Southeast Alaska Coastal Monitoring of Epipelagic Fish and Marine Ecosystem Conditions Associated with Salmon: Continuation of a Long-term Data Series in a Changing Climate

Final Report
Nov. 16, 2018

Pacific Salmon Commission
Northern Fund Project NF-2017-I-12

PERIOD COVERED: May 1, 2017 to March 30, 2019
PERIOD FUNDED: May 1, 2017 to March 30, 2019
TOTAL PSC FUNDS AWARDED: $66,950
PSC FUNDS RECEIVED: $60,255

Co-investigators:
Andrew Gray, Jim Murphy, Jordan Watson, and Emily Fergusson
Research Fish Biologists

NOAA Fisheries,
Alaska Fisheries Science Center,
Auke Bay Laboratories
17109 Pt. Lena Loop Road
Juneau, AK 99801
andrew.gray@noaa.gov

Background

Since 1997 researchers from the NOAA, Alaska Fisheries Science Center, Auke Bay Laboratories' Southeast Coastal Monitoring (SECM) project have sampled juvenile salmon and associated biophysical parameters in the marine waters of the northern region of Southeast Alaska (SEAK) (Figure 1). Because juvenile salmon experience highly variable marine mortality during their early spring residence, fish are sampled later in the season along SECM stations strategically positioned across a primary seaward migration corridor leading into the Gulf of Alaska. This research was originally supported by the NOAA Ship *John N. Cobb*, which was decommissioned in 2008; subsequent research years have been supported by chartered commercial trawl vessels. The SECM time series provides information on salmon pre-recruit year-class strength and associated biophysical data and is used to develop forecast models of adult pink salmon harvest and an index of Chinook salmon abundance. In addition, the continuous SECM time series has provided a baseline window of biophysical metrics to view the potential impact of climate change on salmon production in marine ecosystems.

The Northern Fund (NF) has provided support to the SECM project to continue biophysical sampling in order to improve salmon forecast modeling and better understand factors in marine ecosystems that influence year class strength. The project type identified was: "Improved information for resource management, including stock assessment; data acquisition & scientific understanding of limiting factors," and covered the period from May 1, 2017 to March 30, 2019. Specifically, the project addresses the persistent problems of developing reliable forecast methodologies for pink salmon or Chinook salmon fisheries, and improving knowledge of factors that limit ocean survival.

Complete 2017 SECM information supplemental to this NF Project Final Report is covered in the following 5 attached documents:

1. Memorandum of Understanding between NOAA & the Pacific Salmon Commission. NF-2017-I-12 AKC-208.

2. Murphy, J.M., E.A. Fergusson, J.T. Watson, and A.K. Gray. 2017. Southeast Alaska coastal monitoring survey plan for 2017. NPAFC Doc. 1702. 5 pp. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, Auke Bay Laboratories, Ted Stevens Marine Research Institute (Available at http://www.npafc.org).

3. Fergusson, E., J. Watson, A. Gray, and J. Murphy. 2018. Annual survey of juvenile salmon, ecologically-related species, and biophysical factors in the marine waters of southeastern Alaska, May–August 2017. NPAFC Doc. XXXX. XX pp. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, Auke Bay Laboratories, Ted Stevens Marine Research Institute (Available at http://www.npafc.org).

4. Murphy, J. M., A. C. Wertheimer, E. Fergusson, A. Piston, S. Heinl, C. Waters, J. Watson, A. Gray. xxxx. 2018 Pink Salmon Harvest Forecast Models from Southeast Alaska Coastal Monitoring Surveys. NPAFC Doc. XXX 19 p. Auke Bay Lab., Alaska Fisheries Science Center, NOAA Fisheries. (Available at http://www.npafc.org).

5. Management Analyst and Reporting System (MARS) Summary

Objectives

The SECM project objectives for NF-2017-I-12 were to: 1) conduct May-August ocean surveys in the marine waters of the northern region of SEAK; 2) provide regional stock assessment metrics for pink and Chinook salmon; and 3) contribute ecosystem monitoring reports to better understand mechanisms related to salmon production. The work completed to meet these objectives is summarized below; documents produced from the project to date are also cited where appropriate.

