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United States Bibliography of Publications Linked to the NPAFC Science Plan

by

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center, Auke Bay Laboratories
17109 Point Lena Loop Road, Juneau, AK 99801 USA

and

Alaska Department of Fish and Game
Box 115526, Juneau, AK 99811-5526 USA

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United States Bibliography of Publications Linked to the NPAFC Science Plan

Abstract

This bibliography lists original papers and documents published since June 2018 to May 2019 by United States scientists and/or their collaborators in relation to the 2016–2020 NPAFC Science Plan. The bibliography includes 10 articles with abstracts, corresponding to the five research themes of the NPAFC Science Plan.

Bibliography

Theme 1: Status of Pacific Salmon and Steelhead Trout

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. 1847. 43 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 https://npafc.org).

Juvenile Pacific salmon (*Oncorhynchus* spp.), ecologically-related species, and associated biophysical data were collected from the marine waters of the northern region of southeastern Alaska (SEAK) in 2017. This annual survey, conducted by the Southeast Coastal Monitoring (SECM) project, marks 21 consecutive years of systematically monitoring how juvenile salmon utilize marine ecosystems during a period of climate change. The survey was implemented to identify the relationships between year-class strength of juvenile salmon and biophysical parameters that influence their habitat use, marine growth, prey fields, predation, and stock interactions. Nine stations were sampled monthly in epipelagic waters from May to August (total of 13 sampling days). Fish, zooplankton, surface water samples, and physical profile data were collected during daylight at each station using a surface rope trawl, bongo nets, a water sampler, and a conductivity-temperature-depth profiler. Surface (3-m) temperatures and salinities ranged from approximately 8 to 12 ºC and 18 to 31 PSU across inshore and strait habitats for the four months. Integrated (top 20-m) temperatures and salinities ranged from approximately 7 to 11 ºC and 26 to 31 PSU. A total of 10,277 fish and squid, representing 17 taxa, were captured in 32 rope trawl hauls fished from June to July. Juvenile salmon comprised 4 and 51% of the catch in June and July, respectively. Abundance of juvenile salmon, especially juvenile pink salmon was very low in 2017. Coded-wire tags were recovered from four juvenile coho and one immature Chinook salmon, that all originated from hatchery and wild stocks in SEAK. Of the juvenile salmon examined for otolith marks, Alaska enhanced stocks comprised 79% of the juvenile chum (93 of 118) and 30% of the juvenile sockeye salmon (12 of 40). Of the 153 potential predators of juvenile salmon, no predation on juvenile salmon was observed. The long-term seasonal time series of SECM juvenile salmon stock assessment and biophysical data is used in conjunction with basin-scale ecosystem metrics to annually forecast pink salmon harvest in SEAK. Long term seasonal monitoring of key stocks of juvenile salmon and associated ecologically-related species, including fish predators and prey, permits researchers to understand how growth, abundance, and interactions affect year-class strength of salmon in marine ecosystems during a period of rapid climate change.

Howard, K.G., S.Garcia, and J. Murphy. In press. Juvenile Chinook salmon abundance index and survey feasibility assessment in the Northern Bering Sea. Fishery Data Series No. YY-XX. Alaska Department of Fish and Game, Anchorage, AK.

