

**Forecasting Southeast Alaska pink salmon harvest from juvenile salmon data:  
extension of models**

**Final Report  
September 27, 2013**

**Pacific Salmon Commission  
Northern Fund Project NF-2012-I-1**

**PERIOD COVERED: May 1, 2012 to March 31, 2014**

**PERIOD FUNDED: May 1, 2012 to March 31, 2014**

**TOTAL PSC FUNDS AWARDED: \$49,760**

**PSC FUNDS RECEIVED: \$44,784**

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The Southeast Coastal Monitoring (SECM) project is operated by the NOAA Auke Bay Laboratories and has sampled juvenile salmon and associated biophysical parameters in the marine waters of the northern region of Southeast Alaska (SEAK) since 1997. This research has been accomplished using chartered trawl vessels in the years since decommissioning the NOAA Ship *John N. Cobb*. Juvenile salmon are sampled along a seaward migration corridor en route to the Gulf of Alaska after freshwater and early marine periods of high mortality. The SECM annual marine sampling provides information on juvenile year-class strength that can be used with associated biophysical data to develop forecast models that predict adult pink salmon harvest the following year. Since 2004, in eight of nine years, the accuracy of the SECM forecasts has deviated by an average of 7% from the actual harvests (range 0-17% deviation; Wertheimer et al. 2013). However, in 2006, the pink salmon harvest was well below both the SECM forecast based on juvenile salmon abundance and the Alaska Department of Fish and Game (ADF&G) forecast based on a time series of previous pink salmon harvests. Despite this overestimate, the 2006 SECM forecast did accurately identify a downward trend in pink salmon harvest. Moreover, the ADF&G is now incorporating the SECM juvenile data into their annual harvest time series forecast.

The Northern Fund (NF) has provided support to the SECM project to continue biophysical sampling and to improve the forecast modeling. The project was identified under the type, “Development of improved information for resource management, including stock assessment; data acquisition & scientific understanding of limiting factors,” and covered the period from May 1, 2012 to March 31, 2014. Specifically, the project addresses the persistent problems of developing reliable forecast methodologies for pink salmon fisheries, and improving knowledge of factors that limit ocean survival. This NF final report includes data summaries from the 2012 sampling season (Orsi et al. 2013a) and an evaluation of the 2012 forecast and the model development for the 2013 forecast (Wertheimer et al. 2013).

Sampling in 2012 was successfully completed utilizing the research vessel R/V *Sashin* in May and the charter trawl vessel F/V *Northwest Explorer* (NWE) in June, July, and August. The NWE was assumed to be comparable to the similarly-sized and -powered charter vessel F/V *Chellissa* that was calibrated to the R/V *Medeia*, which was previously calibrated to the NOAA Ship *John N. Cobb* (Wertheimer et al. 2010). These paired comparisons permitted the computation of species-specific calibration factors which were applied to the  $\ln(\text{CPUE}+1)$  for each trawl haul of the NWE in 2012 to convert the data into “Cobb units” directly comparable to the first 15 years of the SECM time series. These calibrated NWE catches were therefore reduced proportionally, resulting in large changes in nominal CPUE at high catch levels (Wertheimer et al. 2013).

The SECM project objectives for NF-2012-I-1 were to: (1) Sample juvenile salmon and associated environmental data in the marine waters of the northern region of SEAK in May, June, July, and August of 2012, and (2) Develop a forecast model to predict the SEAK pink salmon harvest in 2013. The work completed to meet these objectives is summarized below; the documents produced from the project to date are cited where appropriate and are attached as part of this final report. The references section of this report also includes professional presentations and publications of SECM research that were partially supported by this project.

## **Objective 1.**

### **Sample juvenile salmon and associated environmental data in the marine waters of the northern region of SEAK in May, June, July, and August of 2012**

Objective 1 was fully accomplished by sampling inshore, strait, and coastal habitats in the northern region of SEAK in 2012 (Table 1). The R/V *Sashin* was used to complete oceanographic sampling in May and the *NWE* was used to complete oceanographic and fish sampling in June through August. A detailed report of sampling methods and the biophysical data collections from 2012 were presented in a North Pacific Anadromous Fish Commission (NPAFC) document (Orsi et al. 2013a) attached to this final report. An earlier NPAFC document includes a synthesis of interannual catch and biophysical trends (1997-2011) that identifies seasonal and interannual patterns of marine conditions and time series anomalies (Orsi et al. 2012a).