Objective 1. Monthly ocean surveys in the northern region of SEAK:
a. Sample biophysical environmental metrics (May-August 2017);
b. Sample epipelagic fish including salmon (June-August 2017);

Objective 1 was fully accomplished by sampling inshore, strait, and coastal habitats in the northern region of SEAK in 2017 (Figure 1). Survey plans for the SECM sampling were developed for the 2017 SECM surveys and reported in North Pacific Anadromous Fish Commission (NPAFC) documents that are attached to this final report (Murphy et al. 2017). In 2017, the R/V Sashin was used to complete oceanographic sampling in May and September, the chartered vessel Northwest Explorer (NWE) was used to complete oceanographic and fish sampling in June and July. A draft NPAFC document of the biophysical data collections from 2017 (Fergusson et al. 2018) is attached to this final report. A total of 131 biophysical sample collections were made in 2017 (Table 1, Fergusson et al. 2018). Previous documents include syntheses of interannual catch and biophysical trends that allow comparison of the 2017 sampling year with baseline patterns of marine conditions in the time series (i.e., Orsi et al. 2012, Sturdevant et al. 2012, Fergusson et al. 2013, Orsi and Fergusson 2014).

Objective 2. Regional salmon stock assessments:
a. Develop a forecast model for SEAK pink salmon harvest for 2018;
b. Provide data for statewide status of Chinook salmon stock concerns;

Objective 2 was fully accomplished for both pink salmon and Chinook salmon assessments. The pre-season harvest forecast model for pink salmon was evaluated for the actual 2017 SEAK harvest, and the preseason forecast model for pink salmon was developed for 2018 using the SECM time series of peak June-July catch-per-unit-effort (CPUE) of juvenile pink salmon and associated biophysical data collected from 1997-2017 (Table 2). The pre-season pink salmon forecast model is attached as a draft NPAFC Document (Murphy et al. 2018). Pink salmon forecasts have been generally accurate over the past decade (Figure 2, Wertheimer et al. 2014, 2016). An oral presentation of the 2018 pre-season pink salmon harvest forecast was delivered at the Southeast Alaska Purse Seine Task Force Meeting in Sitka, Alaska in December of 2017.

Data from this project are also shared with the Alaska Department of Fish and Game (ADF&G) for their salmon forecasts.

Chinook salmon stock assessment information was available from the SECM trawl catches and reported in a draft NPAFC Document (Fergusson et al. 2018) and attached to this final report. Time was spent developing new forecast methods for regional Chinook abundance based on Chinook caught at the current SECM transects and sampling stations. It was decided that the current SECM transects and stations did not catch enough Chinook to develop a robust forecast tool. Therefore we designed a new transect near the Taku River to be tested in 2018 for increased catches of juvenile Chinook. In 2017 caudal fin clips from all Chinook salmon were also preserved in alcohol and provided to the ADF&G for future genetic work and to better describe the origin of pre-recruit fish in adjacent commercial troll fisheries.

Objective 3. Ecosystem monitoring reports:

a. Contribute to the annual NOAA Ecosystem Considerations Report;
b. Produce North Pacific Anadromous Fish Commission Documents;

NOAA Ecosystem Considerations Reports were completed:

1. Fergusson, E., Orsi, J., Gray, A. 2017. Long-term zooplankton and temperature trends in Icy Strait, Southeast Alaska. In Ecosystem Considerations 2017: Status of the Gulf of Alaska Marine Ecosystem. Eds Zador, S. and E. Yasumiishi.
2. Watson, J.T. Gray, A., Fergusson, E., Murphy, J.M. 2017. Salmon Trends in the Southeast Coastal Monitoring (SECM) Survey. In Ecosystem Considerations 2017: Status of the Gulf of Alaska Marine Ecosystem. Eds Zador, S. and E. Yasumiishi.

