EVOS ANNUAL PROGRESS REPORT

Project Number: PJ090804

Project Title: SIGNFICANCE OF WHALE PREDATION ON NATURAL MORTALITY RATE OF PACIFIC HERRING IN PRINCE WILLIAM SOUND.

PI Name: Dr. Stanley Rice
(Co-PIs Moran, Heintz, Straley, and Quinn)

Time Period Covered by Report: September 1, 2008 - September 1, 2009.

Date of Report: September 1, 2009.

1. **Work Performed:**

Field Component

During the current reporting period we increased our effort in PWS to five ship-based surveys (September 2008, October 2008, December 2008, January 2009, and March 2009), five days in duration, aboard the 17.7m M/V Auklet. As found during the three ship-based surveys during the fall of 2007 and winter of 2008, Pacific herring are the primary prey species for humpback whales during the fall and winter months in PWS. Five surveys greatly increased the confidence in modeling the number of predators and the calculation of whale days of predation on herring in the winter.

Counts of whales will provide a rough index of whale abundance, until our mark-recapture models, based upon sightings of individuals from photo-identification, are finalized. During the 2008/2009 field season, counts of whales from five surveys across PWS changed our perception of whale movements and trends from our 2007/2008 surveys. The notable changes found in 2008/2009 are the findings that 1) humpback whale movements into Sawmill Bay do not reflect the trends observed in PWS as a whole and 2) more whales are present for a longer time in PWS.

Previously we reported a peak in whale abundance occurred during December, based upon three surveys across PWS and observations from Sawmill Bay. During our 2008/2009 PWS-wide surveys we counted 67 whales in September and 112 whales in October; numbers decreased on subsequent surveys with 53, 51 and eight whales counted in December, January and March, respectively. The October peak contrasts sharply with 2007/2008 peak December counts from the vessel surveys combined with the Sawmill Bay counts. We believe the 2008/2009 counts were not an anomaly because the increase in whale numbers was the result of surveying areas not surveyed the year before. These areas included Montague Strait, where a large shoal of whales were observed feeding on herring (this area was not surveyed the previous year due to high seas) and Port Gravina, where whales were consistently found feeding on overwintering herring from October to March. Clearly, as a result of increasing our effort and broadening our survey areas we were able to track

movements of whales into PWS following an apparent pre-winter herring aggregation in Montague Strait to Port Gravina, where a substantial biomass of herring overwinter. The presence of whales in Sawmill Bay occurred later in the season, moving into the bay in November following herring as well, as the fall and winter progressed, but the herring never formed a deep overwintering layer as found in Port Gravina. Therefore the presence of whales and herring in Sawmill Bay was shorter duration than found elsewhere in PWS.

At least two implications arise from these findings. First, a higher number of whales are present in PWS during the early fall than previously thought, with a peak in October. As whales begin their southbound migration to the breeding areas in subtropical waters during the late fall and early winter, whale numbers slowly decline until early February. These movements and trends are similar to fall and winter whale observations found in Sitka Sound and Lynn Canal, southeastern Alaska. Second, the presence of more whales in PWS, in particular from September through January, increases the amount of time and number of whales feeding in PWS upon herring during the fall and winter months. The observations from increased survey effort during the 2008 and 2009 field season reinforced and broadened our understanding of the impact of predation upon herring by humpback whales in PWS. However, which herring age class (pre-recruit juveniles or adults) is targeted by this predation is unknown.

Monthly small boat surveys continued in Sitka Sound and Lynn Canal provided comparison to PWS. Our preliminary winter assessment of the three regions suggest that whale numbers were higher in PWS, whales are staying later into winter (similar to Sitka but different than Lynn Canal), and are targeting primarily herring as prey, thus, having a greater impact on herring than in Sitka Sound or Lynn Canal.

Data processing and mark-recapture analysis of PWS field data
Data processing and error checking the data from the Fall 2007 field season was completed. Modeling the seasonal abundance of whales involved two components: estimation of total whale abundance and approximating the seasonal distribution. Estimation of total whale abundance was accomplished by using the Petersen mark-recapture method, using visual identification of whale flukes as the natural mark. This resulted in an estimate of about 160 whales, similar to the number of unique whales identified (127). Results from the first year were highly uncertain (CV = 24%) The seasonal distribution was approximated by a quadratic function fitted to counts of whales during the three fall-winter surveys in order to calculate whale consumption daily for greater accuracy. Data processing and error checking the data from the Fall 2008 season commenced and is almost completed. Because the mark-recapture and seasonal distribution were so uncertain, we submitted a proposal in FY09 for the second year of field data.