## **Objective 2.**

### **Develop a forecast model to predict the SEAK pink salmon harvest in 2013**

Objective 2 was fully accomplished. The 2013 forecast model was developed using the SECM time series of peak June-July catch-per-unit-effort (CPUE) of juvenile pink salmon and associated biophysical data collected from 1997-2012 (Table 2). A two-parameter model using Ln(PeakCPUE) and the Icy Strait Temperature Index (ISTI) was selected as the best model (Wertheimer et al. 2013). The 2012 forecast of 18.8 M adult pink salmon was within 7% of the actual harvest of 20.2 M ([ADF&G preliminary data, September 2012](#)). The initial forecast was presented at the SEAK Purse Seine Task Force (PSTF) meeting in Sitka on 07 December 2012. The efficacy of this 2012 forecast and the new, 2013 forecast model development are summarized in a NPAFC document attached to this final report (Wertheimer et al. 2013) and will be presented at the PSTF meeting on December 3, 2013 in Ketchikan with forecast parameter information for 2013 (funded under project NF-2012-I-1).

## **Scientific Accomplishments**

Maintaining the longterm SECM project on juvenile salmon metrics and associated marine biophysical conditions in SEAK has contributed substantially to our understanding of processes affecting salmon production. The SECM forecast has been cited as a pragmatic example of ocean research applied to fisheries management (Turner and Haidvogel 2009). The consistency of the research has fostered communications and cooperation with regional ADF&G offices, other NOAA Fisheries Centers, regional aquaculture associations, commercial fishing constituents, academia, and international salmon fisheries organizations such as NPAFC, Yeongdong Inland Fisheries Research Institute (S. Korea), National Salmon Resources Center (Hokkaido), Canada Department of Fisheries and Oceans, and Skeena Fisheries Commission (British Columbia). The SECM staff have presented numerous oral and poster reports at scientific meetings and to stakeholder groups and have published numerous scientific publications and reports. The 2012-2013 publications and presentations are included in the references section of this report and can be accessed through [http://www.afsc.noaa.gov/ABL/MSI/msi\\_secmm.htm](http://www.afsc.noaa.gov/ABL/MSI/msi_secmm.htm).

## **Budget Summary**

The NF allocated a total of \$49,760 for the SECM project. Of this amount, \$43,324 has been spent/obligated to date; an additional \$6,436 has been obligated for spending by March 31, 2014, contingent upon receipt of the 10% NF hold-back (Table 3). Detailed budget accounting is provided by line item on the attached Pacific Salmon Commission budget form (Attachment 1).

Budget expenditures for the SECM project NF-2012-I-1 by line item are: amount projected, amount spent (including projected spending through March 31, 2014), amount and percent variance, and a short explanation for variances greater than 10% (Table 3). The spending for the project was tracked by the NOAA National Marine Fisheries Service Management Analyst and Reporting System (MARS). A MARS object class summary report is included (Attachment 2).

## **Web links**

NOAA SECM website: [http://www.afsc.noaa.gov/ABL/MSI/msi\\_secm.htm](http://www.afsc.noaa.gov/ABL/MSI/msi_secm.htm)

(Updated Jan 2013)

NOAA pink salmon forecasting: [http://www.afsc.noaa.gov/ABL/MSI/msi\\_sae\\_psf.htm](http://www.afsc.noaa.gov/ABL/MSI/msi_sae_psf.htm)

(Updated Jan 2013)

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Orsi, J. A., E. A. Fergusson, M. V. Sturdevant, W. R. Heard, and E. Farley, Jr. 2012a. Annual survey of juvenile salmon, ecologically-related species, and biophysical factors in the marine waters of southeastern Alaska, May–August 2011. NPAFC Doc. 1428. 102 pp. (Available at <http://www.npafc.org>).

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- Wertheimer, A. C., J. A. Orsi, E. A. Fergusson, and M. V. Sturdevant. 2013. Forecasting pink salmon harvest in Southeast Alaska from juvenile salmon abundance and associated biophysical parameters: 2012 returns and 2013 forecast. NPAFC Doc. (Available at <http://www.npafc.org>).

### **List of Attachments**

1. Annotated Pacific Salmon Commission NF-2012-I-1 Budget Spreadsheet
2. Management Analyst and Reporting System (MARS) Summary
3. Orsi et al. 2013a - SECM 2012 sampling year summary - NPAFC Document
4. Wertheimer et al. 2013 – SECM forecasts for 2012 & 2013 - NPAFC Document

Table 1.—Numbers and types of samples collected in inshore, strait, and coastal habitats by month in the marine waters of the northern region of southeastern Alaska, May–August 2012.

