERIENCE**

6/99-present Research Ecologist, Prince William Sound Science Center, Cordova, Alaska.  
11/88-present Principal Investigator, Tibet Black-necked Crane Project, International Crane Foundation, Baraboo, Wisconsin (job location: Tibet, People's Republic of China).  
4/90-3/94 & 4/97-5/99 Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest. Research Station US Forest Service.  
4/94-3/97 Research Wildlife Biologist, Center for Streamside Studies and Dept. Fisheries, University of Washington, assigned to Copper River Delta Institute, Cordova, Alaska.  
5/92-4/93 Acting Manager, Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service, Cordova, Alaska.

## **CURRENT RELEVANT ACTIVITIES**

Co-PI Prince William Sound Herring Survey: Top-down regulation by predatory fish on juvenile herring. funded by Exxon Valdez Oil Spill Trustee Council, 2010-2013.  
Co-PI Prince William Sound Herring Survey: Seasonal and interannual trends in seabird predation on juvenile herring. funded by Exxon Valdez Oil Spill Trustee Council, 2010-2013.  
Co-PI Tracking movements of Lingcod *Ophiodon elongatus* in Prince William Sound using acoustic tags and arrays. funded by Pacific Ocean Shelf Tracking Project (Phases I & II), Prince William Sound Oil Spill Recovery Institute (Phase I), 2008-2011.

## **RECENT RELATED PROFESSIONAL EXPERIENCE**

PI & Co-PI Exxon Valdez Oil Spill Trustee Council projects on avian predators in Prince William Sound (1994-1998 SEA and NVP Programs; 2007-2009 Herring Program).  
Co-PI Residency and movements of Copper Rockfish *Sebastes caurinus* and Lingcod *Ophiodon elongatus* in nearshore areas of Prince William Sound. funded by NPRB, 2007-2008  
Co-PI Trophic dynamics of intertidal soft-sediment communities: interaction between bottom-up & top-down processes. funded by EVOS Trustee Council 2004-2006.  
Co-PI Evaluating Artificial Reefs as Marine Habitat Enhancement Tools in Coastal Alaskan Waters. funded by NOAA, USFWS, 2006-2008.  
Co-PI Estuaries as essential fish habitat for salmonids: Assessing residence time and habitat use of



coho and sockeye salmon in Alaska estuaries. funded by NPRB, 2003-2006.

#### **SELECTED SCIENTIFIC PUBLICATIONS** (10 of 44)

Zuur A.F., N.M. Dawson, **M.A. Bishop**, K.J. Kuletz, A.A. Saveliev E.N. Ieno. 2011. Zero inflated Common Murre density data. Cpt. 11 in A.F. Zuur, A.A.Saveliev, E.N. Ieno (eds). *Analysing Ecological Data - Practical Solutions When Things Get Complicated*. *in press*.

**Bishop, M.A.**, T. Morgan, and W.S. Pegau. 2011. Influence of mesoscale hydrographic features on seabird distribution in central Prince William Sound. *Continental Shelf Research*. *under peer review*.

N.M. Dawson, **M.A. Bishop**, K.J. Kuletz, and A.F. Zuur. 2011. Habitat associations of seabirds during winter in Prince William Sound, Alaska. *Condor*. *under peer review*.

**Bishop, M.A.**, B.F. Reynolds, S.P. Powers. 2010. An *in situ*, individual-based approach to quantify connectivity of marine fish: ontogenetic movements and residency of lingcod. *PLoS One* 5(12): e14267.

Reynolds, B.F., S.P. Powers, **M. A. Bishop**. 2010. Application of acoustic biotelemetry to assess quality of created habitats for Rockfish and Lingcod in Prince William Sound, Alaska. *PLoS One* 5(8): e12130.

Powers, S.P., **M. A. Bishop**, S. Moffitt, and G.H. Reeves. 2007. Variability in freshwater, estuarine and marine residence of Sockeye Salmon (*Oncorhynchus nerka*) within the Copper and Bering River Deltas, Alaska. *American Fisheries Society Symposium* 54:87-99.