NPAFC Documents were completed:

1. Murphy, J.M., E.A. Fergusson, J.T. Watson, and A.K. Gray. 2017. Southeast Alaska coastal monitoring survey plan for 2017. NPAFC Doc. 1702. 5 pp. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, Auke Bay Laboratories, Ted Stevens Marine Research Institute (Available at http://www.npafc.org).
2. Fergusson, E., J. Watson, A. Gray, and J. Murphy. 2018. Annual survey of juvenile salmon, ecologically-related species, and biophysical factors in the marine waters of southeastern Alaska, May–August 2017. NPAFC Doc. XXXX. XX pp. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, Auke Bay Laboratories, Ted Stevens Marine Research Institute (Available at http://www.npafc.org).
3. Murphy, J. M., A. C. Wertheimer, E. Fergusson, A. Piston, S. Heinl, C. Waters, J. Watson, A. Gray. xxxx. 2018 Pink Salmon Harvest Forecast Models from Southeast Alaska Coastal Monitoring Surveys. NPAFC Doc. XXX 19 p. Auke Bay Lab., Alaska Fisheries Science Center, NOAA Fisheries. (Available at http://www.npafc.org).

Scientific Accomplishments

Maintaining the long-term 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. 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.

Budget Summary

The budget summary is provided by Table 3 budget sheet and attached MARS report.

Web links

NOAA SECM project: https://www.fisheries.noaa.gov/alaska/commercial-fishing/southeast-alaska-coastal-monitoring

NOAA pink salmon forecasting: https://www.fisheries.noaa.gov/alaska/commercial-fishing/forecasting-pink-salmon-harvest-southeast-alaska

References

Fergusson, E. A., M. V. Sturdevant, and J. A. Orsi. 2013. Trophic relationships among juvenile salmon during a 16-year time series of climate variability in Southeast Alaska. N. Pac. Anadr. Fish Comm. Tech. Rep. 9.

Orsi, J. A. and E. A. Fergusson. 2014. Annual survey of juvenile salmon, ecologically-related species, and biophysical factors in the marine waters of southeastern Alaska, May–August 2013. (NPAFC Doc.). Auke Bay Lab., Alaska Fish. Sci. Cent., Natl. Mar. Fish., NOAA, NMFS, 17109 Point Lena Loop Road, Juneau, 99801, USA. 85 pp. (Available at http://www.npafc.org).

Sturdevant, M. V., J. A. Orsi, and E. A. Fergusson. 2012. Diets and Trophic Linkages of Epipelagic Fish Predators in Coastal Southeast Alaska during a Period of Warm and Cold Climate Years, 1997–2011, Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 4:1, 526-545

Turner, E. and D. B. Haidvogel. 2009. Taking ocean research results to applications: examples and lessons from US GLOBEC. Oceanography 22(4): 233-241.

Wertheimer, A. C., J. A. Orsi, E. A. Fergusson, and M. V. Sturdevant. 2014. Forecasting pink salmon harvest in southeast Alaska from juvenile salmon abundance and associated biophysical parameters: 2013 returns and 2014 forecast. NPAFC Doc. 1555. 24 pp. Auke

Bay Lab., Alaska Fisheries Science Center, NOAA, NMFS. (Available at http://www.npafc.org)

Wertheimer, A. C., J. A. Orsi, and E. A. Fergusson. 2016. Forecasting pink salmon harvest in southeast Alaska from juvenile salmon abundance and associated biophysical parameters: 2014 returns and 2015 forecast. NPAFC Doc. 1618. 26 pp. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, Auke Bay Laboratories, Ted Stevens Marine Research Institute (Available at http://www.npafc.org).

