FY15 PROJECT PROPOSAL SUMMARY PAGE

New Project

Proposals are due to the EVOSTC office by September 2, 2014. Please note that the information in your proposal and budget form will be used for funding review. Late proposals, revisions or corrections may not be accepted.

Project Title: Aerial surveys & age, sex, size processing.

Project Period: February 1, 2015 – January 31, 2016

Primary Investigator(s): Steve Moffitt, ADF&G (steve.moffitt@alaska.gov)

Project Website (if applicable):

Abstract*:
This project will conduct spring aerial surveys to document Pacific herring Clupea pallasii spawn distribution and biomass as well as the distribution and abundance data on sea lions, other marine mammals, and birds associated with herring schools or spawn. Additionally, this project will process age, sex, and size samples of Pacific herring collected by acoustics surveys, spawning surveys, PWS Herring Program disease sampling and genetics collections. Aerial survey and age, sex, and size data have collected since the early 1970s and are an essential part of the age structured model used by the Alaska Department of Fish and Game to estimate the historical and future biomass for fisheries management. This project will also provide support to other Prince William Sound herring program and Gulf Watch Alaska projects by sharing information about herring or marine mammal locations or processing samples collected by the other projects.

**The abstract should provide a brief overview of the overall goals and hypotheses of the project and provide sufficient information for a summary review as this is the text that will be used in the public work plan and may be relied upon by the PAC and other parties.*

Estimated Budget:
EVOSTC Funding Requested* (*must include 9% GA*):

FY15	FY16	FY17	FY18	FY19	TOTAL
	$60,000.00				

Non-EVOSTC Funds to be used:

FY15	FY16	FY17	FY18	FY19	TOTAL
	$48,987.48				

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

Date: 14 August 2015

I. EXECTUVE SUMMARY

This project will 1) conduct aerial surveys to collect data associated with spring Pacific herring *Clupea pallasii* spawning events and 2) process age, sex, and size (ASL) samples. Spring aerial survey data has been collected since 1972 (Funk 1994), and ASL data is available since 1973 (Sandone 1988); however, collections of both data sets have been more extensive since the early 1980s. Herring age data were collected in 1971 and 1972 also, but only published frequency plots (no individual fish data) are available (Pirtle et al. 1973).

Aerial surveys were used to document spring herring biomass and were the primary management tool prior to the development of the first statistical catch-at-age model or age structured assessment model (ASA) in 1988 (Brady 1987, Funk and Sandone 1990). Biomass is estimated as school surface area converted to biomass from a few paired observations of aerial observers and vessel harvests (Brady 1987, Funk and Sandone 1990). The surface area and biomass conversion methods are as described in Brady 1987 and Lebida and Whitmore (1985). Prior to 1988, the aerial survey program's primary objectives were to collect biomass data for an annual index, document the distribution and linear extent of milt, document herring temporal movements, and document commercial fishing distribution and processing work (Brady 1987). Additionally, the locations of large aggregations of sea lions and other marine mammals were often noted on paper maps.

Brady (1987) described how herring arrive on the spawning grounds over time and may be available to document on multiple aerial surveys. Therefore, the biomass over several days of surveys cannot be necessarily be added to estimate the total or peak biomass. The peak biomass was therefore calculated as the largest biomass observed in all areas on a single survey (Brady 1987). Additional biomass with a discrete time separation would also be added, but these conservative methods were required to estimate the peak biomass because the amount of time herring were available to observation by aerial surveys was unknown and likely variable (Funk and Sandone 1990).

Brady (1987) also detailed how the variable bathymetry of Prince William Sound herring spawning areas has a large influence on the ability to observe herring schools. Herring may spawn in shallow bays (e.g., Rocky Bay), shallow beaches (e.g. Hells Hole beach), or deep bays (e.g., Fairmont Bay). The influence of bathymetry on observer efficiency makes a biomass index less likely to be comparable across years. Although the Funk and Sandone (1990) indicated that peak biomass values may be a useful relative abundance, the issues with biomass observations described by Brady (1987) and Funk and

Sandone (1990) caused the department to investigate the use of an index of spawn from observations of milt.