Powers, S.P., **M. A. Bishop**, J. Grabowski and C.H. Peterson. 2006. Distribution of the invasive bivalve *Mya arenaria* L. on intertidal flats of southcentral Alaska. *Journal Sea Research* 55:207-216.

Powers, S.P., **M. A. Bishop**, J.H. Grabowski, and C.H. Peterson. 2002. Intertidal benthic resources of the Copper River Delta, Alaska, USA. *Journal Sea Research* 47: 13-23

**Bishop, M. A.** and S.P. Green. 2001. Predation on Pacific herring (*Clupea pallasii*) spawn by birds in Prince William Sound, Alaska. *Fisheries Oceanography* 10 (1):149-158.

Cooney, R.T., J.R. Allen, **M. A. Bishop**, D.L. Eslinger, T. Kline, B.L. Norcross, *et al.* 2001. Ecosystem control of pink salmon (*Oncorhynchus gorbuscha*) and Pacific herring (*Clupea pallasii*) populations in Prince William Sound. *Fisheries Oceanography* 10(1):1-13.

#### *RECENT POPULAR SCIENCE ARTICLES*

Warnock, N., **M. A. Bishop**, and J. Takekawa. 2005. Ecology of Western Sandpipers, Dunlins, and Dowitchers that Migrate through Western North America. *Birding* 37: 392-400

**Bishop, M. A.** 2002. Great possessions: Leopold's good oak. Pages 72-87 in R.L. Knight and S. Reidel, eds. *Aldo Leopold and the Ecological Conscience*. Oxford University Press, New York. (originally published *Wildlife Society Bulletin* 26: 732-740.)

#### **GRADUATE FACULTY**

Graduate Faculty, University of South Alabama. Thesis Committee for B. Reynolds (2007-2009).

## Curriculum Vitae: Michele Leigh Buckhorn

Prince William Sound Science Center PO BOX 705, Cordova, AK

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### Education:

- Ph.D. 2009 University of California, Davis, Ecology (AOE Marine Ecology)  
Advisors: Marcel Holyoak, PhD and Peter B. Moyle, PhD
- B.A. 1999 University of California, Santa Cruz, Biology
- A.S. 1993 American River College, Math and Physical Sciences

### Related Employment:

Postdoctoral Researcher Fish Ecologist, Prince William Sound Science Center. 2010 – present

Postdoctoral Researcher. U.C. Davis. Department of Wildlife, Fish and Conservation Biology. 2008-2009.

### Publications

#### *Book:*

Buckhorn, Michele L. Guide to the Marine Fishes from the Gulf of California. American Fisheries Society.  
In press.

#### *Journal Articles:*

Erismann, B. E., M. L. Buckhorn, et al. (2007). "Spawning patterns in the leopard grouper, *Mycteroperca rosacea*, in comparison with other aggregating groupers." *Marine Biology (Berlin)* 151(5):849-1861.

#### *Reports:*

Chapman, E.D., A.R. Hearn, M.L. Buckhorn, A.P. Klimley, P.E. Lacivita, W.N. Brostoff, A.M. Bremner (2009). "Juvenile Salmonid Outmigration and Distribution in the San Francisco Estuary: 2008-2009." U.S. Army Corp of Engineers, LTMS. 87 pp.

#### *In preparation*

- Buckhorn, M.L., P.T. Sandstrom, and A.P. Klimley. Tidally synched movements of sevengill sharks (*Notorynchus cepedianus*) in San Francisco Bay. Target journal: *Environmental Biology of Fishes*
- Buckhorn, M.L. Age, growth and reproduction of leopard grouper (*Mycteroperca rosacea*): evidence of a behaviorally mediated Allee effect. Target journal: *Journal of Fish Biology*.
- Buckhorn, M.L. Identification and monitoring of spawning aggregations to enhance fishery management of leopard grouper (*Mycteroperca rosacea*) in Loreto Marine Park. Target journal: *Fishery Bulletin*.
- Buckhorn, M.L. Influence of habitat and exploitation on reef fish assemblages in Loreto Marine Park. Target journal: *Marine Biology*.