Figures

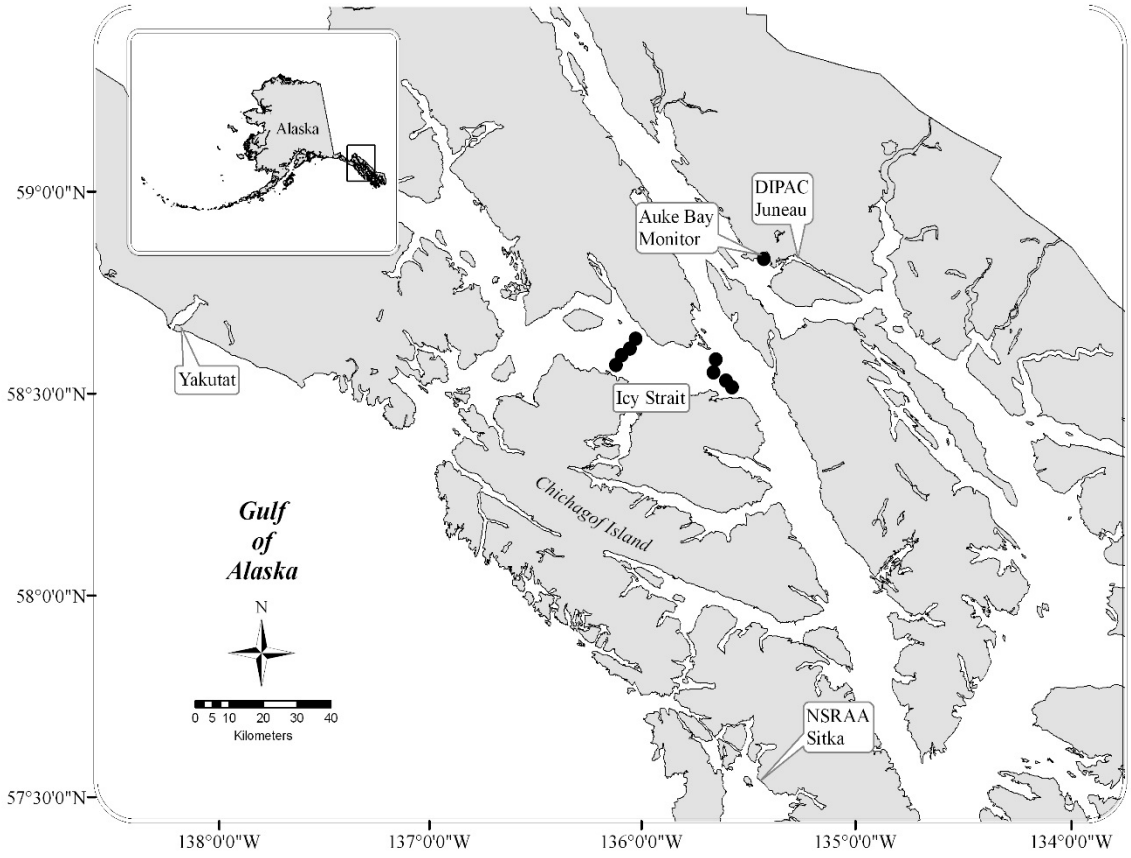

Figure 1.—SECM stations sampled during May-August 2017.

