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# Reintroduction evaluations

## Mckenzie and Santiam

### (Sard et al. 2015)

* Intro:
  + Cougar dam (1964) 158m tall, restricts access to 40km of South Fork Mckenzie
  + Starting in 1993, adult chinook released habitat above dam (likely all hatchery fish)
    - Since 2010 a trap and haul program started releasing NOR chinook above dam
* Methods Summary:
  + Collected tissue samples from nearly all released fish 2008-2011
  + Collected tissue samples from juveniles caught in screw trap 2009-2012
  + Genotyped adults and juveniles at 11 microsats + 1 sex microsat
  + Assigned parents to subyearling caught subsequent year in screw trap using SOLOMON
  + Built glmms using reproductive success within a year as dependent variable, estimated some parameters, variable selection using AIC:
    - Effect of release site
    - Release date
    - Release group
    - Sex
    - HOR/NOR
  + Ran anova on effect of sex\*NOR/HOR on juvenile length as proxy of fitness
  + Used methods from Araki and Blouin (2005) to test effects of factors above on RS
* Results
  + Assignment success was high (99% to at least one parent, 79% to both)
  + Right skewed RS
  + Jacks contribute to cohort
  + Factors retained in the model after viable selection varied year to year (see table 3), but a couple things were interesting
    - fitness differences between HOR and NOR males, driven potentially by size
    - inconsistent results for release date
* Discussion
  + Using juveniles to estimate RS is challenging (Anderson 2011), requires a large number of juveniles captured
  + Release date may affect fitness through increased male competition on spawning grounds, but is inconsistently supported
  + Release location probably doesn’t matter because fish distribute through the system after release
  + Males have lower RS probably due to skewed sex ratio of releases
  + Jacks have RS, increasing Ne of population by adding connectivity among age cohorts
  + Natural origin males have higher RS than hatchery fish potentially because of increased size leading to sexual selection on the spawning grounds
  + it may be prudent to limit the number of HOR males in the reintroduction program

### (Sard et al. 2016)

Lost detailed summary… brief one below

* 29% of fish produced adult offspring that returned to trap
* Glmm: Inconsistent factors explain variation in reproductive success within year
  + Release date – 2007 – later worse
  + Sex – 2008 – male worse
* Migration behavior:
  + 64% NOR fish arriving at trap were from reintroduced parents
  + Number of NOR reintroduction offspring declined over time and the tag and release methods successfully lowered the number of “immigrants”
  + Few carcusses below dam were from reintroduced fish (2 out of ~ 140)
* Cohort replacement rate
  + 0.40 and 0.31

### (Evans et al. 2016)

### (Evans et al. 2019)

* Examines genetic architecture of fitness traits in South Fork Mckenzie and Santiam Rivers using pedigress from the Sard et al 2016 and Evans et al 2016 papers
* Built glmm (animal models) of phenotypic and genetic variance for: body length at maturity, age at maturity, arrival timing and lifetime reproductive success
  + Basic Full model: phenotype ~ breeding value + fixed effects (sex + year + HOR/NOR) + random(sire + dam)
  + Fit with MCMCglmm package
  + Built bivariate models to estimate genetic correlations as well
  + Variable selection using DIC, parameter estimation using credible intervals
  + Estimated selection gradient of parental release date
* Families:
  + Santiam: 468 full sib families+162 maternal half sib fams+178 paternal half sibs (from 4254 NOR adults)
  + Mckenzie: 390 full sib families+91 maternal half sib fams+78 paternal half sibs (from 1567 NOR adults)
* Body-length at maturity
  + Parental origin effect retained in model, as well as dam effect in Santiam
  + h2 = 80%/62%, evolvability (eμ) of 0.009/0.006
* Age
  + Females return older than males, paternal effect
  + h2 = 9%/5%, evolvability (eμ) of 0.266/0.004
* Arrival timing (santiam only)
  + age, sex, and parent origin (HOR, NOR) all significant, plust maternal effect
  + h2 = 19%; evolvability (eμ) of 0.003
* lifetime reproductive success
  + negative binomial distribution
  + low heritability and evolvability
* some trait genetic correlations, only length and age at maturity strongly genetically correlated
* selection
  + selection for later release date in many years in Santiam, but not all
  + also inconsistent for McKenzie but opposite diection (earlier better)
* Discussion
  + “longer-term population persistence may be facilitated through adaptation in adult characteristics in both South Santiam and South Fork McKenzie river Chinook salmon, but also point to potential differences in the degree of response to selection between the populations”
  + Selection on release date varies year to year and system to system, this is (a) a good example of spatially varying selection maintaining variation within the larger metapopulation and (b) highlights the importance of tailoring reintroductions to the specific ecological conditions at each river system
  + Development of selection estimates on the other traits studied here is valuable management information **(future work – see stray thoughts section)**
  + Paternal/maternal effects in fitness related traits highlights the importance of plasticity and epigenetic effects. Particularly relevant if hatchery origin fish are used for reintroductions.