### **Selected Presentations**

- 2009 Buckhorn, M.L. Movements of sevengill sharks (*Notorynchus cepedianus*) in San Francisco Bay. Poster. Joint Meeting of Ichthyologists and Herpetologists. Portland, Oregon.
- 2009 Buckhorn, M.L. Movements of sevengill sharks (*Notorynchus cepedianus*) in San Francisco Bay. California Estuarine Research Society Annual Meeting. Bodega Bay, California.
- 2007 Buckhorn, M.L. Age and growth of leopard grouper, *Mycteroperca rosacea*, in Loreto Marine Park, Baja California Sur. Western Society of Naturalists 88th Annual Meeting. Ventura, California.
- 2007 Buckhorn, M.L. Leopard grouper, *Mycteroperca rosacea*, spawning aggregations in Loreto Marine Park, Baja California Sur. American Fisheries Society 137th Annual Meeting. San Francisco, California.
- 2007 Buckhorn, M.L. Age and growth of leopard grouper, *Mycteroperca rosacea*, in Loreto Marine Park, Baja California Sur. American Fisheries Society 137th Annual Meeting. San Francisco, California.
- 2005 Erisman, B.E., M.L. Buckhorn, P.A. Hastings. Unusual spawning patterns in the leopard grouper (*Mycteroperca rosacea*) from the Gulf of California: Implications for conservation and management. Western Society of Naturalists 86th Annual Meeting. Monterey California.
- 2005 Buckhorn, M.L. Reef organism diversity in relation to leopard grouper spawning sites in Loreto Marine Park: Implications for management. Invited symposium speaker. MPAs: Fitting the Pieces into the Fisheries Mosaic. American Fisheries Society 135th Annual Meeting. Anchorage Alaska.

### **Recent Collaborators**

Scott Pegau, PhD., Prince William Sound Science Center  
Dick Thorne, PhD., Prince William Sound Science Center  
A. Pete Klimley, PhD., UC Davis  
Jorge Torre, PhD., Comunidad y Biodiversidad, AC, Mexico  
Andrea Saenz, PhD., Comunidad y Biodiversidad, AC, Mexico  
Brad Erisman, PhD., Scripps Institute of Oceanography

Richard E. Thorne, Ph.D.  
P.O. Box 705, Cordova, Alaska 99574  
(907) 424 -5800 (work), -5820 (fax)

### Employment History

Prince William Sound Science Center	Senior Scientist	2000-present
BioSonics, Inc.	Vice President	1996-1999
4027 Leary Way NW	Manager Technical Services	1991-1999
Seattle, WA 98107	Senior Scientist	1988-1999
University of Washington	Affiliate Research Professor	1991-2001
School of Fisheries	Research Professor	1981-1990 (LOA 1988-1990)
Fisheries Research Institute	Research Associate Professor	1976-1981
Seattle, WA	Senior Research Associate	1970-1976
Commercial Fisher (salmon and albacore)		1957-1968

### Academic Background

Ph.D., Fisheries-1970, University of Washington, School of Fisheries  
MS Degree-1968, University of Washington, Department of Oceanography  
B.S. Degree-1965, University of Washington, Department of Oceanography

### Selected Publications

Thorne, R.E. and G.L. Thomas 2011. The Role of Fishery Independent Data, Chapter 12, In, Janice S. Intilli (ed) Fisheries Management. Nova Science Publishers, ISBN 978-1-61209-682-7.

Frid, A., J. Burns, G.G. Baker and R.E. Thorne 2008. Predicting synergistic effects of resources and predators on foraging decisions by juvenile Steller sea lions. *Oecologia* 10.1007/s00442-008-1189-5, 12 p.