The two indices considered for spawn documented from aerial surveys were 1) discrete miles of milt over the season and 2) the sum of miles of milt for all survey days (mile-days of milt). The advantages of milt observations compared to school biomass observations are 1) herring schools likely spawn a single time (day?), but a herring school may be observed for many days prior to, or after spawning, 2) milt is relatively easy to observe from the air on beaches and observation efficiency is generally not influenced by ocean bathymetry (Brady 1987).
Discrete miles of milt do not account for multiple spawning events in the same area, so are unlikely to be a good index of total abundance in areas with multiple spawning event days on the same beach (Brady 1987). Mile-days of milt likely provide a better index to abundance as they account for multiple spawning events on the same beach, but maybe biased if the number of surveys vary significantly across years (Funk 1994). Additionally, although bathymetry will likely not influence observation of spawn, it will influence the biomass of spawning fish for each linear mile of milt observed. Willette et al. (1998) collected paired spawn deposition survey estimates and aerial survey estimates of miles of milt, and the short tons per mile of milt were much larger on Montague Island as compared to tons per mile of milt in northern or northeastern PWS.

Funk (1994) used the discrete miles of milt index rather than the mile-days of milt index because there were few surveys flown in the early years (1970s) of the data set for the model. However, subsequent runs of the model have excluded the earlier years so allow use of the mile-days of mile index.

In 2008 the department began using a Tablet computer and GIS application to collect aerial survey data (Bochenek 2010). Because digital maps are scalable and allow much more data to be added to a small area (as opposed to paper maps), and because of interest in herring predators, additional effort has been placed on documenting numbers and locations of sea lions, humpback whales, Orca whales, Dall porpoises, and bird aggregations associated with herring schools or spawn.

Age, sex, and size data from Pacific herring have been collected from commercial fisheries and fishery independent research projects since the early 1970s. The department currently has an archive containing approximately 210,000 scales and paired size data with most of the archive collected since 1979. Summaries of many of these data have been published (e.g., Sandone 1987, Funk and Sandone 1990, Willette et al. 1998). Processing methods are similar those described by Baker et al. (1991); however, an electronic fish measuring board is used to enter all sample data and sex and size data at the time of processing.

Both the aerial survey and ASL data sets are essential parts of the current ASA model the Alaska Department of Fish and Game (ADF&G) uses to estimate the historical biomass and project pre-fishery run biomass a year ahead for management. The formulation of the current ASA model used by ADF&G is described in Hulson et al. 2008. Additionally, the mile-days of milt and ASL data are part of the Bayesian formulation of the ASA model (Muridan 2015), and the scales collected from this archive were used in a project titled “PWS Herring Program - Scales as growth history records.”

This project will conduct aerial surveys to collect data related to spring herring spawning events and process herring for age, sex, and size data. The overall goal of the aerial survey and ASL processing is to collect data consistent with the long-term existing data sets used in the Alaska Department of Fish and Game’s ASA model and Bayesian formulation of the ASA model.

Literature cited – Includes citations for the remainder of the document.

Baker, T.T., J.A. Wilcock, and B.W. McCracken. 1991. Stock assessment and management of Pacific herring in Prince William Sound, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries. Technical Fisheries Data Report No. 91-22, Juneau.

Biggs, E. D. and F. Funk. 1988. Pacific herring spawning ground surveys for Prince William Sound, 1988, with historic overview. Regional Information Report No. 2C88-07. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Brady, J.A. 1987. Distribution, timing, and relative biomass indices for Pacific Herring as determined by aerial surveys in Prince William Sound 1978 to 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Prince William Sound Data Report 87-14, Anchorage.

Brannian, L.K. 1988. Precision of age determination and the effect of estimates of abundance and mortality among Pacific herring. Regional Information Report No. 2A88-11. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Bochenek, R.J. 2010. PWS herring data portal, Exxon Valdez Oil Spill Restoration Project Final Report (Restoration Project 090822), Axiom Consulting & Design, Anchorage, Alaska.

Funk, F. 1994. Forecast of the Pacific herring biomass in Prince William Sound, Alaska, 1993. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J94-04, Juneau.

Funk F., and G. Sandone. 1990. Catch-age analysis of Prince William Sound, Alaska, herring, 1973-1988. Fishery Research Bulletin No. 90-01, Juneau.

Hulson, Peter-John F., S. E. Miller, T. J. Quinn, G. D. Marty, S. D. Moffitt, and F. Funk. 2008. Data conflicts in fishery models:incorporating hydroacoutic data into the Prince William Sound Pacific herring assessment model. – ICES Journal of Marine Science, 65: 25–43.