Data collection, processing, and time series of historical humpback whale data in PWS

We began efforts for data acquisition. More than 30 years of data are available from the non-profit research group Eye of the Whale (since 1978) whose primary researcher is Olga von Ziegesar. We set up a cooperative working relationship with her. We found that although the quality of the data were excellent because of the extensive photo identifications, that there had not been work to provide summaries of the mark-recapture and searching effort necessary to undertake the analysis. Therefore we started obtaining of the raw data found in notebooks and field manuals. We have realized that to do a proper job of database construction and analysis, that an additional year of data acquisition and analysis is necessary. We submitted a proposal to the FY2010 EVOSTC Request for Proposals and have included a second year (FY11) for report writing and preparation of publications as specified in the RFP.

The PWS Herring population modeling in PWS
Working with former PI Gary Marty of the University of California Davis, we updated the herring model with data through 2006. We attempted to publish a paper in Science based on this update, but they declined to consider it. We reformatted the paper for Diseases of Aquatic Organisms and resubmitted. Based on the reviews, the editor asked for a revised manuscript that addressed the issues raised. We have almost completed the revision and are optimistic that it will be accepted.

2. **Future Work:**
Data processing and mark-recapture analysis of PWS field data
For the mark-recapture portion of the analysis, we will be using the state-of-the-art platform for assessment of such data, program MARK. This program will allows us to create several competing models and will produce detailed estimation outputs for model comparison. Basic models will be compared to other, more complex models that (1) allow for varied capture probabilities with time (this represents a difference in sightability, conditions, etc), (2) magnitude of survey effort (both in nautical miles and hours, introduced as a covariate) and (3) misidentification (an issue inherent in identification by natural markings). Models will be compared using Akaike's information criterion (AIC). The Specific models that will be used are a closed capture Huggins models for this analysis. Also, we will be considering photo quality, a factor that can potentially affect the analysis. Results from models run with the abbreviated set of photo data will be compared to model results run using all available photo data, regardless of quality. This will allow us to contrast and evaluate the potential impact poor quality photos have on this analysis.

Data collection, processing, and time series of historical humpback whale data in PWS
If funded, photo identification and associated effort data acquired from Eye of the Whale/North Gulf Oceanic Society will be thoroughly error checked and compiled into a queryable database. This step is expected to be completed during the first part of FY10. From this database, we will then develop two whale time series. The first is based on whale counts per unit effort. The second utilizes mark-recapture theory (Seber 1982). Further details are found in our FY10 proposal.

The PWS Herring population modeling in PWS
We expect to return to the PWS model in FY10 after the whale time series have been constructed. The whale abundance estimates do produce estimates of consumption for the winters of 2007 and 2008. But there is no straightforward way to place these in the model without consumption estimates for all other years. That is why the construction of the historical whale series is so important.

NOT projected to be funded, but a necessary piece of information is the whale predation on juvenile herring. Targeted predation on herring is much greater than presumed prior to the start of these studies, and has a large impact on the standing biomass of the herring. What is not known from these studies is the significance of targeted predation on juvenile herring when massing at the end of summer and early fall, prior to recruitment into the adult schools. This information void is critical. While herring are preyed upon by many species, the targeted consumption by whales will likely be the most dominant predation force. With increasing numbers of whales for the last 50 years, the significance on juvenile life stages needs study.

3. **Coordination/Collaboration:** This project has many collaborators, in the form of data exchanges as well as the sharing of logistics. Prince William Sound Science Center seabird observers were present during all ship-based surveys in PWS (EVOS Project 090814). Craig Matkin (EVOS Project 090742) was onboard during our March survey in PWS. Killer whale photographs and vocalizations were collected during all surveys in support of 090742. Herring samples and chemistry were combined with data collected from EVOS Project 090806. Herring biomass data from PWS was obtained through the ADF&G in Cordova. Whale observations from this project will be included in an updated humpback whale identification catalog authored by Olga von Ziegesar. Whale observations from Southeast Alaska are entered in to a collaborative data base with the University of Alaska Southeast and the National Park Service. Kevin Boswell (Louisiana State University) is collaborating with this project to develop new technique for assessing herring biomass. Four Seasons Marine and Whale Trust are providing whale counts from Lynn Canal.

4. **Community Involvement/TEK & Resource Management Applications:**
Kate and Andy McLaughlin (Chenega Bay, AK) were contracted to report on humpback whale abundance and activity in the waters around Sawmill Bay. Olga von Ziegesar (Eyeof the Whale, Homer, AK) was contracted to provide a summary of her humpback whale observations from PWS.

This project assisted in the mentoring young women scientists (Heather Riley, Suzie Teerlink, Alison Stimpert, Ellen Chenoweth, Lauren Wild, Gwen Miller and Christina Mounce).

<u>Outreach concerning whale-herring interactions:</u>
Ron Heintz

Lecture to University of Alaska Southeast students in Juneau, AK.
Special Seminar at the Auke Bay Laboratories in Juneau, AK.