Thorne, R.E. 2008. Walleye pollock as predator and prey in the Prince William Sound ecosystem. Pp: 289-304, In: G.H. Kruse, K. Drinkwater, J.N. Ianelli, J.S. Link, D.L. Stram, V. Wespestad and D. Woodby (eds), Resiliency of gadid stocks to fishing and climate change. Alaska Sea Grant, University of Alaska, Fairbanks

Thorne, R.E. and G.L. Thomas 2008. Herring and the "Exxon Valdez" oil spill: an investigation into historical data conflicts. *ICES Journal of Marine Science* 65(1):44-50.

- Frid, A., Dill, L.M., Thorne, R. E., Blundell, G. M. 2007. Inferring prey perception of relative danger in large-scale marine systems. *Evolutionary Ecology Research*, Vol. 4.
- Churnside, J.H. and R.E. Thorne 2005. Comparison of airborne lidar measurements with 420 kHz echosounder measurements of zooplankton. *Applied Optics* **44**(26):5504-5511
- Thomas, G.L. and R.E. Thorne 2003. Acoustical-optical assessment of Pacific herring and their predator assemblage in Prince William Sound, Alaska. *Aquatic Living Resources* **16**:247-253.
- Thomas, G.L, J. Kirsch and R.E. Thorne 2002. Ex situ target strength measurements of Pacific herring and Pacific sand lance, *North American Journal of Fisheries Management* **22**:1136-1145.
- Thomas, G.L. and R.E. Thorne 2001. Night-time Predation by Steller Sea Lions. *Nature* **411**:1013.
- Thorne, R.E. and G.L. Thomas 2001. Biological considerations for scaling ecosystem research in Prince William Sound, Alaska. Pp 1-11 in *Proceedings (electronic) ACOUSTGEAR2000*.
- McClatchie, S., R. Thorne, P. Grimes and S. Hanchet 2000. Ground truth and target identification for fisheries acoustics. *Fisheries Research* **47**:173-191.
- Thorne, R.E. 1998. Review: experiences with shallow water acoustics. *Fisheries Research* **35**:137-141, Elsevier Science, Amsterdam
- Thorne, R.E. 1988. Some impacts of remote system technology on future fisheries management. *Fisheries* **13**(4):14-17.
- Thorne, R.E. 1988. An empirical evaluation of the duration-in-beam technique for hydroacoustic estimation. *Can. J. Fish. Aquat. Sci.* **45**:1244-1248.
- Thorne, R.E. 1983. Assessment of population abundance by echo integration. *Proc. Symp. On Assessment of Micronekton. Biol. Ocean. J.* **2**:253-262.
- Trumble, R., R.Thorne and N. Lemberg 1983. The Strait of Georgia herring fishery: A case history of timely management aided by hydroacoustic surveys. *Fish. Bull.* **80**(2):381-388.
- Mathisen, O.A., R.E. Thorne, R. Trumble and M.Blackburn 1978. Food consumption of pelagic fish in an upwelling area. Pp. 111-123 in R. Boje and M. Tomczak (eds) *Upwelling Ecosystems*. Springer-Verlag.
- Thorne, R.E., O.A. Mathisen, R.J. Trumble and M. Blackburn 1977. Distribution and abundance of pelagic fish off Spanish Sahara during CUEA Expedition JOINT I. *Deep-Sea Res.* **24**:75-82.
- Thorne, R.E. 1977. Acoustic assessment of hake and herring stocks in Puget Sound, Washington and southeastern Alaska. Pp. 265-278 in A.R. Margets (ed), *Hydroacoustics in Fisheries Research*. ICES Rapp. Et P.-v., Vol 170.
- Thorne, R.E. 1977. A new digital hydroacoustic data processor and some observations on herring in Alaska. *J. Fish.Res. Bd. Canada* **34**:2288-2294.

Kevin Mershon Boswell, Ph.D.

