Upstream migration in the Columbia River Basin: Lessons learned from two decades of adult salmon and steelhead radiotelemetry projects



Matthew Keefer¹, Charles Boggs¹, Chris Caudill¹, Brian Burke², Tami Clabough¹, Travis Dick¹, Kinsey Frick², Mike Jepson¹, Dan Joosten¹, Steve Lee¹, George Naughton¹, & Chris Peery³

¹ Department of Fish and Wildlife Sciences University of Idaho





² Northwest Fisheries Science Center

³ US Fish & Wildlife Service



Acknowledgments



State of

& Wild

P.U.D









University of Idaho College of Natural Resources

Presentation objectives

- 1) Introduce the Columbia River adult salmon and steelhead project
- 2) Examples of research questions and results
 Gross simplifications of complex animal behavior





Anadromous Fish Evaluation Program (AFEP): Adult studies





Adaptive Management

"Piggyback Science" opportunity



Hendy Mp



Anadromous Fish Evaluation Program (AFEP): Adult studies



downstream passage



En route & prespawn mortality





Reach & migration survival, harvest



Fishway modifications



Methods: fish collection







Methods: sample summary

- 1996-2014: **26,876** radio-tagged adults
 - 11,505 spring-summer Chinook salmon
 - 7,856 summer steelhead
 - 6,139 fall Chinook salmon
 - 1,376 sockeye salmon









Intragastric radio tagging

Methods: Monitoring / Study area

- ~180 antenna sites / year
- Tailraces, fishways at ~8-10 dams
- Most major tributaries



- Including Snake & Upper Columbia river sites



Examples of study questions & results



Fishway & dam passage

• Do adults successfully pass dams?



Columbia & Snake River Dam fishways effectively pass *most* adult salmonids





University of Idaho

College of Natural Resources

Fishways & dam passage

• The Dalles Dam passage efficiency



Fishways & dam passage

Do dams 'delay' upstream migration?



Most adults pass dams quickly (Medians ≤ 1 day), *but* times are highly variable & many fish must pass 8-9 dams Many salmon pass through reservoirs at speeds of 50-75 km/d, likely offsetting some 'delay' at dams

Slow dam passage in adult Columbia River salmonids associated with unsuccessful migration: delayed negative effects of passage obstacles or condition-dependent mortality?

Christopher C. Caudill, William R. Daigle, Matthew L. Keefer, Charles T. Boggs, Michael A. Jepson, Brian J. Burke, Richard W. Zabel, Theodore C. Bjornn, and Christopher A. Peery

CJFAS 64:979-995 (2007)

Transactions of the American Fisheries Society 133:1413-1439, 2004 © Copyright by the American Fisheries Society 2004

Hydrosystem, Dam, and Reservoir Passage Rates of Adult Chinook Salmon and Steelhead in the Columbia and Snake Rivers

Matthew L. Keefer,* Christopher A. Peery, Theodore C. Bjornn,¹ and Michael A. Jepson

Idaho Cooperative Fish and Wildlife Research Unit, Biological Resources Division, U.S. Geological Survey, University of Idaho, Moscow, Idaho 83844-1141, USA

Lowell C. Stuehrenberg²

Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington 98112-2097, USA

• How many survive to potential spawning sites?



Escapement, harvest, and unknown loss of radiotagged adult salmonids in the Columbia River – Snake River hydrosystem CJFAS 62:930-949 (2005)

Matthew L. Keefer, Christopher A. Peery, William R. Daigle, Michael A. Jepson, Steven R. Lee, Charles T. Boggs, Kenneth R. Tolotti, and Brian J. Burke



• What affects migration survival?



Late-season mortality during migration of radio-tagged adult sockeye salmon (*Oncorhynchus nerka*) in the Columbia River

George P. Naughton, Christopher C. Caudill, Matthew L. Keefer, Theodore C. Bjornn, Lowell C. Stuehrenberg, and Christopher A. Peery



Substantially reduced survival for some stocks exposed to warm water temperatures



• What affects migration survival?



Friday, July 31, 2015

250,000-400,000

Sockeye mortalities

University of Idaho College of Natural Resources

• What affects migration success?