Long-term monitoring of juvenile Chinook salmon *Oncorhynchus tshawytscha* is needed to identify recruitment and mortality processes, to understand early marine biology and ecology, and to produce management tools. Juvenile Chinook salmon monitoring of Yukon River stocks was initiated by NOAA Fisheries in 2002 using a pelagic trawl survey program; however, continuation of this program on an annual basis has been tenuous due to funding limitations. This Chinook Salmon Research Initiative project was designed to continue the juvenile salmon monitoring dataset for Yukon River stocks and to assess the feasibility of a lower cost option (approximately half the cost of the existing survey design) with a smaller vessel and trawl. The smaller vessel/trawl platform performed comparably to the larger vessel/trawl platform from 2014–2016 for juvenile Chinook salmon abundance estimation, though with some necessary considerations. Chinook salmon abundance patterns were similar among survey platforms. Timing of the survey appeared to influence spatial distribution, length, and stock composition of catches. Above average juvenile Chinook salmon abundance was observed in 2014–2016. Juvenile abundance per spawner was above average in 2014 and 2015 and near average in 2016. As juvenile abundance in this system has been demonstrated to be a leading indicator of adult productivity, it is expected that adult returns from these juvenile cohorts will be an improvement upon the poor production observed in recent years. Additionally, the unique opportunity afforded by sampling in August and September in this project as well as a concurrent project in the Yukon River delta allowed for estimation of juvenile Chinook salmon early marine growth. This project represents a critical step enabling the long-term monitoring of juvenile Chinook salmon in western Alaska and continued pursuit of factors determining productivity and cohort strength of Yukon River Chinook salmon.

Howard, K.G., S. Garcia, J. Murphy, and T.H. Dann. In Press. Northeastern Bering Sea juvenile salmon survey, 2017. Fishery Data Series No. YY-XX. Alaska Department of Fish and Game, Anchorage, AK.

Monitoring of juvenile Yukon River Chinook salmon stocks rearing in the northeastern Bering Sea (NBS) was initiated by the National Oceanic and Atmospheric Administration (NOAA) in 2002 using a pelagic trawl survey program. Juvenile salmon were caught after their first summer at sea, and prior work has demonstrated a clear relationship between juvenile abundance and future adult returns, enabling the use of juvenile data in adult run size forecasts. Estimated abundance of juvenile Chinook salmon in the NBS was approximately 2,480,000 (S.D. 439,000) in 2017, below the 2003–2016 average. The mean proportion of 2017 NBS juvenile Chinook salmon originating in the total Yukon River and Canadian-origin Yukon River was 72% (S.D. 5%) and 42% (S.D. 4%), respectively. Abundance of total Yukon and Canadian-origin stocks were estimated as 1,774,000 (S.D. 338,000) and 1,049,000 (S.D. 207,000), respectively. A marked decrease in juvenile production (juveniles-per-spawner) for total Yukon and Canadian-origin stocks was also below 2003–2016 averages. These data were incorporated into forecast models to predict total adult run size: forecasted total Yukon Chinook salmon run sizes for 2018–2020 were 220,000–309,000, 200,000–280,000 and 151,000–212,000, respectively; forecasted Canadian-origin Chinook salmon run sizes for 2018–2020 were 72,000–116,000, 75,000–120,000 and 58,000–93,000, respectively. The date-adjusted length (FL) of juvenile Chinook salmon in the NBS was 204 mm, below the 2003–2016 average of 212 mm. Marine data on juvenile Chinook salmon clearly demonstrate that Yukon River Chinook salmon should be expected to remain in a relatively low productivity regime in the near future, but record-low run abundance is unlikely through 2020.

Masuda, M.M., E.A. Fergusson, J.H. Moss, J.M. Murphy, V.J. Tuttle, and T. Holland. 2019. High seas salmonid coded-wire tag recovery data, 2017. NPAFC Doc. 1851. pp 51. Auke Bay Lab., Alaska Fisheries Science Center, NOAA Fisheries. (Available at https://npafc.org).