Department of Oceanography and Coastal Sciences; 2243 Energy Coast and Environment Building; Baton Rouge, LA 70803; Email: [kboswe1@lsu.edu](mailto:kboswe1@lsu.edu); Tel: (225) 485-8181

## Education

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PhD, Oceanography and Coastal Sciences (2006), Louisiana State University, Baton Rouge, LA. Minor-Experimental Statistics

BS, Marine Fisheries (1998), Texas A&M University, Galveston, TX

## Professional Experience- Past Ten Years

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**Assistant Professor- Research** 2010-Date

*Louisiana State University, Baton Rouge, LA  
Department of Oceanography and Coastal Sciences*

**Senior Post-Doctoral Research Associate** 2009-2010

*Louisiana State University, Baton Rouge, LA  
Dept. of Oceanography and Coastal Sciences, Advisor: Dr. James H. Cowan, Jr.*

**Post-Doctoral Research Associate** 2006-2009

*Louisiana State University, Baton Rouge, LA  
Dept. of Oceanography and Coastal Sciences, Advisor: Dr. James H. Cowan, Jr.*

**Graduate Research Assistant** 2001-2006

*Louisiana State University, Baton Rouge, LA  
Dept. of Oceanography and Coastal Sciences, Advisor: Dr. Charles A. Wilson*

## Publications in National and International Journals- Five most recent

---

Boswell KM, RJD Wells, JH Cowan and CA Wilson. 2010. Biomass, density, and size distributions of fishes associated with a large-scale artificial reef complex in the Gulf of Mexico. *Bulletin of Marine Science*. doi:10.5343/bms.2010.1026

Kimball ME, KM Boswell, LP Rozas and JH Cowan. 2010. Evaluating the effect of slot size and environmental variables on the passage of estuarine nekton through a water control structure. *Journal of Experimental Marine Biology and Ecology*. doi:10.1016/j.jembe.2010.09.003

Mueller AM, DL Burwen, KM Boswell and T Mulligan. 2010. Tail Beat Patterns in DIDSON Echograms and their Potential Use for Species Identification and Bioenergetics Studies. *Transactions of the American Fisheries Society*, 139:900-910.

Boswell KM, MP Wilson, PSD MacRae, CA Wilson and JH Cowan. 2010. Seasonal estimates of fish biomass and length distributions using acoustics and traditional nets to identify estuarine habitat preferences in Barataria Bay, Louisiana. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, 2:83-97.

Boswell KM, BM Roth and JH Cowan. 2009. Simulating the effects of fish orientation on acoustic biomass calculations. *ICES Journal of Marine Science*, 66: 1398-1403.

### **Research Grants-**

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Total funded projects in past 4 years: \$7,542,422; Other pending projects: \$635,684.

### **Accomplishments and Awards**

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American Fisheries Society- Parent Society Travel Award: 2007 (San Francisco, CA)  
American Fisheries Society- Southern Division Travel Award: 2007 (Memphis, TN)  
Louisiana State University 2006 Distinguished Dissertation Award, Nominee: 2006  
Best Student Paper, Gulf and Caribbean Fisheries Institute, Xel-Ha, Mexico: 2005  
Best Student Poster, Graduate Student Association Intellectual Gumbo, LSU: 2002  
Rockefeller State Wildlife Scholarship- LSU: 2002, 2003  
Department of Oceanography and Coastal Sciences, LSU, Enhancement Award: 2001- 2003  
William P. Ricker Scholarship awarded for leadership-TAMU: 1997-1998  
National Collegiate Student Government Award-TAMU: 1998  
Who's Who in American Universities and Colleges Award-TAMU: 1998  
Eagle Scout- Boy Scouts of America

### **Journal Reviews**

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American Fisheries Society Symposium Series: Red Snapper Ecology & Fisheries in the US Gulf of Mexico; Estuarine, Coastal and Shelf Science; Experimental Marine Biology and Ecology; Gulf of Mexico Science; ICES Journal of Marine Science; Marine and Coastal Fisheries (AFS); Marine Ecology Progress Series Marine Technology Society Journal; North American Journal of Fisheries Management; Transactions of the American Fisheries Society; Southeastern Naturalist