Lebida, R.C. and D.C. Whitmore. 1985. Bering Sea herring aerial survey manual. Bristol Bay Data Report, No. 85-02. Alaska Department of Fish and Game, Divison of Commercial Fisheries, Anchorage, Alaska.

Muridan, Melissa. 2015. Modeling the Population Dynamics of Herring in the Prince William Sound, Alaska. Master of Science thesis, University of Washington.

Pirtle, R. B., P. J. Fridgen, K. Roberson, and J. Bailey. 1973. Annual Management Report, 1972–1973. Alaska Department of Fish and Game, Division of Commercial Fisheries, Cordova.

Sandone, G. J. 1988. Prince William Sound 1988 herring biomass projection. Regional Information Report No. 2A88-05. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Thompson, S.K. 1992. Sampling. John Wiley & Sons, Inc., New York.

Willette, T.M., G.S. Carpenter, K. Hyer, and J.A. Wilcock. 1999. Herring natal habitats, *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 97166), Alaska Department of Fish and Game, Division of Commercial Fisheries, Cordova, Alaska.

II. COORDINATION AND COLLABORATION

1. Within the Program

1) *PWS Herring Program – Validation of Acoustics Surveys for Pacific Herring using direct capture.*
   This proposed project will process adult samples collected by the currently funded project

2) *PWS Herring Program –Data Management Support.*
   This proposed project will provide additional herring aerial survey and herring age data for use by other PWS Herring Program projects. Past funding and ADF&G funding has allowed us to provide aerial survey GIS data files for linear extent of spawn (1973–2015), survey routes (1997–2015), sea lion distribution and abundance (2008–2015), other marine mammals distribution and abundance (2008–2015), and bird aggregations (2008–2015).

3) *PWS Herring Program – Expanded adult herring surveys.*
   This proposed project (aerial surveys) will provide additional location information for herring aggregations to be surveyed and has provided similar information in past years.

4) *PWS Herring Program – Outreach and Education.*
   This proposed project will assist public outreach through public presentations of methods and results.

5) *PWS Herring Program – Herring Disease Program (HDP)*
   This proposed project will help locate adult herring for disease sampling and has in past years.

6) *PWS Herring Program – Genetic Stock Structure*
   This proposed project will process additional samples (collect paired age, sex, and size data and collect tissues for genetics analysis) for the genetic stock structure program. This project as funded by ADF&G has collected and processed multiple samples for this program in the past. Additionally, NOAA staff (Sharon Wildes and Jackie Whittle) helped us process fish in Cordova in June 2015 for paired age, sex, size, and genetics tissue.

7) *PWS Herring Program – Modeling the population dynamics of PWS herring*
   This proposed project will provide mile-days of milt and age, sex, and size data to update the time series of data required for the Bayesian population dynamics model.

LTM Program – Long-term monitoring of humpback whale predation on Pacific herring in Prince William Sound.
This proposed project (aerial survey portion) will share information on location and abundance of humpback whales and herring with the LTM project. Additionally, this project has shared information relevant to this proposed project in the past.

2. With Other Council-funded Projects
None

3. With Trustee or Management Agencies

This work is to be conducted by a trustee agency and collaborations with other trustees are provided in the section on collaborations within programs.

III. PROJECT DESIGN
A. Objectives

These data will be collected to meet the overall goal of providing necessary inputs to the age structured assessment models of ADF&G and the *PWS Herring Program – Modeling the population dynamics of PWS herring.* There are no proposed hypotheses to be tested directly from this project.

The objectives of the project are as follows:

1.) Conduct spring aerial surveys and collect data on the survey route, location and linear extent of herring milt, classification of herring milt, herring school biomass, sea lion distribution and abundance, other marine mammal distribution and abundance, and distribution and abundance of bird aggregations associated with herring or herring spawn, and other relevant comments.
2.) Process, summarize, and distribute age, sex, and size data from herring collected during ADF&G acoustics surveys, ADF&G spawning grounds surveys, *PWS Herring Program* disease surveys, *PWS Herring Program* genetics collections, or other relevant collections.