Information on high seas recoveries of salmonids (*Oncorhynchus* spp.) tagged with coded-wire tags (CWTs) has been reported annually to the International North Pacific Fisheries Commission (1981–1992) and to the North Pacific Anadromous Fish Commission (1993–present). Data from these CWT recoveries are also reported to the Regional Mark Processing Center (RMPC, http://www.rmpc.org) of the Pacific States Marine Fisheries Commission (PSMFC) for inclusion in their Regional Mark Information System database. This document lists recovery data for 336 CWT salmonids not previously reported to the PSMFC/RMPC. These CWTs were recovered from 1) the U.S. groundfish trawl fisheries in the Gulf of Alaska (GOA) as sampled by observers from the North Pacific Observer Program (NPOP) in 2017 (179 Chinook salmon [*O. tshawytscha*]), 2) U.S. trawl research in the GOA in 2017 (4 coho salmon [*O. kisutch*]), 3) the U.S. groundfish trawl fisheries in the eastern Bering Sea-Aleutian Islands (BSAI) as sampled by NPOP observers in 2017 (44 Chinook salmon), 4) U.S. trawl research in the northern Bering Sea in 2017 (1 Chinook salmon), and 5) the U.S. at-sea Pacific hake (*Merluccius productus*) trawl fishery in the North Pacific Ocean off Washington and Oregon in 2017 (108 Chinook salmon) as sampled by observers from the At-Sea Hake Observer Program.

Murphy, J. M., A. C. Wertheimer, E. Fergusson, A. Piston, S. Heinl, J. C. Waters, Watson, A. Gray. 1848. 2018 Pink Salmon Harvest Forecast Models from Southeast Alaska Coastal Monitoring Surveys. NPAFC Doc. 1848. 19 pp. Auke Bay Lab., Alaska Fisheries Science Center, NOAA Fisheries. (Available at https://npafc.org).

Juvenile abundance indices from the Southeast Coastal Monitoring survey and ecosystem indicators are used to forecast harvests of Southeast Alaska (SEAK) pink salmon (*Oncorhynchus gorbuscha*). We describe the 2018 harvest forecast models and review the performance of the 2017 harvest forecast models. Goodness-of-fit statistics (AIC and AICc) and jackknife prediction errors were used to select the 2018 forecast models. Forecasts models were developed for the total harvest of pink salmon in SEAK and for the northern region of Southeast Alaska (NSEAK). Bootstrap confidence intervals (80%) of the model prediction were used as the forecast range. Two indices of juvenile abundance were considered in the 2018 harvest forecast models: $CPUE_{cal\_loc}$ (catch-per-unit-effort calibrated for sampling vessel and adjusted to balance sampling effort across transects or locations) and $CPUE_{ttd\_loc}$ (catch-per-distance-trawled adjusted to balance sampling effort across transects or locations). The model selected for total SEAK pink salmon harvest included the $CPUE_{cal\_loc}$ and the Icy Strait Temperature Index, and projected a harvest range from 10 M to 23 M with a point estimate of 13 M in 2018. The NSEAK pink salmon harvest model only included $CPUE_{cal\_loc,}$, and projected harvest range of 0–3 M with a point estimate of zero in 2018.

Oxman, D.S. 2019. Proposed thermal marks for brood year 2019 salmon in Alaska. NPAFC Doc. 1817. 8 pp. Alaska Dept. Fish and Game, Juneau, Alaska, 99811, USA. (Available at https://npafc.org).

In Alaska, mass-marking of salmon using otolith thermal marking is an effective research and management tool applicable to a variety of situations. For brood year 2019, approximately 62 million sockeye, 952 million pink salmon, 729 million chum, 19 million Coho, and 9 million Chinook salmon will be marked at 26 different hatcheries using 111 thermal marks, six dry marks, and one strontium mark.

Oxman, D.S. 2019. Releases of otolith marked salmon from Alaska in 2018. NPAFC Doc. 1818. 5 pp. Alaska Dept. Fish and Game, Juneau, Alaska. 99801. (Available at https://npafc.org).

In Alaska, mass-marking of salmon using otolith thermal marking is an effective research and management tool for a variety of situations. This document reports the otolith mark patterns applied to hatchery-raised salmon stocks released in Alaska during 2018. It includes five species of salmon from brood years 2016 and 2017. Release numbers, mark patterns, and release locations are summarized.

Theme 2: Pacific Salmon and Steelhead Trout in a Changing North Pacific Ocean

Garcia, S., and F. Sewall. In Press. Diet and energy density assessment of juvenile Chinook salmon from northeastern Bering Sea trawl surveys, 2004–2017. Fishery Data Series No. XX-YY. Alaska Department of Fish and Game, Anchorage, AK.

