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 May 2017

Alaska Hatchery Priority Research Questions – In May 2011 the Alaska hatchery operators and ADF&G representatives identified 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 of the odd-year run (2013) of pink salmon populations in PWS using DNA microsatellites has been completed and is available online. This study analyzed about 3,000 individuals collected from 19 locations. While overall distinctions among populations were low, significant differences were found among populations in PWS. Analysis of the population structure of the even-year run (2014) is preliminarily complete and will be reported this summer. Archived tissues are currently being analyzed to provide an historic perspective on contemporary population structure odd- and even-year pink salmon collections.

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

Three years have been completed for field studies focused on the variability and extent of hatchery pink and chum salmon straying in PWS, and chum salmon straying in Southeast Alaska. The results are available online and preparations are underway to publish this work in peer-reviewed journal now that it is completed (preliminary results; Table 1 and Figure 1).

Table 1. Preliminary estimates of the proportion 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%

Author: Ron Josephson, ADF&G

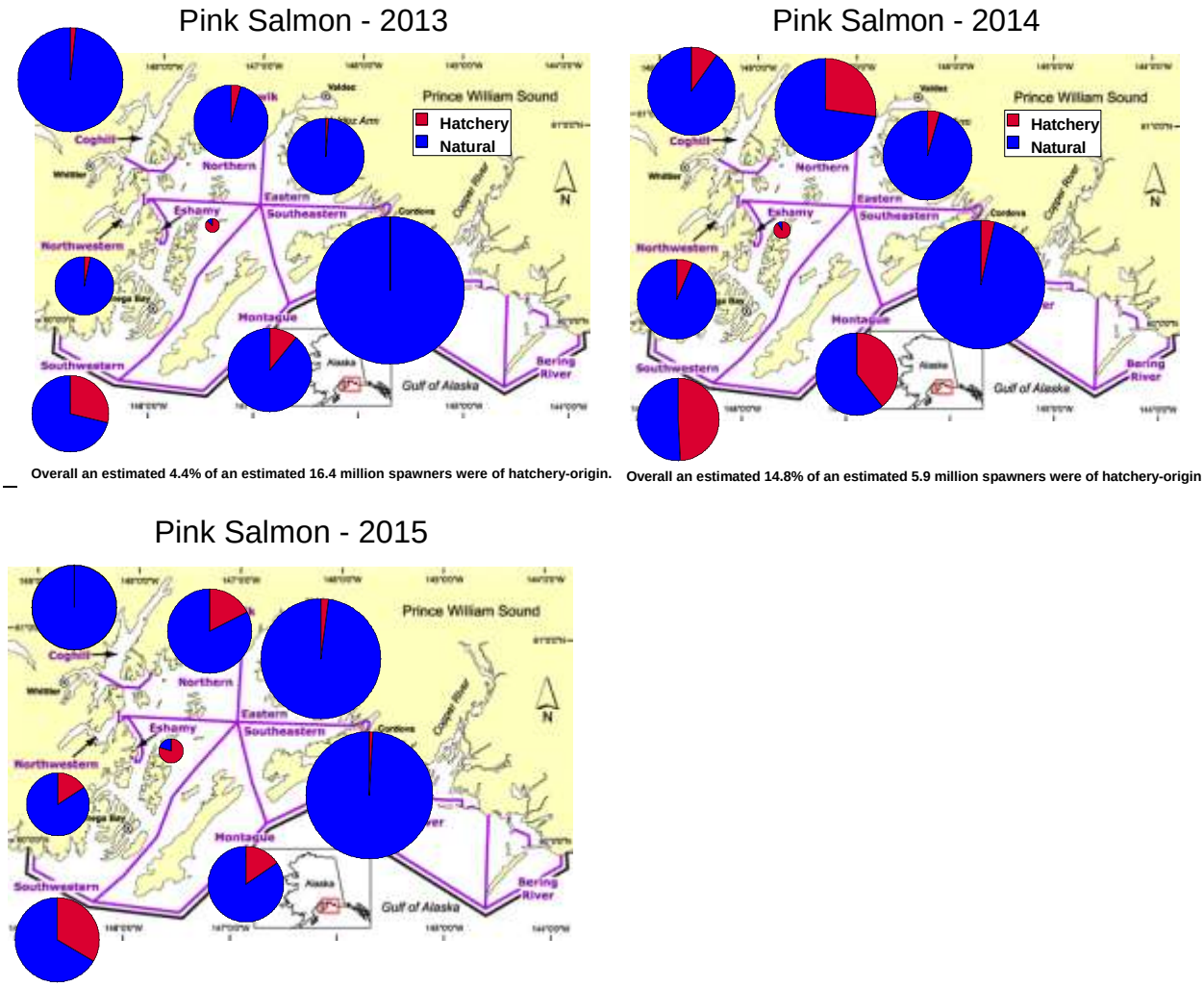

Figure 1. Estimated fractions of hatchery- and naturally-origin pink salmon in spawning streams within ADF&G commercial fishing districts in Prince William Sound, 2013 – 2015. Pie size represents relative size of the population as per the ADF&G aggregate abundance index in a year.

Things that we can infer from work to date:

1. About two thirds of naturally spawned pink salmon in the odd-year line have low proportions of hatchery-produced fish. Strays were low (≤2%) over the spawning grounds in Coghill, Eastern, and Southeastern districts—districts that represented 62 to 72% of the spawning population in 2015 and 2013. Considering that Brenner et al. (2012) found a relationship of straying waning with distance from hatcheries, the lack of strays in the Coghill, Eastern, and Southeastern districts should be 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 systems in PWS continue to be productive in the presence of hatchery straying. The natural production of PWS pink salmon has been particularly robust in the three years of work that provided total return estimates.
3. Compensation in survival rates in naturally produced fry from at-sea competition with hatchery-produced fry is not indicated for the 2013 brood and 2015 return. Just over an estimated 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 for hatchery-produced and naturally produced pink salmon indicates that ADF&G policy of preferential harvest of hatchery-produced fish 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/wild) 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. 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 4 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 over 190,000 salmon have been sampled for this research. The analysis has not been initiated yet pending selection of the single nucleotide polymorphism (SNP) genetic markers that are used to determine parentage. The SNPs have been developed and the state's Gene Conservation Laboratory is currently refining the panel to be used to screen them using new cost-effective sequencing technology.

Funding – A finance committee has been formed with hatchery operators, a processor representative, as well as the commissioner's office and hatchery aquaculture section in the department. This team has focused attention on the essentials with a pared down program primarily directed at the questions about fitness. The current situation with State of Alaska's 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 $300,000 for the coming year's work; those funds in concert with existing funds, and the processor's contribution of $500,000 provide for this year's field work. The hatchery groups expect to increase their contribution and provide at least $350,000 each year. ADF&G provides 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 two streams in PWS over two brood years as part of the fitness study. In addition NSRAA has received a $100,000 grant from the Pacific Salmon Commission for sampling of chum salmon in the fitness streams in SEAK.

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. The initial funding has been secured from federal grants but continued funding for the remaining portion or 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 Southeast Alaska.

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

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