B. Procedural and Scientific Methods

Objective 1: Aerial surveys

Methods

Aerial survey methods are similar to those described in Brady (1987) and Lebida and Whitmore (1985), but with many updates. Surveys will be conducted in a fixed-wing aircraft flying at a standard elevation of ~1,200 ft., if possible. Two observers will be used if possible for each flight. The primary observer sits in the back seat and uses a Tablet computer with a spreadsheet to enter survey metadata and an ESRI ArcPad application and blue tooth GPS to collect georeferenced data electronically (Bochenek 2010). The primary observer will also set up a GoPro camera on the back window (inside) to collect either video or a still image every 1 or 2 seconds (either appears to work…images are higher quality, but take more processing time to create a time lapse movie). The primary observer will use a sighting tube to calibrate the surface area for a few schools at the beginning of each survey, but it usually is not possible to use it on each herring school observation.

The secondary observer sits in the front passenger seat and reports observations to the primary observer, collects observations on paper maps, sets up a handheld Garmin GPS to use as a location backup, and takes photos with a DSLR and fast lens (F2.8) of spawning events, large biomass aggregations, and large sea lion groups. Photos are georeferenced to the GPS track using software to match up the time-date stamps. This requires a photo of the GPS with the Date and time on the GPS screen. During large spawning events, several passes are necessary to collect all the data.

After each survey, data are transferred from the tablet to our network for processing with ESRI ArcMap. The handheld GPS is downloaded with DNRGarmin software, videos or images are downloaded from the GoPro camera, and DSLR images are georeferenced with the GPS data. At the end of the survey season, the spawn locations and lengths are adjusted by comparing to the GoPro imagery. The wide angle format that makes the imagery so useful for documenting milt locations makes the imagery much less useful for school observations or sea lion pod counts.

Measurements

Measurements made during the survey include 1) estimating the linear extent of milt, 2) estimating the surface area and subsequent biomass of herring, 3) estimating the count of sea lions in a large pod, and 4) estimating the count of birds at a location.

Estimates of the linear extent of spawn placed on the tablet computer are probably ± 20% (although we haven't tested this). I think our estimates that are adjusted with imagery are probably ±10%. Biggs and Funk (1988) found that skiff measurements of spawn were often larger than the aerial estimates of milt, but they attributed this to additional spawn after the survey or multiple days between surveys (citation below).

Our estimates of individual herring school biomass in short tons are likely at ±50%. Biomass is estimated in the field from a surface area to short tons conversion based on a limited number of observations that were captured by seine vessels. A sighting tube described in Lebida and Whitmore (1985; Appendix III) is used to calibrate the primary observer on a few schools at the beginning of each survey. However, it's very difficult to use the sighting tube from a plane and larger schools fill the field of view. Also the depth of schools is difficult to estimate from plane. Photos from known focal length, elevation, and angle may be used to check surface areas after the survey; however, we have not attempted this check as yet. There have been very few tests of observer estimates by seining the school after an aerial estimate (Lebida and Whitmore, 1985; ADF&G unpublished). I have less confidence in our ability to estimate the school size in short tons than the linear extent of milt along a beach.

Estimates of sea lion pod counts are likely ±5% if the pod is <50 animals. An examination of observer counts from a few large pods indicated most were underestimated by 100%, i.e., photo counts of pods of 150 were estimated on the survey at 75 animals. However, these data are currently not used in our herring assessment, so all counts in our GIS files are survey estimates.

Estimates of whales are likely ±100% or more given the dive times of most whales. Our estimates of harbor seals at haul outs are most likely ±30% although there are a few locations with groups of ~100 individuals and the estimates are probably larger. We do have some photos and estimates to examine, but once again these are not part of our herring assessment so all counts in our GIS files are survey estimates.

Given the size of many of the bird aggregations (gulls mostly), the uncertainty in our survey estimates is likely ±100% or more. Similar to sea lions and harbor seals, we have photos and survey estimates for comparison, but it is not a priority at this point.

We have also considered using a helicopter for surveys because a steadier platform would make many of the observations much easier; however, there is no helicopter service in Cordova and the cost for chartering a helicopter out of Valdez or Girdwood would be too high.

