State of Alaska Hatchery Research Project:

A study of the interactions between hatchery and natural pink and chum salmon in Southeast Alaska and Prince William Sound streams

Progress Synopsis June 2018

Alaska Hatchery Priority Research Questions – In 2011, ADF&G organized a science panel composed of current and retired scientists from ADF&G, University of Alaska, aquaculture associations, and National Marine Fisheries Service, to discuss ways to systematically evaluate interactions of wild and hatchery produced salmon in Alaska. The science panel designed a long-term research project to potentially answer three top priority research questions:

1. What is the genetic stock structure of pink salmon in Prince William Sound (PWS) and chum salmon in Southeast Alaska (SEAK)?
2. What is the extent and annual variability in straying of hatchery pink salmon in PWS and chum salmon in PWS and SEAK?
3. What is the impact on fitness (productivity) of wild pink and chum salmon stocks due to straying of hatchery pink and chum salmon?

The following is a short description of progress made to date to provide answers to these questions:

Population Structure – Analysis of the genetic stock structure for both the odd-year (2013) and even-year (2014) pink salmon populations in PWS using DNA microsatellites has been completed. A report of the odd-year information is available online. The even-year data and analysis was presented in May 2018 at the American Fisheries Society meeting in Anchorage; the report will be online soon. The study analyzed at least 3,000 individuals from each year, collected from 19 to 26 locations across PWS. Variation among odd-year populations was larger than among even-year populations. Based on preliminary analyses of contemporary samples, populations are genetically similar, but not identical. Population structure in PWS is comparable to structure found in wild pink salmon elsewhere in its geographic range. Archived tissues from mid-1990's odd- and even-year pink salmon collections are currently being analyzed to provide an historic perspective on contemporary population structure.

Straying studies – In a systematic and well-designed manner, following a robust design, the project sampled otoliths from spawned-out fish in representative chum salmon streams in SEAK, and pink and chum salmon streams in PWS, to estimate the hatchery fraction in natural spawning populations on a district scale. Previous studies have documented strays in SEAK and PWS streams, but this is the first study designed to provide an estimate for an entire region. Combining this information with estimates of hatchery and wild productivities will allow us to assess the influence, if any, of hatchery strays on natural production.

Three years of field work focused on the variability and extent of hatchery pink and chum salmon straying in PWS, and chum salmon straying in SEAK were completed in 2015. The sample results are available online and final preparations are underway to publish an analysis of this work in a peer-reviewed journal in 2018 (preliminary results; Table 1 and Figure 1).

Table 1. Preliminary estimates of the region-wide proportions of hatchery-origin spawners in streams.

	Hatchery Proportion		
PWS	**2013**	**2014**	**2015**
Pink salmon	4%	15%	10%
Chum salmon	3%	3%	3%
Southeast	**2013**	**2014**	**2015**
Chum salmon	7%	5%	9%