Dates (days)	Vessel	Habitat	Data collection type <sup>1</sup>				Chlorophyll & nutrients
			Rope trawl	CTD cast	Oblique bongo	20-m Norpac	
22-23 May (2 days)	<i>R/V Sashin</i>	Inshore	0	1	1	1	1
		Strait	0	8	4	8	8
		Coastal	0	0	0	0	0
23-29 June (7 days)	<i>F/V Northwest Explorer</i>	Inshore	0	1	1	1	1
		Strait	28	25	4	25	8
		Coastal	4	4	4	4	4
25-31 July (7 days)	<i>F/V Northwest Explorer</i>	Inshore	0	1	1	1	1
		Strait	28	4	4	28	8
		Coastal	4	28	4	4	4
28 August- 3 September (7 days)	<i>F/V Northwest Explorer</i>	Inshore	0	1	1	1	1
		Strait	28	4	4	24	8
		Coastal	4	24	4	4	4
<b>Total</b>			<b>96</b>	<b>101</b>	<b>32</b>	<b>101</b>	<b>48</b>

<sup>1</sup>Rope trawl = 20-min hauls with Nordic 264 surface trawl 18 m wide by 24 m deep; CTD casts = to 200 m or within 10 m of the bottom; oblique bongo = 60-cm diameter frame, 505- and 333- $\mu$ m meshes, towed double obliquely down to and up from a depth of 200 m or within 20 m of the bottom; 20-m Norpac = 50-cm diameter frame, 243- $\mu$ m conical net towed vertically from 20 m; chlorophyll and nutrients are from surface seawater samples.

Table 2.—Regression models relating juvenile catch per unit effort (CPUE) of pink salmon in year  $y$  to adult harvest in Southeast Alaska (SEAK) in year  $y + 1$ , for  $y = 1997$ -2012.  $R^2$  = coefficient of determination for model;  $AIC_c$  = Akaike Information Criterion (corrected);  $P$  = statistical significance of regression equation. Adult harvest is the total for SEAK harvest (except Yakutat).

Model	Harvest area	Adjusted $R^2$	$AIC_c$	Regression $P$ - value	2012 Prediction (M)
Ln(PeakCPUE)	SEAK	85%	99.3	<0.001	47.8
Ln(PeakCPUE) + ISTI	SEAK	91%	94.6	<0.001	53.8



Table 3.—Project NF-2012-I-1 budget expenditures by line item, including amount projected, amount spent (including projected spending through March 31, 2014), the amount and percent variance (negative values are shown in parentheses), and a short explanation for variances greater than 10% of the projected spending.

Line item	Projected	Spent	Variance	% Variance	Comments
<b>Subcontractors &amp; consultants</b>					
Technician support, laboratory	\$10,500	\$19,035	(\$8,535)	(81%)	Increased lab support was utilized due to positive variance from otolith processing (see below)
Technician support, vessel	\$9,960	\$10,800	(\$840)	(8%)	
Biometric support	\$5,000	\$5,000	\$0	0%	
Otolith/water sample processing	\$10,000	\$952	9,048	90%	Other agency funding covered otolith processing for this year, positive variance applied to other line items.
<b>Total subcontractor &amp; consultants</b>	<b>\$35,460</b>	<b>\$35,787</b>	<b>(\$327)</b>	<b>(1%)</b>	
<b>Site/project costs</b>					
Travel	\$6,000	\$1,877	4,123	69%	Travel was covered by agency funding, positive variance applied to other line items.
Site supplies & materials	\$7,000	\$9,233	(\$2,233)	(32%)	Positive variance from travel was used to replace aging lab & survey equipment/supplies.
Work & safety gear	\$500	\$515	(\$15)	(3%)	
Repairs & maintenance	\$800	\$2,348	(\$1,548)	(194%)	Shipping for maintenance items was included in this line item. Transferred from positive variance above.
<b>Total site/project costs</b>	<b>\$14,300</b>	<b>\$13,973</b>	<b>\$327</b>	<b>2%</b>	
<b>Total project costs</b>	<b>\$49,760</b>	<b>\$49,760</b>	<b>\$0</b>	<b>0%</b>	