Age, sex, and size processing

These methods are outlined in Baker et al. (1991) with only a few changes. Samples are randomly collected and stratified by area, time, and gear. Sample sizes (n=450) are set to estimate the age composition of each sample to within ±5% of the true proportion 90% of the time (Thompson 1992) assuming no more than 10% of the scales are unreadable. Samples are collected in the field and frozen in large 6 mm plastic bags with labels inside the bag that document the date, time, location, gear, samplers, and the number of bags. Other information including the approximate coordinates of the sample location are collected and added to a sample log. Often more than 450 fish are collected, so an equal number of fish are randomly selected from each bag for processing to meet the sample goal. From the fish selected for processing, 10 fish are place on a tray and their length measured to the nearest mm (standard length, tip of snout to hypural plate), whole weight to the nearest gram collected from an electronic balance, sex determined from examination of the gonads (1=male, 2=female, 3= unknown), and gonad condition estimated from examination of the gonad (scale of 1, undeveloped, to 8, recovering from spawning). All these data are collected directly into an electronic fish measuring board. The precision of length measurements collected on the electronic fish measuring board have been tested and are within ±1mm. Weights are collected with an electronic balance that is checked with calibration weights (and recalibrated if necessary) prior to each sampling event.

A scale is then collected from the left side of the fish from a preferred area if possible. The preferred area is above the lateral line and 3-4 rows of scales back from the operculum. This area generally has symmetrical growth patterns and distinct annuli. Scales are cleaned and placed on a pre-labeled glass microscope slide after dipping in a solution of 1:10 mucilage glue to water. A single scale from each of 10 fish is placed as two rows of 5 scales on each slide. Scales are viewed on a microfiche to ensure they are readable for age (not regenerated) and useable for measuring growth increments. If they are not useable to interpret age or measure growth increments, another scale is collected and examined. After all scales are checked they are covered with a second slide and taped together at the label end of the slide. All slides are stored in a labeled box or cabinet tray until examining for age.

Once a sample is complete, data are downloaded from electronic fish measuring board into an MS Excel spreadsheet. The scales are examined for age interpretation on a microfiche by 2 or 3 readers. Ages are interpreted independently and then the committee discusses any differences before agreeing on an age by consensus. The crew leader spot checks all samples to reduce the chance of reader drift in age interpretation.

C. Data Analysis and Statistical Methods

Aerial survey estimates of linear extent of Pacific herring milt, herring school biomass, sea lion counts, other marine mammal counts, and sea bird counts are saved directly in GIS shape files and an MS Excel spreadsheet is used to capture survey metadata. Once a survey is complete, shape files, the Excel metadata log file, GPS route files, GoPro video/image files, and DSLR photos are copied to the ADF&G Cordova file server. Survey metadata are entered into a yearly log file, and shape files, GPS route files, photos and videos are saved into an aerial survey subdirectory by survey date. Shape file data are plotted in ArcMap and attribute tables are examined for errors and adjusted as necessary.

After all surveys are complete, copies of the GIS miles of milt files will be compared to GoPro video or still images and the location and classification of milt will be adjusted if necessary. This is the highest priority as these data are used to tune the ASA model. If possible, biomass, sea lion counts and bird estimates will be compared against available georeferenced images.

After adjustments are complete, the individual survey GIS data will be combined into shape files for the year and then added to the historical GIS shape files. These historical shape files will allow comparison across all years for milt observations (1973–2015), survey routes (1997–2015), sea lion location and abundance (currently 2008–2015), other marine mammals (currently 2008–2015), and birds (currently 2008–2015). These data could be compared to other areas if they have similar data sets.

The ability to detect a change in mile-days of milt among years depends on the frequency of surveys and the completeness of the survey coverage. Similar to most years since 1973, this project will begin surveys in mid to late March on the east side of PWS to examine fish and sea lion distribution and fly daily surveys once spawning begins in the areas with significant fish and sea lion counts. Surveys will be extended to the Kayak Island area next and then the Montague Island area. Additionally, pilot reports of herring or spawn from other areas will be considered in flight route planning.

Size and sex data are collected directly into an electronic fish measuring board. At the completion of a sampling event, data are downloaded from the fish measuring board to the ADF&G Cordova file server. Data are reformatted into an Excel spreadsheet using a VBA application. Age is interpreted from scales and keyed into the Excel spreadsheet. A VBA application is used to generate age, sex, and size composition summaries that include sample size and percentage by age class and sex, mean and standard deviation by age class and sex for weight and standard length. Currently, historical data (1973–present) are summarized in an Excel spreadsheet; however, data are in the process of being organized for inclusion in a database that could be used by other herring research efforts.

Detecting a change in the sex, age, or size composition among areas will depend on sample collection; however, collections have exceeded 1,000 fish per year since 1981 with a median of 5,300 fish (1982–2014). Age interpretations have been compared across areas in past, e.g., Brannian 1988).