### **Proposal Reviews**

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Hudson River Foundation; National Oceanographic & Atmospheric Administration, Chesapeake Bay Fisheries Research Program; North Pacific Research Board; United States Department of Agriculture Small Business Innovation Research; West Coast and Polar Regions Undersea Research Center

### **Professional Memberships**

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American Fisheries Society (Parent, Southern Division, Louisiana Chapter, and Marine Fisheries Section); American Society of Limnology and Oceanography; Acoustical Society of America; Coastal and Estuarine Research Federation; Gulf and Caribbean Fisheries Institute; Gulf Estuarine Research Society

**Shane StClair**

shane@axiomalaska.com

Work Telephone: (907) 350-8526

523 West Eighth Avenue, Suite 104, Anchorage, Alaska 99501

**PROFESSIONAL EXPERIENCE**

**March 2008 – Present**

**Axiom Consulting & Design, LLC** – Senior Software Engineer

**September 2006 – February 2008**

**Exxon Valdez Oil Spill Trustee Council (EVOSTC)** – Analyst/Programmer III

**June 2002 – September 2006**

**Alaska Department of Fish & Game, Commercial Fisheries Division** – Research Analyst II

**Recent Professional Activities**

- October 2009 – Participated in the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) Web Portals Workshop in Portland, Oregon.
- June 2009 – Presented prototype data portal at the Copper River Strategy Group meeting in Gakona, Alaska.

**Education**

B.S. in Biological Sciences, University of Alaska Anchorage, 2002.

**Publications**

Brannian, L. K., S. Darr, H. A. Moore, and S. StClair. 2004. Scope of work for the AYK salmon database management system. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-29, Anchorage.

Brannian, L. K., S. Darr, H. A. Krenz, S. StClair, and C. Lawn. 2005. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2005. Alaska Department of Fish and Game, Special Publication No. 05-10, Anchorage.



Brannian, L.K., S. Darr, H. A. Moore, and S. StClair. 2005. Development of the Arctic-Yukon-Kuskokwim salmon database management system through 2004. Alaska Department of Fish and Game, Special Publication No. 05-04, Anchorage.

Brannian, L. K., K. R. Kamletz, H. A. Krenz, S. StClair, and C. Lawn. 2006. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2006. Alaska Department of Fish and Game, Special Publication No. 06-21, Anchorage.

Estensen J. L., S. St Clair. 2003. Pacific herring stocks and fisheries in the Arctic-Yukon-Kuskokwim region of the Bering Sea, Alaska, 2003 and outlook for 2004. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-37, Anchorage.

Hamner, H. H., S. Karpovich, S. StClair. 2003. Development Of A Shared AYK Salmon Database. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-23, Anchorage.

Hamner, H. H., S. Karpovich, S. St. Clair. 2003. Norton Sound salmon information database file inventory and problem review. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-01, Anchorage.

Hamner, H. H., S. St Clair, and H. Moore. 2004. An inventory of age, sex and length data for Norton Sound, Kotzebue, and Kuskokwim chum salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-06, Anchorage.

# Trevor A. Branch

## (Principal Investigator)

Address: School of Aquatic and Fishery Sciences, Box 355020, University of Washington, Seattle, WA, 98195

Telephone: 206-221-0776, Fax: 206-685-7471

Email address: tbranch@uw.edu

## Education

University of Cape Town	Zoology and Computer Science	B.Sc.	1994
University of Cape Town	Zoology	B.Sc.(Hons)	1995
University of Cape Town	Conservation Biology	M.Sc.	1998
University of Washington	Aquatic and Fishery Sciences	Ph.D.	2004

## Employment (Position, institution, start and end year):

2010–present	Assistant Professor, School of Aquatic and Fishery Sciences, Univ. of Washington
2006–2010	Research Scientist, School of Aquatic and Fishery Sciences, Univ. of Washington
2005–2006	Research Officer, Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, University of Cape Town

## Professional Recognition (Societies, honors and awards):

Associate Editor for Animal Conservation, 2011-present.