John Moran
Two public lectures "Juneau's Winter Whales" in Juneau, AK.
Public Lecture "Prince William Sound's Winter Whales" Cordova, AK.
Radio interview KTOO, Juneau, AK.
Naturalist Training at the Auke Bay Laboratories in Juneau, AK.
Article in Delta Sound Connections, Summer 2009" Humpback Whales Stay Longer in Winter"
Video for the Auke Bay Laboratories Featured Research program "Humpback Whale Biopsy".

Stanley Rice
Public lecture, EVOS 20th Anniversary in Anchorage, AK (for the EVOS office).
Public lecture, EVOS 20th Anniversary in Anchorage, AK (Forum on the environment; and organized the effort).
Public lecture, EVOS 20th Anniversary in Kodiak, AK.
Public lecture, EVOS 20th Anniversary in Juneaue, AK.
Public lecture, EVOS 20th Anniversary in Bergen Norway
Invited Lecture, EVOS after 20 years, Environmental Law, Minneapolis.
Invited Lecture, Long term effects of EVOS, Univ. Alaska SE, Juneau.
Invited Lecture, Long Term Effects of EVOS, Alaska Science Center, Seattle.
Drafted long term effects for the 20 year EVOS publication.
Invited Lecture, Long Term EVOS effects at Univ. of Texas, Corpus Christi
Invited Lecture, Long Term EVOS effects at Louisiana State Univeristy, Baton Rouge.

Janice Straley
Public lecture in Petersburg, AK "Weaving through the food web with whales and fish."
Naturalist training in Sitka, AK.

Suzie Teerlink
Public lecture "Photographic Identification of Humpback Whales in Alaska" in Juneau, AK.
Naturalist Training at the Auke Bay Laboratories in Juneau, AK.

Resource Management Applications - Information collected during this study was considered by the Biological Review Team when evaluating the petition to list Lynn Canal herring under the Endangered Species Act and by the Department of Fisheries and Oceans Canada humpback whale recovery strategy team.

5. **Information Transfer:**
Presentations

Stanley Rice organized a workshop on Prince William Sound herring for the 20th anniversary year since the Oil Spill at the 2009 Forum on the Environment. In Anchorage. Several talks were included. (Rice, Short, Bodkin, Heintz, and Matkin)

The long term effects of EVOS for the 20 year report was drafted by Rice.

Peter-John F. Hulson, Terrance J. Quinn II, Brenda L. Norcross, and Gary D. Marty. Empirical comparison of historical data and age-structured assessment (ASA) models for Prince William Sound (PWS) and Sitka Sound Pacific herring.

Gary D. Marty, Peter-John F. Hulson, Sara E. Miller, Terrance J. Quinn II (presenter), Steve D. Moffitt, and Richard A. Merizon. Failure of Population Recovery in Relation to Disease for Pacific Herring in Prince William Sound.

John R. Moran, Stanley D. Rice, Ron A. Heintz, Janice M. Straley, and Terrance J. Quinn. Humpback Whales Exert Top-Down Control on Prince William Sound Herring.

Janice M. Straley. Year Round Presence of Humpback Whales in Alaskan Waters and the Impact upon Pacific Herring.

(Poster) Lawrence E. Schaufler, Gwen Miller, John R. Moran, and Janice Straley. Characterization of humpback whale (Megaptera novaeangliae) diets using fatty acid markers.

Other Presentations:

Featured keynote speaker at Salmon Ocean Ecology Meeting 2009 in Juneau, AK. Jan Straley. "Weaving through the food web with whales and fish".

DFO humpback whale recovery strategy meeting in Nanaimo, B.C. Stanley Rice. "Humpback whale predation on Pacific herring in Prince William Sound, southern Lynn Canal, and Sitka Sound, Alaska".

DFO humpback whale recovery strategy meeting in Nanaimo, B.C. Janice Straley. "Humpback whale predation on Pacific herring in Prince William Sound, southern Lynn Canal, and Sitka Sound, Alaska".

Publications:

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

6. **Budget:** Contractual costs were reduced by sharing ship time with other EVOSTC and NOAA projects. Commodity costs were inflated due to unforeseen cost with associated with the chemical processing of samples. Much of the contract funds supported the work by PI's Straley and Quinn. Not included in the numbers below were the matching funds for some ship time and labor for Seymour and Lynn Canal, and Sitka Sound (excess of 200K).

Category	Authorized	Actual	Difference
Personnel	$22.8 K	$22.2 K	$0.6 K
Travel	$10.2 K	$6.0 K	$4.2 K
Contractual	$290.2 K	$277.4 K	$12.8.0 K
Commodities	$13.0 K	$30.0 K	$-17.0 K

Total Difference = $0.6 K

Signature of PI: Stanley D Rice 30 Aug 09

Project Web Site Address: