Effects of Encountering Juvenile Bypass Systems on Migration and Smolt-to-Adult Survival Rates

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Some of the Previous Research

- Juvenile bypass and migration delay
 - Beeman and Maule (2001)
 - Muir et al. (2001)
 - Tuomikoski et al. (2010)
- Juvenile bypass and SARs
 - Sandford and Smith 2002
 - Williams et al. 2005
 - Ferguson et al. 2006
 - Buchanan et al. 2011
 - Tuomikoski et al. (2010)



Juvenile Bypass Systems



Juvenile Bypass Systems

1. Do bypass systems result in delays in travel time relative to fish utilizing all other routes of passage ?

2. Do bypass systems result in reduced SARs relative to fish utilizing all other routes of passage ?

Comparative Survival Study

- PIT-tagged spring/summer Chinook + steelhead
- Migration years 2006-2014



Mixed Models for Travel Time

Travel Time ~ Gamma(μ ,r)

 $log(\mu) = Fixed + Random$

Fixed = (Day +Flow + Specific Dam Effects) x Year

Random = Origin Origin ~ Normal(0, σ_0)



Estimates of Bypass Delay



Migration Year

Estimates of Bypass Delay



Hatchery Steelhead

31 of 45 significant estimates

2014

2012

9.6 hours – 1.9 days delay

Ice Harbor

2008

2010

 Consistent delay observed across projects and years

Mixed Models for SARs

Survival ~ Bernoulli(p)

logit(p) = Fixed + Random

Fixed = (Day +Cumulative Bypass Effects) x in the Snake River and upper Col-Year

Random = OriginOrigin ~ Normal(0, σ_{0}) Length ~ Normal(0, σ_L)?

Evidence Linking Delayed Mortality of Snake River Salmon to Their Earlier Hydrosystem Experience PHAEDRA BUDY* AND GARY P. THIEDE

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The Snake River stocks semer et al. 1997). Became of their earlier declinrelative to other Columbia River stocks, the extinction or near extinction of some stocks, and their long migration past as many as eight large hydro fost recently, the fate of the Snake Ri stocks has received national attention, and the question of whether or not to breach the lower fou Snake River hydroelectric dams is being discusse mong trie hits managers and politician an Ficheries Society 1000a 15G 100

SURVIVAL AND SELECTION OF MIGRATING SALMON FROM CAPTURE-RECAPTURE MODELS WITH INDIVIDUAL TRAITS

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dynamics, providing information on population abundance, survival growth rates, and selection for phenotypic traits. In these studies, the serving a tagged individual reflects both the probability of the individual rcapture and the probability of recapturing an animal, given that it bilities are related to the same phenotypic trait, st can be difficult to dis and that ment of salmonid populations.

behavioral variability: capture-model averaging: Onconhynchus

and Kendall 2002), selection coefficients (Endler 1986), or survival (Lebreton et al. 1992). Of particular

when a phenotypic trait

capture and survival pri-

not distinguish be

standing the behav

sutes such as life

that only have one opportunity to

is often critical for estimating

mation that is crucies an To address this, recent advances in capture in incorporation methodology have focused on incorporating indiviually varying traits into capture-recapture in

Terra orrest mon

tions typically exhibit behavioral het rogeneity, and this can confound efforts to understand spearing, and any can control of entry to understand pulation dynamics. Capture-excepture experiment, r example, yield information on population abun-nce, hife-stage-specific survival, population growth te, and selection for phenotypic traits (Seber and Schwarz 2002), but behavioral variability arising from geneity, variability in developmental lev vic plasticity can lead to differ dore laite ture within norsala

al Marine Fisheries Sec (NMFS) has estimated a 55-100% probability cular stock groups over the FS 2000). These low popuon levels, and the high risk of extinction, led ared Species Act listing of 13

Received August 17, 2000; accepted July 19, 2001

mificant units (ESUs) in the Co a (Myers et al. 1998). The decline in iver Basin salmon and steelhead is the result of a combination of factors. est, habitat degradation, hydroelec * Conveponding author: phawles budy@em ura.edu

Post-Bonneville SARs



Number of Bypasses

- 2 - 3 - 4+

* = Significant Cumulative Bypass Effect

= Significant Bonneville Dam Arrival Date Effect

Bonneville Dam Juvenile Arrival Date

Post-Bonneville SARs



Number of Bypasses

2

4+

F = Significant Cumulative
Bypass Effect

= Significant Bonneville Dam Arrival Date Effect

Hatchery Steelhead

- Consistent "-" Bypass/SAR
- 3 significant Bypass effects
- 3 significant "-" Arrival/SAR

Overall Conclusions

Bypass systems delay fish

and the state of t

Reducing bypass exposure should increase SARs

 There's other metrics related to bypass systems than concrete survival