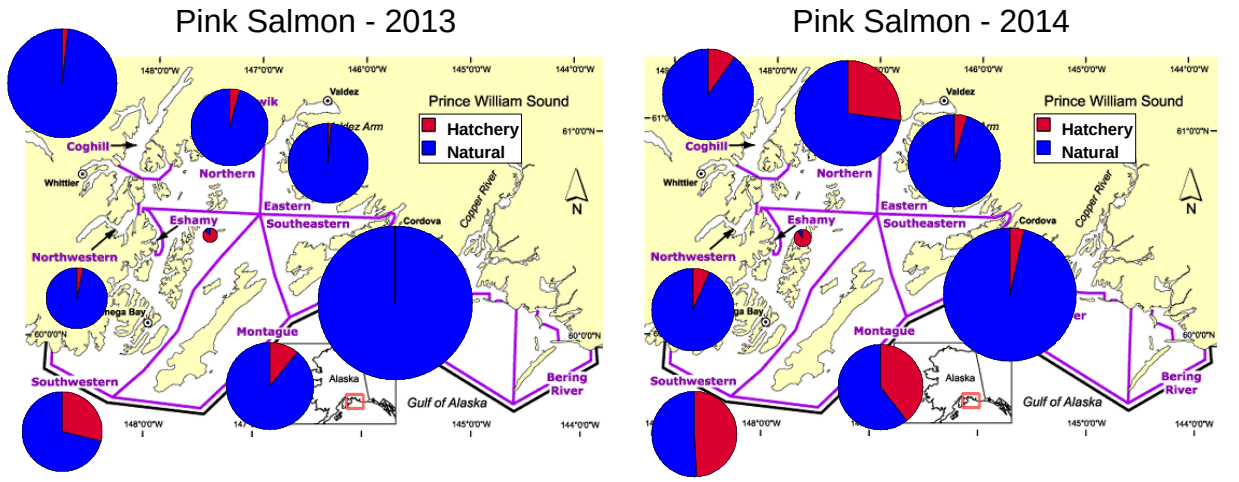

Figure 1. Estimated fractions of hatchery- and naturally-origin pink salmon in spawning streams within ADF&G commercial fishing districts in Prince William Sound, 2013 – 2015. Pie size represents relative size of the population as per the ADF&G aggregate abundance index in a year.

Things that we can infer from work to date:

1. About two thirds of pink salmon streams sampled in two odd-years had low proportions of hatchery-produced fish. Strays were low (≤2%) over the spawning grounds in Coghill, Eastern, and Southeastern districts, which represented 62 to 72% of the natural spawning population in 2013 and 2015. Considering that Brenner et al. (2012) found a relationship of straying waning with distance from hatcheries, the infrequency of strays in the Coghill, Eastern, and Southeastern districts is probably persistent.
2. Hatchery proportions in streams for the single even-year collections were higher, but the distribution of hatchery-origin fish in natural systems was consistent with the odd-year line.

Ocean Sampling – Ocean sampling in the entrances to PWS has provided an un-biased estimate of the hatchery fraction in the total return of pink and chum salmon. This information, when combined with the estimates from the streams and the known removals through harvest and hatchery take provides a means to estimate: the number of natural-origin salmon spawning in streams, the number of hatchery salmon

spawning naturally (Hatchery strays), total production of hatchery salmon (including strays; Hatchery run), and total production of natural salmon (excluding hatchery strays; Natural run). With knowledge of the total number of fish spawning in streams and the total return of natural fish, it is a simple matter to determine the return per spawner, an important measure of productivity and fitness. It is also possible to determine the proportion of the hatchery return that spawned naturally.

Table 2. Preliminary Prince William Sound run size estimates for pink and chum salmon 2013-2015 (Thousands)

Species Year	Natural spawners	Hatchery strays	Total spawners	Natural run	Hatchery run	Total run
Pink salmon						
2013	15,698	701	16,399	33,096	69,888	102,985
2014	5,130	741	5,872	6,960	42,757	49,718
2015	37,972	4,009	41,981	63,531	77,335	140,866
Chum salmon						
2013	894	50	944	1,141	3,007	4,148
2014	925	49	975	1,175	1,228	2,404
2015	890	28	919	1,128	2,484	3,612

Table 3. Estimated harvest rate of hatchery and natural pink salmon in Prince William Sound, 2013-2015.

	Estimated Harvest Rates	
Year	Hatchery	Natural
2013	0.99	0.53
2014	0.98	0.26
2015	0.95	0.40

Things that we can infer from work to date:

1. Between 1% and 5% of the pink salmon hatchery returns, and 1% and 4% of the hatchery chum salmon returns (Table 2) in PWS during the three study years spawned naturally. Preparations are underway to publish run reconstruction and straying results.
2. These results indicate that natural populations in PWS continue to be productive in the presence of over 18 generations of straying from large scale hatchery production. The natural production of PWS pink salmon has been particularly robust in the three brood years represented in the work so far.
3. 16 million spawners in 2013 produced an estimated natural run of just under 64 million return, a 4 to 1 return-to-spawner ratio.
4. Comparison of harvest rates indicates that ADF&G policy of preferential harvest of hatchery-produced fish (>90%) and sustainable harvest of naturally-produced fish (<60%) is effective (Table 3).