D. Description of Study Area

The study will include all of Prince William Sound and Copper River/Bering River coastal areas between Cape Suckling to the east and Cape Puget to the west. The bounding coordinates are 61.300 N, -144.00 W and 59.750 N, -148.760 W.

IV. SCHEDULE

A. Project Milestones

Objective 1.

Complete all aerial surveys of spring herring assessment

To be met by June 2016

Summarize, edit, and combine all spring 2016 aerial survey shape files into yearly totals.

To be met by August 2016

Objective 2.

Finish processing all herring samples for age, sex, and size
To be met by July 2016

Distribute final age data and summaries.
To be met by July 2016

B. Measurable Project Tasks

FY 16, 1st quarter (February 1, 2016 - April 31, 2016)
March: *Start Aerial surveys*
April: *Continue Aerial surveys*
April: *Start herring ASL sample processing*

FY 16, 2nd quarter (May 1, 2016-July 30, 2016)
May: *Continue aerial surveys*
May: *Continue herring ASL sample processing*
June: *Finish herring ASL sample processing*
June: *Quality control work on ASL data*
June: *Finish ASL analysis and distribute ASL sample summaries*
July: *Quality control and editing of aerial shape files.*
FY 16, 3rd quarter (August 1, 2016 – October 31, 2016)
August: *Finish analysis of aerial survey data.*
August: *Combine aerial survey shape files into historical version.*

FY 16, 4th quarter (November 1, 2016- January 31, 2016)
January: *Write summary reports.*

V. PROJECT PERSONNEL

Steven D. Moffitt

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Work: (907) 424-3212
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steve.moffitt@alaska.gov

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. Supervises two 11-month seasonal Fishery Biologist I's. Current supervisor: Dr. Jack Erickson, 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

<u>Education:</u>

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

<u>Selected Publications:</u>

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.

Brenner, R.E., S.D. Moffitt, and W.S. Grant. 2012. Straying of hatchery salmon in Prince William Sound, Alaska. Environmental Biology of Fishes. Vol. 94:179–195.

Jasper J.R., Habicht C., Moffitt S., Brenner R., Marsh J., et al. 2013. Source-Sink Estimates of Genetic Introgression Show Influence of Hatchery Strays on Wild Chum Salmon Populations in Prince William Sound, Alaska. PLoS ONE 8(12): e81916. doi:10.1371/journal.pone.0081916

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.

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.

Moffitt, S.D., R.E. Brenner, J.W. Erickson, M.J. Evenson, R.A. Clark, and T.R. McKinley. 2014. Escapement goal review of Copper and Bering rivers, and Prince William Sound Pacific salmon stocks, 2014. Alaska Department of Fish and Game, Fishery Manuscript No. 14–05, Anchorage.

Recent collaborators:

Paul Hershberger – U.S. Geological Survey, Marrowstone Marine Laboratory
Peter-John Hulson – University of Alaska Fairbanks
Dr. Gary Marty – University of California Davis
Melissa Muradian – University of Washington
Scott Pegau – Oil Spill Recovery Institute and Prince William Sound Science Center
Dr. Terry Quinn – University of Alaska Fairbanks

VI. BUDGET

A. Budget Spreadsheet (Detailed budget Attached)

Budget Category:	Proposed FY 12	Proposed FY 13	Proposed FY 14	Proposed FY 15	Proposed FY 16	TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	$0.0	$0.0	$0.0	$0.0	$19,533.87	$19,533.87	
Travel	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
Contractual	$0.0	$0.0	$0.0	$0.0	$35,512.00	$35,512.00	
Commodities	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	
SUBTOTAL	$0.0	$0.0	$0.0	$0.0	$55,045.87	$55,045.87	
General Administration (9% of	$0.0	$0.0	$0.0	$0.0	$4,954.13	$4,954.13	N/A
PROJECT TOTAL	$0.0	$0.0	$0.0	$0.0	$60,000.00	$60,000.00	
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.00	$0.00	

B. Sources of Additional Funding

A additional month of Fisheries Biologist I time ($7,587.48 from Fish and Game funds) will be spent on quality control and summarization of herring aerial survey data. This will include editing spawn lengths based on video or still images, checking attribute files for errors, and combining shape files into historical shape files.

R/V Solstice boat time (10 days at $4,125 per day or $41,250), State of Alaska General Funds) and permanent personnel (FB III for 10 days of Sea Duty, $4,400) will be used to collect samples processed by this project.