Ecological Applications, 18(8), 2008, pp. 1888-1900 © 2008 by the Ecological Society of America

TRANSPORTING JUVENILE SALMONIDS AROUND DAMS IMPAIRS ADULT MIGRATION

MATTHEW L. KEEFER,¹ CHRISTOPHER C. CAUDILL, CHRISTOPHER A. PEERY, AND STEVEN R. LEE



Barged fish had reduced survival to the Snake River (~ 10%)

Barging impairs adult orientation: - Increased fallback at dams - Increased permanent straying



Rev Fish Biol Fisheries (2014) 24:333-368 DOI 10.1007/s11160-013-9334-6

REVIEWS

Homing and straying by anadromous salmonids: a review of mechanisms and rates

Matthew L. Keefer · Christopher C. Caudill

Downstream fallback



Transactions of the American Fisheries Society 133:932-949, 2004 © Copyright by the American Fisheries Society 2004

Fallback, Reascension, and Adjusted Fishway Escapement Estimates for Adult Chinook Salmon and Steelhead at Columbia and Snake River Dams

C. T. Boggs,* M. L. Keefer, C. A. Peery, and T. C. Bjornn¹

Idaho Cooperative Fish and Wildlife Research Unit, Biological Resources Division, U.S. Geological Survey, University of Idaho, Moscow, Idaho 83844-1144, USA

L. C. STUEHRENBERG²

Northwest Fisheries Science Center, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, Washington 98112, USA

Volitional and non-volitional fallback is common: 15-21% of each run

Results in reduced survival (1-4% impact) for each run

Key challenge: minimize fallback risks while providing safe routes for 'overshoot' fish and kelts

Journal of Fish Biology (2006) 68, 944–950 doi:10.1111/j.1095-8649.2006.00958.x, available online at http://www.blackwell-synergy.com

Long-distance downstream movements by homing adult chinook salmon

M. L. KEEFER*, C. A. PEERY AND C. C. CAUDILL



Archival tags: temperature & depth



Pinniped predation

- How do predators affect salmon behavior, survival?
- Does impact vary among ESA-listed populations?





Influence of pinniped-caused injuries on the survival of adult Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*) in the Columbia River basin

George P. Naughton, Matthew L. Keefer, Tami S. Clabough, Michael A. Jepson, Steven R. Lee, Christopher A. Peery, and Christopher C. Caudill

CJFAS 68:1615-1624 (2011)



Transactions of the American Fisheries Society 141:1236–1251, 2012 © American Fisheries Society 2012 ISSN: 0002-8487 print / 1548-8659 online DOI: 10.1080/00028487.2012.688918

ARTICLE

Use of Radiotelemetry and Direct Observations to Evaluate Sea Lion Predation on Adult Pacific Salmonids at Bonneville Dam

Matthew L. Keefer* Department of Fish and Wildlife Sciences, University of Idaho, 975 6th Street, Moscow, Idaho 83844-1136, USA

Robert J. Stansell U.S. Army Corps of Engineers, Fisheries Field Unit, Post Office Box 150, Cascade Locks, Oregon 97014, USA

Sean C. Tackley U.S. Army Corps of Engineers, Portland District, Environmental Resources Branch, Post Office Box 2946, Portland, Oregon 97208, USA

William T. Nagy and Karrie M. Gibbons U.S. Army Corps of Engineers, Fisheries Field Unit, Post Office Box 150, Cascade Locks, Oregon 97014, USA

Christopher A. Peery U.S. Fish and Wildlife Service, Idaho Fishery Resource Office, 276 Dworshak Complex Drive, Ahsahka, Idaho 83520, USA

Christopher C. Caudill

Department of Fish and Wildlife Sciences, University of Idaho, 975 6th Street, Moscow, Idaho 83844-1136, USA

Pinniped predation



Inter-population variability





Transactions of the American Fisheries Society 137:1120–1133, 2008 © Copyright by the American Fisheries Society 2008 DOI: 10.1577/107-008.1

> Migration Timing of Columbia River Spring Chinook Salmon: Effects of Temperature, River Discharge, and Ocean Environment

MATTHEW L. KEEFER,* CHRISTOPHER A. PEERY, AND CHRISTOPHER C. CAUDILL

River & Ocean environment predictably influence run timing

Population timing sequences are stable within species & within life history types

Inter-population variability



Behavioral thermoregulation and associated mortality trade-offs in migrating adult steelhead (Oncorhynchus mykiss): variability among sympatric populations

CJFAS 66:1734-1747 (2009)

'Late' steelhead far more likely to overwinter in Hydrosystem reservoirs

Matthew L. Keefer, Christopher A. Peery, and Brett High

Warm-water exposure & thermoregulation vary widely among steelhead populations

North American Journal of Fisheries Management 28:81-96, 2008 © Copyright by the American Fisheries Society 2008 DOI: 10.1577/M07-011.1

[Article]

Overwintering Distribution, Behavior, and Survival of Adult Summer Steelhead: Variability among **Columbia River Populations**

MATTHEW L. KEEFER,* CHARLES T. BOGGS, CHRISTOPHER A. PEERY, AND CHRISTOPHER C. CAUDILL

Looking ahead...

- Continue adaptive management, advisory role
- Data synthesis
 - Prioritizing adult passage and survival issues
 - 'Post-reactionary' summaries
 - Maximize the value of this remarkable dataset!