The northeastern Bering Sea (NBS) is the rearing habitat for juvenile Yukon River Chinook salmon. In 2002, a marine survey was initiated by the National Oceanic and Atmospheric Administration to estimate juvenile Chinook salmon abundance in the NBS. Predetermined stations were sampled each year, and a subsample of the juvenile Chinook salmon catch was assessed for stomach content and energy density analyses. Juvenile Chinook salmon in the NBS primarily ate fish, including Pacific sand lance, capelin, and other fish species, and smaller proportions of decapods and other invertebrates. Annual average piscivory in juvenile Chinook salmon ranged from 74% to 95% by mass from 2004 through 2017. Diet composition was size dependent, with higher proportions of decapods and invertebrates eaten by smaller fish (<160 mm). Diets varied between warm and cold periods in the Bering Sea with warm years dominated by Pacific sand lance and decapods and cold years dominated by capelin. Juvenile Chinook salmon energy density differed yearly, largely due to differences in average length and sea surface temperature. Energy density of juvenile Chinook salmon was higher in warmer years than colder years, despite lower piscivory. Annual size-adjusted energy density for juvenile Chinook salmon across 2006–2017 was highest in 2017 and lowest in 2011. Changes in diet and energy density between warm and cold periods suggests changing ocean conditions may be important to the nutritional ecology of juvenile Chinook salmon. Continued annual monitoring of juvenile Chinook salmon size, condition, and diets will enable further investigation of the relationship between ocean conditions, fish condition, and marine survival.

Theme 3: New Technologies

Agler, B.A., L.I. Wilson, and R. Brenner. 2019. Salmon scale wiki—an interactive online protocol for estimation of Chinook salmon (*Oncorhynchus tshawytscha*) scale age. NPAFC Doc. 1849. 9 pp. Alaska Department of Fish and Game (Available at https://npafc.org).

As part of a project to examine consistency in age estimates of Chinook salmon scales within Alaska, we created Salmon Scale Wiki, an interactive website designed to help standardize methods and to facilitate interaction and learning among scale readers. Scale readers throughout the state estimated age of 10,000 digital images of Chinook salmon scales using an online application. Participants subsequently attended a workshop in Anchorage, Alaska to review project results and develop guidelines for estimating Chinook salmon scale ages from growth patterns. These guidelines were then incorporated into Salmon Scale Wiki, where scale readers can access information about Chinook salmon scales and stocks within Alaska. This website includes pages where readers learn about scale age estimation protocols, acquire training techniques, and explore images from a variety Alaskan Chinook salmon stocks. In addition, viewers learn how to develop quality control and quality assurance methods and improve data collection. The Wiki provides a glossary to encourage standardization of terms used to describe and explain the scale aging process.

Taal, Levi, J.M. Allen, D. Bell, J.Joyce, J.R. Russell, D.A. Tallmon, S.C Vulstek, C. Yang, and D.W. Yu. 2019. Environmental DNA for the enumeration and management of Pacific salmon. Mol. Ecol. Resour. 2019:1–12.

Pacific salmon are a keystone resource in Alaska, generating annual revenues of well over ~US$500 million/year. Due to their anadromous life history, adult spawners distribute amongst thousands of streams, posing a huge management challenge. Currently, spawners are enumerated at just a few streams because of reliance on human counters and, rarely, sonar. The ability to detect organisms by shed tissue (environmental DNA, eDNA) promises a more efficient counting method. However, although eDNA correlates generally with local fish abundances, we do not know if eDNA can accurately enumerate salmon. Here we show that daily, and near-daily, flow-corrected eDNA rate closely tracks daily numbers of returning sockeye and coho spawners and outmigrating sockeye smolts. eDNA thus promises accurate and efficient enumeration, but to deliver the most robust numbers will need higher-resolution stream-flow data, at-least-daily sampling, and a focus on species with simple life histories, since shedding rate varies amongst jacks, juveniles, and adults.