(Banks 2014)

* ODFW report summarizing/synthesizing the Sard 2015 and Sard 2016 results
  + Brief summary of results available on page 25
* Able to compare reproductive success (RS - juveniles Sard 2015) with total lifetime fitness (TLF- adult returns Sard 2016)
  + Reproductive success explains ~26% of total lifetime fitness for the same fish
* Ne remains “high” year to year ~200
* “Newly developed methods that accurately identify unsampled parents using knowledge of grandparent and grandoffspring genotypes are a promising means to identify unsampled parents in this system (Christie et al. 2011). We intend to thoroughly evaluate these three hypotheses in forthcoming analyses”

Evaluating Spring Chinook Salmon Reintroductions Above Detroit

Dam, On The North Santiam River, Using Genetic Parentage Analysis

(Banks 2015 and omalley 2015) estimating number of breeders for south santiam and south fork mckenzie

## Other Watersheds

### (Anderson et al. 2013)

### (Anderson et al. 2015)

Keefer et al. 2010, 2011; Baumsteiger et al. 2008

## Reviews

### (Anderson et al. 2014)

* Great review that synthesizes ideas about the risks, benefits and biological contraints of reintroducing salmonids into habitats, specifically using framework and conservation goals of the ESA for these species.
* Articulates a metapopulation perspective on planning and evaluating reintroductions
  + Integrates demographic, evolutionary and ecological processes that determine the risks, benefits and challenges of reintroduction programs
* Includes brief but broad review of results from previous reintroductions (tables 4 and 5)

# Parentage Based Tagging

# Stray thoughts for project

* Increasing the number of release sites may alter the success of a reintroduction strategy by changing density dependent processes on the spawning grounds (i.e. allee effects or competition). While release sites does not appear to vary reproductive success within a year, there are enough study years that it may be possible to assess if the spatial variation of release sites explains year to year variation in reproductive success.
* In terms of framing the monitoring project as one that examines the benefits, risks and constraints of the reintroduction (i.e. along the framework of Anderson 2014), it might be interesting to frame the manuscript specifically on the stated goals of the reintroduction program (should find that document).
* Is it worth examining the extent to which straying contributes to geneflow and therefore outbreeding populations in the river segment beneath the dam. previous ms report the number of fish id’d as offspring of the reintroduction program among below-dam carcasses. Is this data enough to estimate the extent of introgression from these fish and therefore the amount of risk they pose to the evolutionary legacy of the south fork mckenzie?
* Read Johnson and Friesen 2014 hatchery supplementation paper to clarify the program
* Evans et al 2019 had to limit their selection estimates to phenotypes with both parental and offspring data, later papers will be free to expand these results to other phenotypes to guide management (e.g. if still need to include HOR fish to supplement the population above dam, strong selection for body size suggests the biggest demographic benefit to the reintroduction will be had by choosing large HOR fish).
* Maybe do a power analysis to see if adding new individuals to the Evans 2019 quant genetics paper will be an interesting result

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