Invited participant to Scientific Committee meetings of the International Whaling Commission, 2000–2008, advising on abundance, current status, and trends of Antarctic minke whales, Antarctic blue whales and other large cetaceans.

Consultant to Independent Scientific Advisory Panel for Commission for Conservation of Southern Bluefin Tuna, 2004–present.

Young Investigator award for best oral presentation at the Mote Symposium, November 2004.

Faculty merit award for best PhD student, School of Aquatic and Fishery Sciences, University of Washington, 2004.

Reviewer for 22 journals including Science, Canadian Journal of Fisheries and Aquatic Sciences, Proceedings of the Royal Society B, Fisheries Research, ICES Journal of Marine Science, Fish and Fisheries, Ecology, and Marine Ecology Progress Series.

### **Graduate students and post-doctorates supervised:**

M.S. Advisor, Cole Monnahan (2011-present), Quantitative Ecology and Resource Management (QERM) interdisciplinary program.

Ph.D. committee member: Kotaro Ono (2011-present), School of Aquatic and Fishery Sciences, University of Washington.

M.S. Committee member: Curry Cunningham (2011-present), School of Aquatic and Fishery Sciences, University of Washington.

### **Selected publications since 2009 (total = 34):**

**Branch, T.A.**, Watson, R., Fulton, E.A., Jennings, S., McGilliard, C.R., Pablico, G.T., Ricard, D., & Tracey, S.R. 2010. The trophic fingerprint of marine fisheries. Nature. 468:431-435.

Worm, B., Hilborn R., Baum, J.K., **Branch, T.A.**, Collie, J.S., Costello, C., Fogarty, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jensen, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A.A., Watson, R. & Zeller, D. 2009. Rebuilding global fisheries. Science. 325:578-585.

Sethi, S. A., **Branch, T.A.** & Watson, R. 2010. Fishery development patterns are driven by profit but not trophic level. Proceedings of the National Academy of Sciences U.S.A. 107:12163-12167.

**Branch, T.A.**, Jensen, O.P., Ricard, D., Ye, Y. & Hilborn, R. 2011 Contrasting global trends in marine fishery status obtained from catches and from stock assessments. Conservation Biology. doi: 10.1111/j.1523-1739.2011.01687.x

Froese, R., **Branch, T.A.**, Proel  $\beta$ , A., Quaas, M., Sainsbury, K. & Zimmermann, C. 2011. Generic harvest control rules for European fisheries. Fish and Fisheries. doi: 10.1111/j.1467-2979.2010.00387.x

**Branch, T.A.** & Hilborn, R. 2010. A general model for reconstructing salmon runs. Canadian Journal of Fisheries and Aquatic Sciences. 67:886-904. doi: 10.1139/F10-032

**Branch, T.A.** 2009a. How do individual transferable quotas affect marine ecosystems? Fish and Fisheries. 10:39-57.

**Branch, T.A.** 2009b. Differences in predicted catch composition between two widely used catch equation formulations. Canadian Journal of Fisheries and Aquatic Sciences. 66: 126-132. doi:10.1139/F08-196

### **Collaborators and co-editors in the last 48 months**

Abbott, J. (Arizona State University), Abubaker, E.M.N. (Sudan), Allison, C. (IWC, U.K.), A'Mar, Z.T. (UW), Anderson, R.C. (Maldives), Ashe, E., (U.K.), Baker, A.N. (New Zealand), Baker, M.R. (UW), Bannister, J.L. (W. Australian Museum), Baum, J.K. (Scripps Inst. Oceanography), Best, P.B. (South African Museum), Borsa, P. (New Caledonia), Bravington, M. (CSIRO, Australia), Brownell Jr, R.L. (NOAA), Burton, C.L.K. (private, Australia), Butterworth, D.S. (Univ. Cape Town, South Africa), Cabrera, E. (Centro de Conservacion Cetacea, Chile), Carlson, C.A. (College of the Atlantic), Childerhouse, S. (Department of Conservation, New Zealand), Clarke, E. (NOAA), Clark, S. (Sea World), Collie, J.S. (Univ. Rhode Island), Costello, C. (UC Santa Barbara),