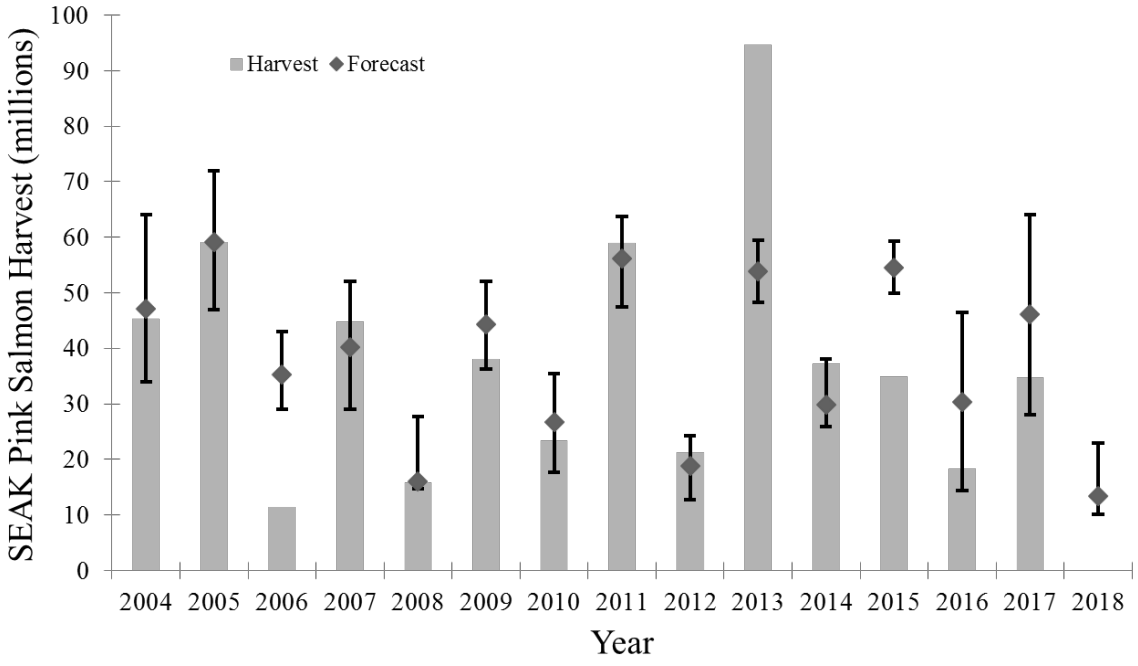

Figure 2.—Previous SECM pink salmon pre-season forecast model predictions (with 80% confidence intervals) and actual SEAK harvests over the past 15 years. Harvest data from the SEAK pink salmon fishery is currently below the lower confidence level of the 2018 forecast estimate (ADF&G 2018).

Tables

Table 1: Numbers and types of samples collected by habitat and month, May–August 2017.

			Data Collection Type			
Dates (days)	Vessel	Habitat	Rope trawl[a]	CTD[b]	Bongo[c]	Chlorophyll[d]
05/26-05/30 (2)	R/V Sashin	Inshore	0	1	1	0
		Strait	0	8	4	0
06/29-07/03 (5)	F/V NW Explorer	Inshore	0	1	1	1
		Strait	16	16	4	8
07/28-07/31 (4)	F/V NW Explorer	Inshore	0	1	1	1
		Strait	16	16	4	8
09/05-09/06 (2)	R/V Sashin	Inshore	0	1	1	1
		Strait	0	8	4	8

[a] 20-min hauls with Nordic 264 surface trawl 18m wide by 24m deep

[b] To 200m or within 10m of the bottom

[c] 60-cm frame, 505- & 333-µm mesh, oblique tows down to & up from 200m or within 20m of bottom.

[d] chlorophyll are from surface seawater samples.

Table 2.—Selected 2018 pink salmon harvest forecast model summaries for the total Southeast Alaska (SEAK) and northern Southeast Alaska (NSEAK) harvest regions. Model variables include juvenile catch-per-unit-effort ($CPUE_{cal}$ and $CPUE_{cal\_loc}$) and the Icy Strait Temperature Index (ISTI). Model estimates and bootstrap confidence intervals (LCI80 and UCI80) are included (in millions). Model performance statistics include: R^2 and $AdjR^2$ (model coefficients of determination), *AIC and AICc* (Akaike Information Criteria), and *MAPE* and *MEAPE (*mean and median absolute prediction errors).

Region	**Model**	**Estimate**	**LCI80**	**UCI80**	***R^2***	***$AdjR^2$***	***AIC***	***AICc***	***MAPE***	***MEAPE***
SEAK	$CPUE_{cal}$+ISTI	7	5	18	0.74	0.71	160	162	21%	17%
	$CPUE_{cal\_loc}$+ISTI	13	10	23	0.71	0.67	162	165	22%	17%
NSEAK	$CPUE_{cal}$	0	0	1	0.63	0.61	146	147	54%	57%
	$CPUE_{cal\_loc}$	0	0	3	0.61	0.59	147	148	53%	58%

Table 3. Project NF-2017-I-12 budget expenditures by line item, including amount projected, amount spent (including projected spending through March 31, 2019), 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
Subcontractors & consultants					
Technician support, laboratory	$15,158	$15,229	$71	0.5%	
Technician support, vessel	$19,291	$20,000	$709	3.7%	
Biometric support	$6,000	$6,000	$0	0%	
Otolith/water sample processing	$4,500	$4,500	$0	0%	
Total subcontractor & consultants	**$44,950**	**$45,729**	**$780**	**1.7%**	
Site/project costs					
Travel	$7,000	$6749	$251	3.6%	
Cruise and laboratory supplies	$7000	$6450	$550	7.8%	
Work & safety gear	$1000	$950	$50	5%	
CTD calibration, trawl repairs and shipping (**Contract Services**)	$7000	$7072	$72	1%	
Total site/project costs	**$22,000**	**$21,221**	**$779**	**3.5%**	
Total project costs	**$66,950**	**$66,950**	**$0**	**0%**	