Fitness Studies – This ground-breaking work is based on first identifying origin (hatchery/natural) using otolith marks and genotypes of potential parents spawning in study streams and subsequently identifying parental origin (hatchery/natural) of returning fish using genetic pedigree reconstruction. This information will allow us to begin to assess the ecological and genetic consequences of hatchery strays on fitness of natural spawners at the drainage scale by estimating the relative reproductive success, or fitness, of hatchery and naturally produced fish in nature. Evaluation at this scale is important because it will provide insight into how much these consequences can vary locally (and, potentially, why).

The field crews have completed 5 years of intensive sampling directed toward studies of the relative fitness of hatchery and natural fish on 5 pink salmon study streams in PWS and 4 chum salmon study

streams in SEAK. Collectively nearly 255,000 salmon have been sampled for this research to date. The laboratory analysis using single nucleotide polymorphism (SNP) genetic markers to determine pedigrees has begun for pink salmon in PWS. The first step in this analysis is refining methods that utilize a new cost-effective sequencing technology to screen samples taken from carcasses. Pedigree data for a full generation (2 brood years) in 2 streams is expected to be out of the lab in the fall of 2018.

Funding – In 2015, a finance committee was formed comprised of hatchery operators, a processor representative, and the ADF&G commissioner's office and aquaculture section. This team has focused attention on maintaining the funding to meet the targeted research costs of $16 million, necessary to answer the fundamental questions natural spawner fitness. The current State of Alaska budget precludes additional state funds, however 7 of Alaska's largest hatchery corporations (SSRAA, NSRAA, DIPAC, PWSAC, VFDA, KRAA, and CIAA) have combined to provide $350,000 for the coming year's work. Those funds in concert with existing funds, and the processor's requested contribution of $500,000 will provide for this year's field work. ADF&G will continue to provide considerable in-kind support. In 2016, ADF&G successfully secured funding from NOAA's Saltonstall-Kennedy Grant Program ($250,000) and North Pacific Research Board ($289,000) to genetically analyze adult and offspring pink salmon from 2 streams in PWS over 2 brood years as part of the fitness study. In addition, NSRAA has received $200,000 in grants from the Pacific Salmon Commission to support sampling of chum salmon in the fitness streams in SEAK. To date, funding received in support of the project totals $9.091 million. Of this, the Seafood Processors Association has provided $2.494 million, PNP operators combined have provided $2.65 million, the State of Alaska appropriated $3.5 million, and $0.447 million is from grants.

Future –Field work for Questions 1 and 2 has been completed and analyses are nearing completion. The scope of work for the research project has narrowed to address the fitness question (Question 3). Even so, there are still significant costs. The science panel considers the fitness studies to be the most important to our long term understanding of the hatchery-natural fish interactions. Some funding has been secured from federal grants but continued funding for the remaining portion of this component of the project is currently being provided by fishermen through the hatcheries via additional cost recovery, as well as the processor community through a consensus agreement.

It is particularly important that hatchery operators and processors continue their support of the project, both for financial reasons as well as showing a commitment to maintaining this ground-breaking research that is designed to directly address questions about the Alaska salmon hatchery program. Processors had initially committed to 5 years; we hope they will continue their same level of support for the remainder of the project.

This project is expected to end in 2023 with the conclusion of the fitness analysis of chum salmon in SEAK.

This study provided Marine Stewardship Council and Alaska Seafood Marketing Institute information helpful for their certification programs.

Additional information on this project is available at:
http://www.adfg.alaska.gov/index.cfm?adfg=fishingHatcheriesResearch.main