Essington, T.E. (UW), Findlay, K.P. (Univ. Cape Town, South Africa), Fogarty, M.J. (NOAA), Froese, R. (Leibniz Inst. Mar. Sci., Germany), Fulton, E.A. (CSIRO, Australia), Galletti Vernazzani, B. (Centro de Conservacion Cetacea, Chile), Gerrodette, T. (NOAA), Gill, P.C. (Blue Whale Study, Australia), Haynie, A.C. (NOAA), Hammond, P. (U.K.), Hedley, S. (U.K.), Hilborn R. (UW), Hollowed, A. (NOAA), Holland, D.S. (NOAA), Holtgrieve, G.W. (UW), Huckle-Gaete, R. (Universidad Austral de Chile), Hoyt, E. (Whale & Dolphin Cons. Soc.), Hutchings, J.A. (Dalhousie Univ., Canada), Ianelli, J. (NOAA), Ilangakoon, A.D. (Sri Lanka), Jannot, J. (NOAA), Jenner, K.C.S. (Centre for Whale Research, Australia), Jenner, M.-N.M. (Ctr. Whale Res, Australia), Jennings, S. (Ctr. Env. Fish. Aqu. Res., U.K.), Jensen, O.P. (Univ. Rutgers), Joergensen, M. (Denmark), Kahn, B. (Indonesia), Kato, H. (Tokyo Univ. Mar. Sci. Tech., Japan), Kendall, N.W. (UW), Krkošek, M. (New Zealand), Ljungblad, D.K. (private), Lotze, H.K. (Dalhousie Univ., Canada), Mace, P.M. (Min. Fisheries, New Zealand), Matsuoka, K. (Inst. Cet. Res., Japan), Maughan, B. (U.K.), McCauley, R.D. (Curtin Univ., Australia), McClanahan, T.R. (Wildlife Cons. Soc., Kenya), McGilliard, C.R. (UW), McKay, S. (Deakin Univ., Australia), Melvin, E. (UW), Mikhalev, Y.A. (South-Ukrainian Pedagogical Univ.), Minto, C. (Dalhousie Univ., Canada), Miyashita, T. (Natl Res. Inst. Far Seas Fish., Japan), Mkango, S. (Univ. Cape Town, South Africa), Morrice, M.G. (Deakin Univ., Australia), Nishiwaki, S. (Inst. Cet. Res., Japan), Noren, D. (NOAA), Norris, T.F. (private), Pablico, G. (WorldFish Cntr., Philippines), Palacios, D.M. (NOAA), Palumbi, S.R. (Stanford Univ.), Parma, A.M. (Centro Nacional Patagónico, Argentina), Proelß, A. (Germany), Quaas, M. (Germany), Quinn, T.P. (UW), Ranjan, R. (UW), Rankin, S. (NOAA), Ricard, D. (Dalhousie Univ., Canada), Rosen, D. (UBC, Canada), Rosenberg, A.A. (Univ. New Hampshire), Sainsbury, K. (Australia), Samaran, F. (Cntr. d'Etudes Biol. Chize, France), Schindler, D.E. (UW), Sethi, S.A. (UW), Stafford, K.M. (UW), Sturrock, V.J. (Australia), Thiele, D. (Deakin Univ. Australia), Tormosov, D. (Russia), Tracey, S.R. (Univ. Tasmania), Van Waerebeek, K. (Peruvian Cntr. Cet. Res.), Warneke, R.M. (Australia), Watson, R. (Univ. British Columbia), Williams, R. (Canada), Worm, B. (Dalhousie Univ., Canada), Ye, Y. (FAO, Italy), Zeller, D. (Univ. British Columbia), Zerbini, A.N. (NOAA), Zimmermann, C. (Germany).